

Postsecondary Peer Cooperative Learning Programs: Annotated Bibliography 2019



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Postsecondary Peer Cooperative Learning Program Annotated Bibliography

Compiler/Editor, David R. Arendale, University of Minnesota

Peer collaborative learning has been popular in education for decades. As both pedagogy and learning strategy, it has been frequently adopted and adapted for a wide range of academic content areas at the elementary, secondary, and postsecondary levels due to its benefits. The professional literature is filled with reports of individual professors integrating this approach into postsecondary classrooms in diverse ways. Increased attention has been placed on this practice due to claims that carefully implementing learning programs with specific protocols can increase student persistence rates towards graduation, supporting both student goal aspirations as well as bolstering institutional revenues. Much of the narrative from this overview to the bibliography is drawn from my previously published article on peer cooperative learning groups (Arendale, 2004).

This annotated bibliography does not attempt to be inclusive of this broad field of literature concerning peer collaborative learning. Instead, it is focused intentionally on a subset of the educational practice that shares a common focus with increasing student persistence towards graduation. At the end of this overview, several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them.

The seven student peer learning programs included in this bibliography meet the following characteristics: (a) implemented at the postsecondary or tertiary level; (b) clear set of systematic procedures for its implementation that could be replicated by another institution; (c) program evaluation studies have been conducted and are available for review; (d) intentionally embeds learning strategy practice along with review of the academic content material; (e) outcomes include increased content knowledge, higher final course grades, higher pass rates, and higher college persistence rates; and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature, six programs emerged: (a) **Accelerated Learning Groups** (ALGs), (b) **Emerging Scholars Program** (ESP), (c) **Peer Assisted Learning** (PAL), (d) **Peer-Led Team Learning** (PLTL), (e) **Structured Learning Assistance** (SLA), (f) **Supplemental Instruction** (SI), and (g) **Video-based Supplemental Instruction** (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

When possible, original text from the author's document overview or summary paragraphs were used in this annotated bibliography. Frequently when peer collaborative programs are adopted for use outside the institution or country of origin, it is often contextualized for the educational system and needs of each individual setting. Nearly one fourth of the entries in this database are from authors and researchers outside of the United States. Sometimes particular program are renamed. For example, while the Supplemental Instruction Program is the common term used in the United States, in other countries it is sometimes called PASS (*Peer Assisted Study Sessions*)

or PALS (*Peer Assisted Learning Sessions*). The Emerging Scholars Program sometimes operates under different names as well. Examples include Treisman Workshop Program and the Gateway Science Program. If the reader of this document is aware of a publication related to one of the peer collaborative learning programs that has not been included or have corrections to the annotations, please contact the compiler/editor by e-mail (arendale@umn.edu).

Collaborative Learning, Cooperative Learning & Learning Communities

A review of the professional literature finds that the terms collaborative learning, cooperative learning, and learning communities are often used interchangeably with one another. Although they share similarities with one another, a more precise differentiation is needed to help explore the area and the utility of each for its intended educational outcomes (Cooper, Robinson, & Ball, 2003). Regarding their historical development and appearance within the professional literature in the United States, collaborative learning appeared first, cooperative learning second, and learning communities last. A search of the ERIC Database (March 13, 2016) found more than 21,000 entries regarding descriptive and research studies that contained one or more of these three terms indexed within their documents.

Collaborative learning refers to a wide range of formal and informal activities that include any form of peer student interaction. This is the broadest and most general of the three terms. This term describe any classroom activity by an instructor that involves student peer-to-peer involvement. Cooperative learning is more narrowly defined as a subset of collaborative learning. It often follows these principles: (a) positive interdependence is established in the group through adoption of different roles that support the group moving to complete a goal, (b) peers interact with one another, (c) activities are structured to establish individual accountability and personal responsibility, (d) development of interpersonal and small group skills, and (e) group processing of small group activities through verification of information accuracy (Cuseo, 2002; Johnson, Johnson, Holubec, & Roy, 1984).

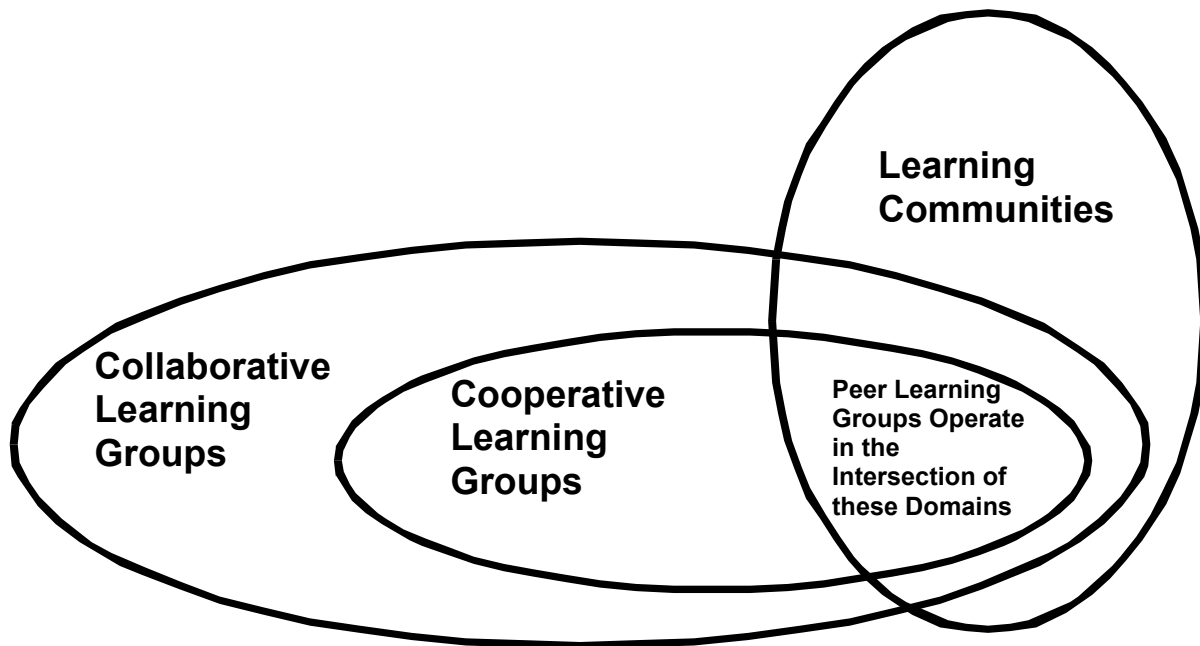
Collaborative and cooperative learning groups, learning communities are distinguished by their focus on interactive peer learning. Learning communities often focus on enhanced curricular and pedagogical outcomes. In addition to often employing some version of student interactive learning, learning communities take several approaches to modifying the classroom experience by restructuring the curriculum. Some of the ways that courses may be modified is through linked courses, learning clusters, freshman interest groups, federated learning communities, and coordinated studies (Gabelnick, MacGregor, Matthews, & Smith, 1990).

A way to understand the relationships among these three terms is through a Venn visual diagram, most often used in mathematics. Collaborative learning is considered the largest construct, both due to its general definition as well as its numerical ranking as most frequently cited in professional literature (ERIC, 2004). A smaller construct lies within collaborative learning. This is cooperative learning. While it holds to the same goals of collaborative learning, it is much more specific in its implementation and following of specified protocols for its use. A related term to both collaborative and cooperative learning is that of learning communities. While learning

communities often utilize some peer collaborative or peer cooperative learning activities as part of its pedagogy, it is generally focused more on curricular transformation. However, it is possible to implement some aspects of learning communities without extensive use of either collaborative or cooperative learning since the focus may be more on team teaching by instructors and the integration of academic content material (i.e., cluster course that merges the content of an introduction to science with an ethics course) rather than extensive use of student peer interactive learning activities.

Relationship among Selected Learning Pedagogies

In this bibliography, the focus is with postsecondary peer cooperative learning programs that embed learning strategies practice within review of the academic content



material and which meet the other selection criteria previously mentioned. This is an important topic in the field of developmental education and learning assistance in particular and with postsecondary education in general. This is due to the need by institutions to both meet the needs of a more diverse entering student body while maintaining or increasing academic rigor (Bastedo & Gumpert, 2003). The institution must make systemic changes in the educational environment that will increase the academic success and persistence rates of all students to meet the expectations of stakeholders such as parents, legislators, and funding agencies. Although the number of academically underprepared students is increasing, historic delivery systems of academic development for students such as remedial and developmental courses are being reduced or eliminated by some states (Barefoot, 2003; Damashek, 1999; Parsad & Lewis, 2003). Many institutions have already adopted one or more of the six programs described in this chapter. The need for such approaches may increase due to the

demands to meet the needs of access to an increasingly diverse student body without the traditional approaches offered by developmental education in the past.

Seven Major Postsecondary Peer Cooperative Learning Programs

Six postsecondary peer collaborative learning programs were selected for inclusion in this chapter based on the criteria mentioned earlier in the narrative: (a) **Accelerated Learning Groups** (ALGs), (b) **Emerging Scholars Program** (ESP), (c) **Peer Assisted Learning** (PAL), (d) **Peer-Led Team Learning** (PLTL), (e) **Structured Learning Assistance** (SLA), (f) **Supplemental Instruction** (SI), and (g) **Video-based Supplemental Instruction** (VSI). These programs have been divided into two groups.

The first group are those that provide adjunct support through outside-of-class activities with little change by the primary course instructor. A dominant program in this category is SI. In recent years, another program was developed to address limitations of the SI model: SLA. ALGs were added to augment the impact of SI through addition of a learning specialist to work with individual students with particular needs. The second group of peer cooperative programs share a common characteristic of a transformed classroom learning environment by all enrolled students. Major changes have been made by the primary course instructor through either integration of the peer learning model into the basic course delivery or heavy involvement by the instructor with the peer learning activities. The first of these programs is ESP, developed at approximately the same time as SI in the 1970s. In the 1990s, two programs were created with similar purposes and protocols to ESP: PLTL and VSI. ESP was added in the early 2000s that merged features from ESP, PLTL, and SI. Most of these seven programs cite in their literature reviews references concerning the other peer learning programs as it appears that each have been an incremental improvement upon previous peer learning models.

Categorization, Relationship, and Historical Development of Peer Cooperative Learning Programs

Adjunct to the Course	Embedded Within the Course
Accelerated Learning Groups	1. Emerging Scholars Program
Structured Learning Assistance	2. Peer Assited Learning
Supplemental Instruction	3. Peer-Led Team Learning
	3. Video-based Supplemental Instruction

Selecting the Cooperative Learning Model for Institutional Needs

To display the relationship between the seven identified peer cooperative learning programs and learning assistance programs in general, it would be helpful to compare them with Keimig’s (1983) Hierarchy of Learning Improvement Programs. In the Hierarchy of Learning Improvement Programs, four basic program types are described and ranked, differentiated by the extent by which they are comprehensive in response to the various needs of students and institutionalized into the academic mainstream. Level 1: Isolated courses in remedial skills. Level II: Learning assistance to individual students. Level III: Provides course-related supplementary learning activities

outside the class for some objectives. Level IV: Comprehensive learning system in the course.

Using Keimig’s hierarchy it is possible to arrange the six peer cooperative programs into the following figure. According to Keimig, the highest level of student outcomes occurs when a comprehensive learning system is integrated throughout the course learning experience. This requires a transformative experience by the institution due to: (a) heavy involvement of the course professor with curriculum development; (b) training, monitoring, and supervision of peer group facilitators; (c) alignment of educational objectives among all course components; (d) changes in institutional and course policies and expectations; (e) release time for professors to complete essential tasks; and (f) stable, long-term institutional funding since outside grants are difficult to obtain or maintain. ESP, PAL, PLTL, and VSI fit into this fourth level category. While these programs have a higher likelihood of improved student outcomes, they are also the most demanding of institutional resources and changes in the campus environment.

The next level of programs, according to Keimig, are those adjunct to the course and provide support for it through either voluntary or required participation. ALGs, SLA, and SI are placed into this group. The expectancy for results, based on Keimig’s model, is not as high as for the level four comprehensive programs as described in the previous paragraph. Nevertheless, ALG, SLA, and SI are predicted to yield higher student outcomes than either individual assistance to students such as tutoring or enrollment in remedial courses. This third category is less expensive and less labor intensive to implement, but may yield lower desired student outcomes.

Placing Postsecondary Peer Cooperative Learning Programs Within Keimig’s Hierarchy of Learning Improvement Programs

Levels of Integration	Peer Cooperative Learning Programs	Likelihood of Improved Student Outcomes
Level Four: Comprehensive learning system in the course	ESP, PAL, PLTL, and VSI	High
Level Three: Course-related supplementary learning activities	ALG, SI, and SLA	Above average
Level Two: Learning assistance to individual students	Tutoring	Below average
Level One: Isolated courses in remedial skills		Low

Higher levels of institutionalization of peer learning programs require high levels of funding and support from administration and faculty members. This investment may pay high dividends. The future political and economic environment may be supportive for these types of programs for supporting higher student persistence rates in comparison with traditional remedial or developmental education courses which are under considerable pressure for curtailment as described earlier in this chapter. It is recommended that before adoption of any of the six programs, that both a careful

review of the published literature be undertaken as well as personal communication with those successfully operating the programs.

Some of the programs, such as PLTL and SI, offer training workshops in the U.S. and other countries to implement the programs. On site observations can probably be negotiated with any of the six programs. The investment in such telephone and onsite observations will help to reveal the numerous essential elements needs for successful implementation of the specific practice. Often these essential details are not revealed in the published literature which tend to be more focused on statistical studies and not on the detailed implementation protocols. Based on personal experience as a former national training director for one of the seven programs (SI) and teammate to develop another of the programs (PAL), the author of this document recommends careful planning before attempting to implement the programs. While the educational outcomes described in the published literature are replicable, it generally requires careful implementation and constant monitoring to assure continued quality.

Further Research Issues Regarding Peer Cooperative Learning

One of the most perplexing issues facing peer cooperative learning groups is dealing with student motivation and goal orientation. Sometimes the students who could most benefit from the positive effects of peer learning are the ones least likely to participate due to fear of exposing their academic weaknesses to others or even to themselves. Many of these seven programs have dealt with the issue through mandatory attendance at sessions. Although brute force does compel attendance, it does not necessarily follow that students willingly adopt the new academic behaviors and implement them in other courses when not under the dictates of program requirements. Exploring the complexity of student motivation is being carefully studied among elementary and secondary education student populations. However this important construct is often ignored in the study of postsecondary education in general, and the provision of learning assistance at the college level, in particular.

Creating peer cooperative learning programs that provide both structure and an environment that encourages students to modify their motivations for learning will require more work by program designers. Too often students have been expected to adopt the expectations and learning conditions of the institution without direct instruction. This literature supports the notion that it is necessary for institutions to implement programs that are more attentive to individual differences among students. Much work has yet to be done.

Overview of the Seven Peer Cooperative Learning Programs

Accelerated Learning Groups (ALGs)

Accelerated Learning Groups (ALGs) were developed at the University of Southern California in Los Angeles in the early 1990s by Dr. Sydney Stansbury. ALGs were designed to meet the needs of students who had significant skill or knowledge deficiencies that often inhibited their effective use of other peer collaborative learning programs such as SI. ALGs combined peer-led small group learning activities, assessment, frequent feedback by a learning skills specialist, and development of an individual education plan (IEP) for each student. ALG students were concurrently

enrolled in a challenging entry level course while they developed the necessary skills and knowledge prescribed by the IEP. The ALG students were placed into a triad with another student with similar IEP objectives and a peer leader who worked intensely with the students under the supervision of a learning skills specialist. Participation in ALGs continued in the academic term until the learning skills specialist deemed it appropriate to transition into another peer development program such as SI or individual tutoring. The developer of the ALG model, Dr. Sydney Stansbury, can be contacted via email at sydbury@yahoo.com

Emerging Scholars Program (ESP)

Developed by Dr. Uri Treisman in 1977, this multi-ethnic honors-level program originated as the *Mathematics Workshop of the Professional Development Program* at the University of California at Berkeley. It is widely disseminated across the United States as a part of first-year courses in academic departments (EXAMPLES: mathematics, physics, and chemistry) and as an academic workshop component of numerous Minority Engineering Programs. In studies of ESP in research universities—such as the University of Texas at Austin, the University of Wisconsin at Madison, the University of Kentucky (Lexington), Rutgers University, and others—not only do ESP participants score well above the general class average, but two-thirds or more regularly earn an A or B. Common activities include structured workshops of varying difficulty developed in collaboration with the course instructor. The ESP facilitator is often a graduate student due to knowledge needed. Close coordination between ESP program and course instructor. Other components include building a cohort community of first-year students that is academically-oriented and a source of peer support; providing the cohort with an extensive orientation to the college and with ongoing academic advising; advocating the interests of the cohort and monitoring their academic progress and adjustment to the environment; providing the cohort with ongoing supplementary instruction in order to develop independent learning; and linking high school-level and undergraduate-level affirmative action efforts. The program is known by various names including *Emerging Scholars Program* (often used in the 1980s), *Gateway Science Workshop Program*, *Mathematics Workshop Model*, *Professional Development Program Mathematics Workshop* (original name), *Math Excel* (University of Kentucky, Lexington), *Excel* (Rutgers State University of New Jersey), *Merit* (University of Illinois at Urbana-Champaign) and the *Treisman Model* (Asera, 2001). Other names for PLTL are reported at the web site, http://merit.illinois.edu/educators_treismanprograms.html

Peer Assisted Learning (PAL)

Peer Assisted Learning (PAL) was developed at the University of Minnesota in 2006 to meet needs of students enrolled in STEM and other historically-difficult courses. The PAL program drew upon best practices from ESP, PLTL, and SI along with emerging learning practices to develop a model to meet high expectations placed upon it by the faculty and administrators. Quantitative and qualitative studies reveal not only academic benefits for participating students, but also academic, vocational, and

personal benefits for the students who serve as the PAL facilitators. Description of the model, <http://www.sciedu.ca/journal/index.php/ijhe/article/view/4151/2498> .

Peer-Led Team Learning (PLTL)

The program was developed at the City University of New York in the 1990s. Support through a grant from the National Science Foundation has assisted in the model being adopted by more than 100 institutions. Student-leaders (peers) guide the activities of small groups of students in weekly Workshop meetings. The students work through challenging problems that are designed to be solved cooperatively. The peer leaders are trained to ensure that the students are actively and productively engaged with the material and with each other. This methodology offers a number of educational opportunities: the supportive format encourages questions and discussions that lead to conceptual understanding; students learn to work in teams and to communicate more effectively; peer leaders learn teaching and group management skills. The following are guiding principles of PLTL: the program is integral to the course through required attendance at two hours of workshop time weekly; peer leaders are trained in group leadership and course content; activities and materials are challenging yet accessible (e.g., worksheets, supplemental workbook); faculty are deeply involved in the program; physical space and environments are conducive to discussion and learning; and the program has strong support from the institution (Roth, Goldstein, & Marcus, 2001). The Peer-Led Team Learning International Society supports practitioners and institutions implementing PLTL, both in the U.S. and internationally. They host an annual conference that rotates around the globe, <http://ptlis.org/>

Structured Learning Assistance (SLA)

SLA was developed at Ferris State University (MI) in the 1994. It is available to all interested students in targeted courses which are historically difficult. SLA features weekly study and practice workshops in which students master course content, develop and apply specific learning strategies for the course, and strengthen their study skills to improve performance in the current SLA course, and for future courses. With some SLA programs, attendance is mandatory for all students until the first exam. With some SLA programs, students earning ABC grades are invited but not required to attend further (Morton, 2006). The SLA homepage is <http://www.ferris.edu/sla/>

Supplemental Instruction (SI)

SI was initially developed for health science students at the University of the Missouri-Kansas City by Dr. Deanna C. Martin and her colleagues in 1973. SI was implemented in historically-difficult courses with permission of the instructor, which commonly serves “gatekeeper” introductory courses that require mastery before advancing in the subject area, invites voluntary participation in out-of-class student-led study sessions, provides extensive training and ongoing coaching of student facilitators of the study groups throughout the academic term, and evaluates outcomes in each course every time it is offered. Based on studies from hundreds of institutions in the U.S. and abroad, participating students earn higher final course grades, demonstrate lower rates of DFWI, and have higher persistence rates. Some studies also show that participation improves personal and professional development outcomes for both the participants and facilitators. Goals of SI include: (1) improve student grades in targeted

courses; (2) reduce the attrition rate within those courses; and (3) increase the eventual graduation rates of students. All students in a targeted course are urged to attend SI sessions, and students with varying ability levels participate. There is no stigma attached to SI since *historically difficult courses* rather than *high risk students* are targeted. SI is scalable and can be implemented in one or more courses each academic term. There are four key persons involved with SI. The first is the *SI supervisor*, a trained professional on the SI staff. The SI supervisor is responsible for identifying the targeted courses, gaining faculty support, selecting and training SI leaders, and monitoring and evaluating the program. Once the historically difficult courses have been identified, the SI supervisor contacts the faculty member concerning SI for their course. The second key person for SI is the *faculty member* who teaches one of the identified courses. SI is only offered in courses in which the faculty member invites and supports SI. Faculty members screen SI leaders for content competency and approve selections. The third key person is the *SI leader*. SI leaders are students or learning center staff members who have been deemed course competent, approved by the course instructor and trained in proactive learning and study strategies. SI leaders attend course lectures, take notes, read all assigned materials, and conduct three to five out-of-class SI sessions a week. The SI leader is the "*model student*," a facilitator who helps students to integrate course content and learning/study strategies. The fourth key member of the SI program are the *participating students*. The original name for SI was *Supplemental Course Instruction (SCI)*. SI is sometimes named *Peer Assisted Learning (PAL)*, *Peer Assisted Study Sessions (PASS)*, *Peer Assisted Study Schemes (PASS)*, or *Peer Assisted Study Support (PASS)*. A few times SI is named *Academic Mentoring*, *Peer Mentoring in Praxis (PMIP)*, *Academic Peer Mentoring Scheme (APM)*, and simply *Peer Mentoring*. Other than use of the capitalized SI name, some of these other names may be used to describe approaches that are different than SI both domestically in the U.S. and globally. The homepage for SI is <https://info.umkc.edu/si/>

Video-based Supplemental Instruction (VSI)

VSI was developed at the University of Missouri-Kansas City by Dr. Deanna Martin during the 1990s. VSI combines course content and Supplemental Instruction (SI) study sessions with video recordings of lectures identical to the instructor's in-person class session. Trained facilitators, using the recorded lectures and the SI model, guide students through the learning process while emphasizing critical thinking and study skills. VSI students, led by a trained facilitator, start and stop the videotaped presentation at pre-determined times and, in addition, whenever they have a question or want clarification. Professors design the video presentations to include periodic small group assignments to insure mastery of one concept before the next is introduced. Students complete these tasks under the supervision and with the guidance of the facilitator. When the taped lecture resumes, the professor models how he/she thinks about the assigned tasks. In this way, the students have time to construct and verify their understanding as well as compare their own thinking to that of the expert. Assessment is provided by the professor, keeping the facilitator in the role as a peer supporter and not an evaluator. The program was originally designed to take the place of developmental-level courses that were prohibited due to an institution mandate. VSI differs from SI in several respects. The students enroll in required, core curriculum

courses. The course professor records all didactic presentations on videotape for use with underprepared students as well as other students who opt for this interactive way of learning. Instead of attending the professor's regular lecture classes, students enroll in the video section of the professor's course. Students in both sections are held to the same performance standards. Specially designed facilitator and student manuals support the video sections.

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Accelerated Learning Groups (ALGs)

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1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online:
<https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for personal use under a Creative Commons license.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Retrieved from <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative,

some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing.

These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Stansbury, S. L. (2001). Accelerated Learning Groups enhance Supplemental Instruction for at-risk students. *Journal of Developmental Education*, 24(3), 20-22, 24, 26, 28, 40.

In order to increase Supplemental Instruction (SI) attendance, Accelerated Learning Groups (ALGs) were developed. A pilot study investigated whether at-risk students who participated in an ALG/SI combination demonstrated higher self-efficacy and SI attendance than those who participated in only SI. Results suggested that at-risk students were more likely to participate in 12 or more SI sessions if they attended an ALG/SI combination than if they attended only SI. In addition, the range of final grades was higher for those who attended an ALG/SI combination than for those who attended only SI. The development of prerequisite skills was essential for the efficacy of SI to serve academically underprepared students may shun the academic intervention that would be of most help to them. Additional research is warranted.

Stansbury, S. L. (2001). *How to turn Supplemental Instruction nonparticipants into participants*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available from the author at Sydbury@Yahoo.com

This study investigated the outcomes of the Supplemental Instruction (SI) model with 215 students enrolled in General Biology and 200 students in General Chemistry at the University of Missouri-Kansas City. A variety of preentry attributes were collected from the students including self-reported grade in a previous course of the same academic sequence, mastery goal orientation, performance-approach goal orientation, performance-avoidance goal orientation, self-efficacy, and interest in group study. While the findings were complex, several general statements include: higher SI attendance was correlated with higher final course grades, academically weaker students were less likely to attend SI sessions, academically weaker students reported higher levels of self-efficacy suggesting that they were less likely to accurately assess their strengths and weaknesses. This may also partly explain why these students were less likely to participate in SI sessions. The author recommends that the course professor administer a content-valid pretest during the first class period to provide feedback to all students and hopefully motivate the low scoring students to attend SI sessions. The paper concludes with an overview of Accelerated Learning Groups (ALGs), an intervention designed by the author at the University of Southern California to increase the academic success of at-risk students. The objective of ALGs is to identify students who have below average prerequisite skills for a course and assist them in strengthening these skills while they attend SI. ALGs were designed to work simultaneously with the campus SI program. Procedures for implementing ALGs is provided with data from a study of the effectiveness of ALGs in a chemistry course.

Stansbury, S. L. (n.d.). *Beyond the Supplemental Instruction summary report*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available from the author at Sydbury@Yahoo.com

This handout was used during training workshops conducted by the SI Director of Research and Training. Going beyond the descriptive statistics that were the baseline reporting system, Dr. Stansbury presents a variety of research methods to study SI more deeply to understand the impact of SI. In particular, the role of prior academic achievement and the frequency of SI attendance were critical to understand whether SI was making a statistically significant difference for the participating students regarding their final course grades.

Zulu, C. (2003). A pilot study of Supplemental Instruction for at-risk students at an Historically Black University (HBU) in South Africa. *Association Internationals de Linguistique Appliqu Review*, 16(1), 52-61.

This article discusses a pilot study during 2002 that sought to evaluate the effectiveness of Supplemental Instruction (SI) at the University of North-West, an historically black university in South Africa. The course under investigation was "Introduction to South African Legal Method and Theory" which first-year law students enrolled. Two questions were investigated: does SI have an effect on students' mastery of content? and does SI have an effect on students' perceptions of their mastery of skills? Three measures were used to evaluate SI: pre and posttests of content knowledge, student perceptions, and final course grades. There was a correlation of higher SI attendance and higher final course grades. The study also revealed barriers and challenges that students experience at the institution. SI was most effective for students who were better prepared academically and for whom English was their first language. These students had more capacity to engage in the SI sessions and gain the most benefit. The author also noted the disadvantage of voluntary SI attendance. Often the students who most needed to be there chose not to attend due to self-reported reluctance to expose their weakness and discomfort due to lacking the skills of the most prepared students. The author recommends that SI attendance be made compulsory and that SI be combined with other academic interventions such as Accelerated Learning Groups developed by Dr. Sydney Stansbury.

Emerging Scholars Program (ESP)

Developed by Dr. Uri Treisman in 1977, this multi-ethnic honors-level program originated as the *Mathematics Workshop of the Professional Development Program* at the University of California at Berkeley. It is widely disseminated across the United States as a part of first-year courses in academic departments (EXAMPLES: mathematics, physics, and chemistry) and as an academic workshop component of numerous Minority Engineering Programs. In studies of ESP in research universities—such as the University of Texas at Austin, the University of Wisconsin at Madison, the University of Kentucky (Lexington), Rutgers University, and others—not only do ESP participants score well above the general class average, but two-thirds or more regularly earn an A or B. Common activities include structured workshops of varying difficulty developed in collaboration with the course instructor. The ESP facilitator is often a graduate student due to knowledge needed. Close coordination between ESP program and course instructor. Other components include building a cohort community of first-year students that is academically-oriented and a source of peer support; providing the cohort with an extensive orientation to the college and with ongoing academic advising; advocating the interests of the cohort and monitoring their academic progress and adjustment to the environment; providing the cohort with ongoing supplementary instruction in order to develop independent learning; and linking high school-level and undergraduate-level affirmative action efforts. The program is known by various names including *Emerging Scholars Program* (often used in the 1980s), *Gateway Science Workshop Program*, *Mathematics Workshop Model*, *Professional Development Program Mathematics Workshop* (original name), *Math Excel* (University of Kentucky, Lexington), *Excel* (Rutgers State University of New Jersey), *Merit* (University of Illinois at Urbana-Champaign) and the *Treisman Model* (Asera, 2001). Other names for PLTL are reported at the web site, http://merit.illinois.edu/educators_treismanprograms.html

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online: <https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

Adams, G. M., & Lisy, J. M. (2007). The Chemistry Merit Program: Reaching, teaching, and retaining students in the chemical sciences. *Journal of Chemical Education*, 84(4), 721-726. This article describes the Chemistry Merit Program at the University of Illinois at Urbana-Champaign. The program was created to support historically underrepresented students achieve success in chemistry. Long-term and short-term successes of the program are highlighted.

Alexander, B. B., Burda, A. C., & Millar, S. B. (1997). A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an Emerging Scholars

Program. *Journal of Women and Minorities in Science and Engineering*, 3(3), 145-159. Available online: ERIC database. (ED408180).

This document contains the final evaluation of the Wisconsin Emerging Scholars Program (ESP) for the year 1993-94. The evaluation report includes an executive summary, a discussion of the parameters of the evaluation including research questions and methods, implementation processes and outcomes for faculty and administrators, student learning processes and outcomes including those indicated by both qualitative and quantitative data; conclusions related to the use of the ESP program; and recommendations related to pedagogical issues, out-of-class issues, and implementation issues. Critical factors for ESP success included the student small group work, the careful construction of the problem worksheets, and the involvement of the faculty members.

Arendale, D., R. (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>
This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing.

These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*.

Department of Curriculum and Instruction, University of Minnesota. Available online:

<https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational,

something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Asera, R. (1988). *The mathematics workshop: A description*. Unpublished manuscript. This report describes the Mathematics Workshop, also known as the Emerging Scholars Program (ESP). The paper describes the history of the program, the students targeted for participation, the types of activities that occur inside the ESP sessions, samples of the workshop problem sets, and some student perceptions of its benefit.

Asera, R. (1998). Supporting student persistence. *Black Issues in Higher Education*, 15(10), 104.

This article provides a short overview of the Emerging Scholars Program (ESP).

Asera, R. (2001). Calculus and community: A history of the Emerging Scholars Program of Work. of Work. Department. College Board National Task Force on Minority High Achievement. New York, NY. Available online <https://files.eric.ed.gov/fulltext/ED562582.pdf>

This multi-ethnic honors-level program originated in 1977 as the Mathematics Workshop of the Professional Development Program at the University of California at Berkeley. It is now widely disseminated across the United States as a part of freshman courses in academic departments (mathematics, physics, chemistry, etc.) and as an academic workshop component of numerous Minority Engineering Programs. In studies of Emerging Scholars Programs in public research universities—such as the University of Texas at Austin, the University of Wisconsin at Madison, the University of Kentucky (Lexington), Rutgers University, and others—not only do ESP participants score well above the general class average, but two-thirds or more regularly earn an A or B.

Beier, M. E., Saterbak, A., McSpedon, M., & Wolf, M. (2017). *Board # 132 : Selection Process of Students for a Novel STEM Summer Bridge Program*. Conference Proceedings of the 2017 ASEE Annual Conference & Exposition, Columbus, OH.

This NSF Grantee Poster explores the selection process for Rice University's Emerging Scholar Program (RESP). Developed in June 2012, RESP is a comprehensive summer bridge and term-time advising program aimed at increasing STEM retention, graduation, and achievement in promising students who attended under-resourced high schools. RESP is not a remedial program, nor even an 'early college course' program. Rather, RESP aims to target deficits in K-12 preparation that may create undue obstructions for the program's participants (named Scholars in the program and this paper) compared to their peers. The objective of the non-credit summer bridge portion of the program is to prepare Scholars for the pace, rigor, and depth of the STEM curriculum at Rice University. This is achieved through exposure to the most challenging portions of freshman calculus, chemistry, and physics with special focus on complex word problems. During subsequent years, Scholars receive intensive and intrusive term-time advising from staff devoted to the program. RESP Scholars are admitted to Rice through the regular admissions process. After accepting a spot in the entering class, these students are

invited to attend the bridge program in the summer before their freshman year. Scholar admittance occurs independent of consideration for, or participation in, RESP. Scholars are selected through partnerships with Rice's Office of Admissions and other groups on campus. RESP partners with the Office of Admissions to review student admission information including SAT/ACT test scores, SAT subject test scores, first-generation status, academic ambitions and high school competitiveness ranking. A separate principal selection mechanism for RESP is a novel diagnostic exam created in conjunction with the Schools of Natural Sciences and Engineering. The 11-question exam covers conceptual knowledge and tests skills in mathematics, chemistry, and physics with quantitative word problems that students are expected to know prior to arrival at Rice University. By focusing on applied problems and conceptual knowledge, the exam demonstrates a student's academic preparation, not their intellectual ability. The current study examines the validity of the RESP diagnostic exam and its predictive validity relative to standardized tests with a sample of students (N = 976) who matriculated into Rice University from 2012 to 2014. The RESP diagnostic exam was related to grades, and we found that the correlation between the RESP diagnostic exam and grades was greater for STEM grades than non-STEM grades. We found that the diagnostic exam accounted for an incremental 9% of variance in STEM grades above SAT performance, but only 1% of incremental variance above SAT in non-STEM grades. Moreover, we found evidence of range restriction for both SAT and RESP diagnostic exam performance for Rice University matriculants, further suggesting the utility of the diagnostic exam is at the lower end of the distribution. In summary, our results suggest that an additional diagnostic exam written by schools to specifically measure STEM preparation for their program can be a useful addition to procedures for selecting students for special experiences such as summer bridge programs.

Bonsangue, M. V. (1990). *Long-term effects of the Calculus Workshop model*. Unpublished manuscript. California State University, Fullerton. Fullerton, CA.

This report describes the Calculus Workshop Model, also known as the Emerging Scholars Program (ESP), and displays several research studies conducted concerning a set of research questions. The three questions were: are there effects on academic performance past the first year of college when ESP was available? Does the ESP program merely "skim" the best students or does program participation affect achievement in the course? Are the types of academic and social issues addressed by the ESP program relevant only for underrepresented minority students, or for non-majority students as well? After providing a program description and theoretical underpinning to the model, the paper presents several research studies focused on the previously described research questions. The students in the study were minority and non-minority students enrolled in a first-year calculus course and also were a mathematics-based major at the College of Engineering or the College of Science at California Polytechnic State University, Pomona (also known as Cal Poly). In comparison between ESP and non-ESP participating students, the ESP students earned higher mean grades in first-quarter Calculus, higher rate of persistence in a math/science/engineering major in college, higher mean grade in first two years of Calculus, and lower course attempt ratio in first-year Calculus (lower withdrawal and subsequent reenrollment). The data suggested that self-selection into the program was not a major variable in explaining the positive differences for the ESP participations. In addition, the data suggested the effectiveness of the ESP model for improving academic achievement of female students who are underrepresented in the area of math/science/engineering.

Bonsangue, M. V. (1993). The effects of calculus workshop groups on minority achievement and persistence in mathematics, science, and engineering. *Cooperative Learning and College Teaching Newsletter*, 3(3), 8-9.

This report describes the Academic Excellence Workshop Program, also known as the Emerging Scholars Program (ESP) at California Polytechnic State University (Cal Poly), Pomona. This article presents a short summary of a research study investigated four questions: What effect did the workshop have on achievement and persistence of workshop students in first quarter calculus? What effect did the workshop have on achievement and persistence of workshop students in subsequent calculus courses? What effect did the workshop have on achievement and persistence of workshop students within their mathematics-based majors? What socio-academic effects did the workshop experience have as defined and interpreted by workshop students? The students in the study were minority and non-minority students enrolled in a first-year calculus course and also were a mathematics-based major. In comparison between workshop and non-workshop participating students, the workshop students earned higher mean grades in first-quarter Calculus, higher rate of persistence in a math/science/engineering major in college, higher mean grade in first two years of Calculus, and lower course attempt ratio in first-year Calculus (lower withdrawal and subsequent reenrollment). The data suggested that self-selection into the program was not a major variable in explaining the positive differences for the workshop participants. In addition, the data suggested the cost effectiveness of the workshop model by demonstrating the cost savings through lower numbers of students reenrolling in first-year calculus courses due to their initial academic success and progression through their required math course sequence.

Bonsangue, M. V. (1993). The effects of calculus workshop groups on minority achievement and persistence in mathematics, science, and engineering [Dissertation, The Claremont Graduate University, 1992]. *Dissertation Abstracts International*, 53(09), 3132.

The following is a dissertation study from The Claremont Graduate University. Among the most successful academic intervention programs has been the calculus workshop model developed for African-American students at the University of California, Berkeley, by Uri Treisman. The present research represents the first longitudinal investigation of the effects of workshop participation upon persistence and achievement of underrepresented minority students enrolled in mathematics, science, and engineering majors. Based on the Academic Excellence Workshop Program at California Polytechnic State University, Pomona, 133 workshop and 187 non-workshop minority students, including 86 % of Latino ethnicity, were individually tracked throughout their academic careers over a period of five years. There were no statistically significant differences between workshop and non-workshop groups in pre-college academic measures, including SATV, SATM, HSGPA, and precalculus diagnostic test, suggesting no initial academic advantage by either group. Multiple linear path analysis was used to estimate the effects of workshop participation upon achievement and persistence. Within three years after entering the institution, forty percent of the non-workshop students had withdrawn or been academically dismissed from the institution, compared to five percent of the workshop students. Non-workshop students required an average of one full quarter more to complete their three-quarter calculus sequence due to course failure or withdrawal. Ninety-one percent of the workshop students still enrolled in mathematics, science, and engineering majors after three years had completed their mathematics requirement, compared to fifty-eight percent of the non-workshop students. Interviews with former workshop students indicated that participation in the workshop sessions was of critical importance in adapting to and attaining the level of performance required in their technical courses, as well as building peer communities within their subsequent upper-division courses. Moreover, University fiscal data indicated that the cost of the calculus workshop program was less than the institutional or state costs of course-repeating for the non-workshop students. This study demonstrates that an intervention program promoting academic excellence and peer interaction in academic contexts can directly affect student performance in technical majors independently of pre-intervention cognitive factors. The data strongly suggest that achievement among underrepresented minority students in

mathematics, science, and engineering disciplines may be less associated with pre-college ability than with in-college academic experiences and expectations.

Bonsangue, M. V. (1994). An efficacy study of the calculus workshop model. In E. Dubinsky, A. H. Schoenfeld & J. Kaput (Eds.), *Research in collegiate mathematics education I* (pp. 117-137). Providence, RI: American Mathematical Society

This chapter provides an in depth investigation of the Emerging Scholars Program (ESP). Three questions were studied: are there effects on academic performance of students beyond the first year when they are ESP participants; does the ESP program only enroll the best students who would have done well academically; and are the academic and social issues dealt with by the ESP approach important not only for the target population of underrepresented students in the sciences, but actually good pedagogy for all students. In addition to the study, a comprehensive literature review, ESP description, and theoretical basis for ESP is provided. While the self-selection bias issue was an intervening variable that had an impact on program effectiveness, it appears that ESP contributed to higher achievement for the participating students. The results were less clear for the impact on future academic terms. A cost-benefit analysis suggested that ESP reduced dropouts and reenrollment in courses due to poor marks. Both results contributed to lower costs to the institution and made the program cost neutral if not a cost saver.

Bonsangue, M. V., & Drew, D. E. (1990). *Long-term effects of the Calculus Workshop model*. Unpublished manuscript, California State University, Fullerton.

This report describes the Academic Excellence Workshop Program, also known as the Emerging Scholars Program (ESP) at California Polytechnic State University (Cal Poly), Pohnoma. A research study investigated four questions: What effect did the workshop have on achievement and persistence of workshop students in first quarter calculus? What effect did the workshop have on achievement and persistence of workshop students in subsequent calculus courses? What effect did the workshop have on achievement and persistence of workshop students within their mathematics-based majors? What socio-academic effects did the workshop experience have as defined and interpreted by workshop students? The students in the study were minority and non-minority students enrolled in a first-year calculus course and also were a mathematics-based major. In comparison between workshop and non-workshop participating students, the workshop students earned higher mean grades in first-quarter Calculus, higher rate of persistence in a math/science/engineering major in college, higher mean grade in first two years of Calculus, and lower course attempt ratio in first-year Calculus (lower withdrawal and subsequent reenrollment). The data suggested that self-selection into the program was not a major variable in explaining the positive differences for the workshop participants. In addition, the data suggested the cost effectiveness of the workshop model by demonstrating the cost savings through lower numbers of students reenrolling in first-year calculus courses due to their initial academic success and progression through their required math course sequence.

Bonsangue, M. V., & Drew, D. E. (1995). Increasing minority students' success in calculus. In J. Gainen & E. W. Willemsen (Eds.), *Increasing student success in quantitative gateway courses*, (pp. 23-33). New Direction for Teaching and Learning, No. 61. San Francisco: Jossey-Bass

The Emerging Scholars Program (ESP), called the Academic Excellence Workshop at California State Polytechnic University-Pohnoma, has supported higher academic outcomes in academic achievement and persistence for nontraditional students in science, math, and engineering majors. The study focused on students enrolled in college calculus which serves as a gatekeeper course for these majors. Higher outcomes were reported for women and Latinos

who participated in the program. Procedures for conducting the ESP are also shared. An analysis of the cost effectiveness of the program is documented.

Born, W. K. (2001). The effect of workshop groups on achievement goals and performance in biology: An outcome evaluation [Dissertation, Northwestern University, 2000]. *Dissertation Abstracts International*, 61(11), 6184.

This two-year quasi-experiment contained in a dissertation study from Northwestern University evaluated the effect of peer-led workshop groups on performance of minority and majority undergraduate biology students in a three-course series and investigated motivational explanations for performance differences. The workshop intervention used was modeled after a program pioneered by Treisman (1992) at the University of California. Majority volunteers randomly assigned to workshops ($n = 61$) performed between 1/2 and 1 standard deviation better than those assigned to the control group ($n = 60$; $p < .05$) in each quarter without spending more time studying. During Quarter 1, workshop minority students ($n = 25$) showed a pattern of increasing exam performance in comparison to historic control minority students ($n = 21$), who showed a decreasing pattern ($p < .05$). Although sex differences in biology performance were a focus of investigation, none were detected. Motivational predictions derived from the hierarchical model of approach and avoidance achievement motivation (Elliot & Church, 1997) were partially supported. Self-report survey measures of achievement goals, modeled after those used by Elliot and colleagues, were requested from all enrolled students. Volunteers ($n = 121$) reported higher average levels of approach and avoidance goals than nonvolunteers ($n = 439$; $p < .05$) and the relationship of goals to performance was moderated by volunteer status. Performance of volunteers was negatively related to avoidance of failure goals ($r = .41$, $p < .01$) and unrelated to performance approach goals. Performance of nonvolunteers was unrelated to avoidance of failure goals and positively related to performance approach goals ($r = .28$, $p < .01$). Mastery goals were unrelated to performance for all students. Results were inconsistent with Dweck and Leggett's (1988) theory of mastery vs. performance orientation, but were similar to results found by Elliot and colleagues. Contrary to hypotheses, motivational goals did not mediate performance for any group of students. Results suggest that challenge interventions can be highly beneficial for both majority and minority participants and that institutions can promote excellence by incorporating workshop programs like the one described here. These interventions have been shown to be more effective and cost less than remedial interventions.

Born, W. K., Revelle, W., & Pinto, L. H. (2002). Improving biology performance with workshop groups. *Journal of Science Education and Technology*, 11(4), 347-365.

This article describes a two-year quasi-experimental study of the effect of a program similar to Emerging Scholars Program (ESP) on both minority and majority students enrolled in an undergraduate biology course. Outcomes from the study include: participants outperformed their nonparticipant counterparts, interest in biology was increased, and a reduction of anxiety. An extensive review of the professional literature identifies factors that may have a negative impact upon minority students including stereotype threat. Included with the data analysis is an investigation of the potential impact of student motivation for both participation and performance.

Bradford, B., Beier, M. E., Saterbak, A., McSpedon, M., Wolf, M., & Kincaid, K. (2018). *Board 14: Examining First-Year Chemistry Outcomes of Underprepared STEM Students Who Completed a STEM Summer Academic Bridge Program* Paper presented at the 2018 ASEE Annual Conference & Exposition, Salt Lake City, UT.

This NSF S-STEM Grantee poster examines the results of a selective university's summer science, technology, engineering, and mathematics (STEM) bridge program on participants'

introductory chemistry grades in a quasi-experimental design that compared performance of participants in the bridge program, a control group with similar preparation as bridge program participants, and the remaining students in the class. The outcome of interest was first-semester chemistry exam performance. The researchers also examined performance on exam items that directly tested concepts taught in the summer bridge program. The bridge program was designed to prepare matriculating students for core STEM coursework through six weeks of intensive instruction in math, physics, and chemistry. Students are selected for participation in the bridge program based on their SAT scores, AP credits, and scores on a faculty-developed diagnostic exam. Control group participants were also students in the natural science and engineering divisions who qualified for the bridge program but who could not participate for various reasons. The research hypotheses were that 1) bridge program participants would outscore the control group on bridge-taught chemistry exam questions and 2) bridge program participants would also outscore the control group on chemistry questions not taught in the bridge program, due to acquiring a stronger foundation of chemistry overall. The researchers explored but did not hypothesize whether program participants would outperform the rest of the class on either item type. An analysis of chemistry grades, which consisted of three exams and a final, was conducted. Exam topics were divided roughly evenly between questions covering content taught in the bridge program and content not covered. A t-test showed significant differences between the experimental and control groups on exam questions directly taught in the bridge program, such that bridge participants outscored the control group by a large margin ($t(111) = 4.42, p < .001, d = .84$), supporting Hypothesis 1. Further, there was no significant difference between the experimental group and the remaining students' scores on these questions ($t(1018) = 1.30, p = .20$). For the introductory chemistry exam questions that covered content not taught during the program, there was no significant difference between the experimental group and the control group's exam scores ($t(111) = 0.79, p = .43$), providing no support for Hypothesis 2. Furthermore, a planned contrast showed that both groups lagged the rest of the class's performance on these questions ($F(1,1043) = 11.62, p = .001, \eta^2 = .011$). These findings provide insight into the effectiveness of teaching STEM content in bridge programs. The fact that participants successfully retain and apply the content taught during the summer program is promising, especially given that bridge participants' scores on program-taught content were actually brought to a level equal to the rest of the students in the class (who were theoretically better prepared for college coursework). Further research is needed into how to effectively teach participants the skills to use the bridge program content as a foundation for learning other STEM topics and ultimately successfully graduating as a STEM major.

Bressound, D. M. *Attracting and retaining students to complete two- and four-year undergraduate degrees in STEM: The role of undergraduate mathematics education*. Macalester College. St. Paul, MN. Available online: http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_088835.pdf

This report explains the urgency of ESP programs to promote equity and opportunity.

Bressound, D. M., Carlson, M. P., Mesa, V., & Rasmussen, C. (2013). The calculus student: Insights from the Mathematical Association of America national study. *International Journal of Mathematical Education in Science and Technology, 44*(5), 685-699. doi: 10.1080/0020739X.2013.798874.

In fall 2010, the Mathematical Association of America undertook the first large-scale study of postsecondary Calculus I instruction in the United States, employing multiple instruments. This report describes this study, the background of the students who take calculus and changes from the start to the end of the course in student attitudes towards mathematics and intention to continue in mathematics.

Chan, S. L. (2011). *An investigation of the conceptual understanding of continuity and derivatives in calculus of Emerging Scholars versus non-Emerging Scholars Program students*. (Master of Sciences thesis), The University of Texas at Arlington, Arlington, Texas.

The Emerging Scholars Program (ESP) has been adapted at colleges and universities across the nation in efforts to increase student access to Science, Technology, Engineering and Mathematics (STEM) disciplines. This study uses a written assessment to gain insight regarding conceptual knowledge on continuity and derivatives for ESP students versus non-ESP students in the same lecture course in first semester calculus at large urban university in the southwest. We analyze the assessment results of 22 ESP and 48 non-ESP students and discuss findings, particularly, those that indicate statistically significant differences regarding continuity over an interval.

Clubine, B. J. (1993). *An evaluation of the Emerging Scholars Program at the University of Texas at Austin: A non-remedial approach to the advancement of minority students and women in mathematics*. (Master of Arts thesis), University of Texas at Austin, Austin, TX.

This MA thesis evaluates the Emerging Scholars Program (ESP) at the University of Texas at Austin. ESP was evaluated in the School of Natural Sciences concerning student involvement in the 1990-91 academic year. The program was found helpful in increasing academic success of historically underrepresented students of color and females in mathematics. Five questions were examined: how do students perceive and respond to the experience of ESP; how does the ESP fit into students' overall experience at the large university; what kinds of secondary school experiences are most instrumental in introducing minority and other students to mathematics and the natural sciences; what kinds of academic and other experiences confirm them in their choice of science and/or mathematics as an area of endeavor; and what kinds of academic and other experiences lead to their successful commitment to research in mathematics and the natural sciences as life-long careers.

Conciatore, J. (1990). From flunking to mastering calculus: Treisman's retention model proves to be "too good" on some campuses. *Black Issues in Higher Education*, 6(22), 5-6.

This short article describes the Emerging Scholars Program (ESP). The background for the development of ESP is provided through Treisman's observation and research of the study behaviors of students of color who were taking calculus courses. Rather than being offered as a "remedial" program, ESP is presented as an honors program. Some information is provided about the adoption and adaptation of ESP by 24 other colleges in the U.S.

Dancis, J. (1991). Group learning helps minority students excel at university. *Cooperative Learning*, 12(1), 26-27.

This article provides a short overview of the Emerging Scholars Program (ESP). ESP is an honors-type program that challenges students. Key elements in the ESP program are: small group learning; work on interesting hard problems; guidance and mentorship from a faculty member; a comprehensive support system for the participating students; many opportunities to correct the homework problems without grading; peer discussion; requirement that students explain to one another how to understand and solve problems; and minor emphasis on study skills and memorization of facts.

Dawkins, P. C., & Epperson, J. A. M. (2014). The development and nature of problem-solving among first-semester calculus students. *International Journal of Mathematical Education in Science and Technology* 45, 45(6), 838-862. doi: 10.1080/0020739X.2014.884645.

This study investigates interactions between calculus learning and problem-solving in the context of two first-semester undergraduate calculus courses in the USA. We assessed

students' problem-solving abilities in a common US calculus course design that included traditional lecture and assessment with problem-solving-oriented labs. We investigate this blended instruction as a local representative of the US calculus reform movements that helped foster it. These reform movements tended to emphasize problem-solving as well as multiple mathematical registers and quantitative modelling. Our statistical analysis reveals the influence of the blended traditional/reform calculus instruction on students' ability to solve calculus-related, non-routine problems through repeated measures over the semester. The calculus instruction in this study significantly improved students' performance on non-routine problems, though performance improved more regarding strategies and accuracy than it did for drawing conclusions and providing justifications. We identified problem-solving behaviours that characterized top performance or attrition in the course. Top-performing students displayed greater algebraic proficiency, calculus skills, and more general heuristics than their peers, but overused algebraic techniques even when they proved cumbersome or inappropriate. Students who subsequently withdrew from calculus often lacked algebraic fluency and understanding of the graphical register. The majority of participants, when given a choice, relied upon less sophisticated trial-and-error approaches in the numerical register and rarely used the graphical register, contrary to the goals of US calculus reform. We provide explanations for these patterns in students' problem-solving performance in view of both their preparation for university calculus and the courses' assessment structure, which preferentially rewarded algebraic reasoning. While instruction improved students' problem-solving performance, we observe that current instruction requires ongoing refinement to help students develop multi-register fluency and the ability to model quantitatively, as is called for in current US standards for mathematical instruction.

Deshler, J. M., Miller, D., & Pascal, M. (2016). An active classroom: The Emerging Scholars Program at West Virginia University. *Problems, Resources, and Issues in Mathematics Undergraduate Studies*, 26(9), 811-823. doi: 10.1080/10511970.2016.1191570.

In an effort to support the success of minority students and to incorporate inquiry-based learning (IBL) into the calculus sequence of courses at West Virginia University, a modified version of the Emerging Scholars Program (ESP) was implemented in the fall of 2009. Since then, approximately 100 students have taken ESP Calculus I, with many of them subsequently taking the ESP sections of Calculus II, III, and Differential Equations. In this paper, we describe in detail the use of class time in this modified course with a focus on IBL and present student success data and information from student evaluations of instruction. Data indicate students take authority for their own learning in this class and prefer the format to that of a traditional classroom. Success rates indicate they are succeeding at higher rates than their non-ESP counterparts in Calculus I and at the same rates as the general population in Calculus II.

Drew, D. E. (Ed.). (1996). *Aptitude revisited: Rethinking math and science education for America's next century*. Baltimore, MD: John Hopkins University Press. Available online: ERIC database. (ED405207).

Chapter six of the book provides an overview to the Emerging Scholars Program (ESP) developed at the University of California, Berkeley.

Dunbar, J., & O'Connor, J. (2016). Why early engagement in college research is important: Lessons learned at Wayne State University *The power and promise of early research* (pp. 185-193): American Chemical Association

Undergraduate students that attend Wayne State University typically have excellent high school academic records and many begin their first year of college with goals of a career in academic disciplines. However, many exceptionally talented and high-achieving students, particularly students from disadvantaged backgrounds, first-generation college and/or under-represented

minority (URM) students, often lack a complete package of the academic tools, persistence, confidence and developmental mentoring necessary to persist effectively in a college environment. Many of these students are left behind or inadvertently allowed to drift and become emotionally disengaged in the university. These factors often can result in students dropping out, changing majors or losing focus resulting in them pursuing “convenient” career options when they otherwise could have been successful if an appropriate focus and support structure had been in place to build their skills and develop their ambition. In this chapter, we will describe, analyze and provide some conclusions on our experience in the early engagement of students in research and its impact on their career outcomes.

Duncan, H., & Dick, T. (2000). Collaborative workshop and student academic performance in introductory college mathematics courses: A study of a Treisman model math excel program. *School Science and Mathematics, 100*(7), 365-373.

This article reports on the effectiveness of Math Excel, an implementation of the Emerging Scholars Program (ESP) at Oregon State University over five academic terms. Results suggest a significant effect on achievement favoring the Math Excel students (.671 grade points on a 4-point scale). After adjusting for prior mathematics achievement using linear regression with SAT-M as predictor, Math Excel groups grade averages were over half a grade point better than predicted (significant at the .001 level).

Epperson, J., & Treisman, P. U. (Writers). (2001). Collaborative learning [Video recording]. Arlington, TX: Academy of Distinguished Teachers, University of Texas at Arlington

Epperson, J. A. M., Peterson, L., & Houser, F. J. (2015). *Intervention in calculus: Back-mapping performance differences to tasks in the Emerging Scholars Program*. Conference Proceedings of the 2015 ASEE Gulf-Southwest Annual Conference

Increasing success rates in calculus is of critical importance for improving the pipeline to careers in STEM. The Arlington Undergraduate Research-based Achievement in STEM (AURAS) project, partially funded by the National Science Foundation, implemented the Arlington-Emerging Scholars Program (A-ESP) to address these pipeline issues. The A-ESP intervention involves engineering, mathematics, chemistry, and physics intended majors in an intensive supplemental workshop setting in which students encounter calculus tasks at a deeper more conceptual level. We compare the mathematical experiences of A-ESP students versus non-A-ESP students in the same lecture (n=93) in the context of their performance on departmental exams. In general, A-ESP students outperform non-A-ESP students on departmental exams, but in an effort to further improve curriculum, items in which A-ESP students drastically outperformed their counterparts or vice versa were back-mapped to the homework, labs, and A-ESP tasks. Findings suggest that on items where A-ESP students outperformed the non-A-ESP students the tasks students worked in the A-ESP problem sets tended to be more conceptual or abstract. However, on the items where non-A-ESP students outperformed the A-ESP students, the A-ESP tasks tended to resemble ordinary homework tasks. Thus, on typical primarily procedurally based calculus exams, the conceptual and abstract tasks appear to be boosting student performance and ultimately helping them successfully complete the course. The implications of this work will be discussed as well as ways to follow up on the findings.

Fernandez, O. E. (2018). How constructivism can boost success in STEM fields for women and students of color *Constructivist education in an age of accountability* (pp. 113-126): Springer National Science Foundation statistics document a stark gap in degree attainment in most STEM fields for women and students of color. This chapter summarizes research on learning, academic achievement, and persistence to help understand the origin of this gap. Discussion

focuses on the central role that constructivist teaching and learning environments play in boosting success for women and students of color in STEM. Practical tweaks and tips are presented to encourage educators to incorporate this pedagogy to improve learning and achievement for all students.

Fullilove, R. E. (1986). *Sealing the leaks in the pipeline: Improving the performance and persistence of minority students in college*. Unpublished manuscript. University of California, Berkeley. Berkeley, California.

This report provides both an overview of the Emerging Scholars Program (ESP) as well as a research study evaluating its impact upon student outcomes. The initial part of the document provides an overview of the problems with academic success and persistence of students of color with academic majors in math, science, and engineering. Then the report provides an overview of ESP with some details concerning specific activities that occur within the program. The report then concludes with inclusion of several data tables from Uri Treisman's doctoral dissertation study on ESP. The data suggested that ESP participants earned higher grades, persisted longer both at the university as well as within their original SME academic major.

Fullilove, R. E., & Treisman, P. U. (1990). Mathematics achievement among African American undergraduates at the University of California, Berkeley: An evaluation of the Mathematics Workshop Program. *Journal of Negro Education*, 59(3), 63-78.

This article describes the Mathematics Workshop Program (MWP), sometimes also known on other campuses as the Emerging Scholars Program (ESP). Data from the program evaluation between 1978-1984 at the University of California, Berkeley suggested that the program has succeeded in promoting high levels of academic performance among African American mathematics students. To provide comparison data, a baseline of student performance was established during the period of 1973 to 1977 before the ESP program was provided to students. The percentage of nonparticipants earning grades of D or below ranged from 33% to 41%. The participants ranged between 3% to 7% in comparison. The percentage of nonparticipants earning grades of B- or higher ranged from 10% to 28%. The participants ranged between 39% to 61%. The persistence and graduation rates favored the participants, 65% vs. 41%. The study took into account preentry attributes such as SAT scores on the verbal and mathematics subtests.

Ganter, S. L. (1991). *Improving the achievement of minorities in mathematics: A formative evaluation of a community college program* [Dissertation, University of California, Santa Barbara, 1990]. *Dissertation Abstracts International*, 52(05), 1673.

The following is a dissertation study from the University of California, Santa Barbara. By 1980, the interest for improving mathematics education at the post-secondary level had become so great that a committee was formed by NSF to discover the needs of the mathematics community as seen by educators in the field. The results indicated that a lack of guidance in developing math courses has led to discontinuity and a general state of confusion for many math programs and for the students in them. The Professional Development Program (PDP) is one post-secondary program that has been developed and implemented across the country. This program was conceived by Uri Treisman at UC Berkeley in response to the low completion rate of Black students in freshman calculus. Treisman developed a workshop program that would provide peer support for minority students, as well as other students, in lower division undergraduate mathematics courses. Santa Barbara City College (SBCC), a two-year community college, implemented the workshops developed by Treisman during the 1989-90 school year in first semester pre-calculus. This study examined the initial implementation and effects of the SBCC program. The major goal was to examine the program's success in increasing the persistence and performance of students in mathematics. It also examined how

well the program was implemented, since faulty implementation can jeopardize intended outcomes just as much as a faulty program design. In order to assess the degree to which the program was implemented, each student involved in the workshops was involved in a brief interview to obtain student impressions of the workshops. In addition, weekly observations of the workshop sessions were made and compared to the UC Berkeley workshops. To assess student performance, comparisons were made between workshop and non-workshop students. These comparisons could not be made through random assignment since students volunteered to participate in the workshops. Therefore, it was necessary to make comparisons that utilized matching, a within-subject design. The workshop effect on student performance was then obtained by comparing the student matches in five areas: attrition rates, attitudes toward math, course grades, scores on a posttest, and mathematical understanding as determined by individual interviews. Although the program appears to be successful at UC Berkeley, it was not true that this apparent success was easily transferable to a community college. The major difference in this new setting was that the program was working with an entirely different student population than would be found at most four-year institutions. Many students wanted to, and did, commit to the program only to find that the workshops were very difficult to attend on a regular basis because of job and family commitments. This greatly influenced the effectiveness of the program.

Garland, M. (1983). The Mathematics Workshop Model: An interview with Uri Treisman. *Journal of Developmental Education*, 16(3), 14-16, 18, 20, 22.

This article provides an interview with Dr. Uri Treisman, creator of the Emerging Scholars Program (ESP) that was initially developed at the University of California, Berkeley. The interview topics include: background and history of the ESP program, core ideas that the program is based upon, structural impediments to success in the curriculum, other ESP programs in the U.S., and related issues.

Hildebrand, J. (1988, 1988, January 24). Math tutor finds strength in numbers, *Chicago Sun-Times*, p. 42.

This newspaper story provides some information about the Emerging Scholars Program (ESP). One of the features of the program is that it is not about surviving calculus, but excelling with the academic content material.

Hobby, B. (1993, 1993, January 25). Professors ease fear of math monster, *Austin American Statesman*, p. A9.

This newspaper article describes the Emerging Scholars Program (ESP) implemented at Rice University. The article provides the rationale for the program and includes quotations from Uri Treisman, originator of ESP.

James, D. W., Jurich, S., & Estes, S. (2001). *Raising minority academic achievement: A compendium of education programs and practices*. Unpublished manuscript. American Youth Policy Forum. Washington, D.C.

This report provides an overview of a wide variety of programs that have been effective for students of color in increasing their academic success in secondary and postsecondary education. The Emerging Scholars Program (ESP) is one of the featured programs with an overview and preliminary data studies included.

Johnson, S. D., & Fischbach, R. M. (1992). *Teaching problem solving and technical mathematics through cognitive apprenticeship at the community college level*. Available online: ERIC database. (ED352455).

This report describes a program called "Cognitive Apprenticeship" that is partially based on the Emerging Scholars Program (ESP). The traditional format of mathematics instruction has not succeeded in providing the skills students need to work cooperatively to solve problems in industry. New models of instruction have been proposed to resolve this deficiency. Schoenfeld has used a technique that incorporates coaching, modeling, and fading strategies with college-level students. Treisman has improved minority student performance in calculus using a model based on collaborative problem solving. A hybrid model called cognitive apprenticeship merges the coaching-modeling-fading components of Schoenfeld's model and Treisman's collaborative workshop model to enable students to become better problem solvers while working together as members of a community of learners. Cognitive apprenticeship instruction was tested in community college industrial technology classes: two instructors each taught a traditional and an experimental technical mathematics class. Quantitative data from indicated students in the cognitive apprenticeship group scored slightly better than the control group on a problem-solving exam and the final exam, although not significantly. The scores of the cognitive apprenticeship students on a standardized exam were slightly lower than the control group, but not significantly. Two recommendations were proposed based on the results of the study: first, to explore the model further after certain suggestions were incorporated and second, to test it in other math-based classes. (Contains 61 references.)

Korejwa, E., Borges, D. R., & Wright, J. (2016). *Opening the pipeline: Increasing student diversity in the UMASS Dartmouth College of Nursing*. Dartmouth, MA. Available online: <http://masslib-dspace.longsight.com/bitstream/handle/2452/629926/ocn978293353.pdf?sequence=1&isAllowed=y>

The nursing workforce should ideally reflect the community it serves. Diverse nurses are able to provide culturally competent care that promotes better communication, more trust, and practices that are aligned with cultural preferences, which in turn is associated with improved health outcomes. This is particularly relevant in an urban center such as New Bedford, where 33 percent of residents are part of a minority group. The racial and ethnic landscape has also changed considerably over the last two decades, particularly in terms of the number of Latinos, Brazilians, and Central Americans who call New Bedford home. This change requires the region's healthcare providers to refocus on a different cultural population who have specific needs and cultural attitudes toward health. The current demographic profile of students in the UMass Dartmouth (UMD) College of Nursing (CON) does not reflect the demographics of local residents. For example, in 2014, 15 percent of the CON's incoming class of undergraduate students and 11 percent of their incoming class of graduate students were an ethnic or racial minority. In comparison, 25 percent of Massachusetts residents and 33 percent of New Bedford residents were an ethnic or racial minority during the same time period. Likewise, the CON has lower rates of first generation college students and low-income students in comparison to UMD as a whole and New Bedford's high schools. In an effort to increase the diversity of the local nursing workforce, the CON applied for and received funding under the "Diversity Nursing Scholars Program" (DNS) that provides scholarships and additional services to students from disadvantaged groups.¹ As part of this effort, the CON asked the Public Policy Center (PPC) at UMass Dartmouth to design and complete a community needs assessment that identifies opportunities and challenges among local middle and high school students who are interested in a nursing career. This report focuses specifically on obstacles that prevent students from choosing a nursing career, gaining admission to the CON, and choosing to enroll at UMD. To that end, PPC pulled together information from key informant interviews, previous scholarly research, and secondary data in order to understand the complex system of individual decisions, policies, organizations, and institutional arrangements involved in the path from high school to entrance in a nursing program. The research concludes that there are several barriers

to be addressed and solutions that can be implemented by various entities to increase diversity among UMD's nursing students. One overarching conclusion is that minority students do not get accepted into the CON at the same rate as their peers. If they did, these students would make up between a quarter and a third of all incoming students, and thereby, the demographics of the CON's incoming class would match those of the community and that component CON's diversity goals would be achieved. Instead, from 2011 to 2014, the proportion of minority students among students accepted into the CON was consistently 14 percentage points lower than the proportion of minority students in the applicant pool. For instance, in 2014, minority students made up 33 percent of applicants, but they made up only 19 percent of students who are accepted into the program. Conversely, white students make up 67 percent of applicants, but 81 percent of those who are accepted. Holding all else equal, this evidence points to the high school academic performance of the minority applicant pool as a driving factor affecting the level of diversity in the program

Koretsky, M., Bouwma-Gearhart, J., Brown, S. A., Dick, T., Brubaker-Cole, S., Sitomer, A., & Fisher, K. Q. (2015). *Enhancing STEM education at Oregon State University*. Conference Proceedings of the 122nd ASEE Annual Conference & Exposition, Seattle, WA. Available online: file:///C:/Users/David/Downloads/enhancing-stem-education-at-oregon-state-university-year-1.pdf

Development and implementation of innovative instructional practices are currently underway in courses in many STEM programs at Oregon State University. Not surprisingly, they tend to be largely siloed within a discipline, target different, specific elements, and are at varying stages of implementation. However, Oregon State University is witnessing elements of transdisciplinary collaboration emerging. The ESTEME@OSU Program presents an opportunity to catalyze broad institutional change through scaling and cross-pollination of efforts utilizing two evidence-based instructional practices (EBIPs), interactive engagement with frequent formative feedback and formal cooperative learning, in targeted classes in five STEM departments (integrative biology, chemistry, engineering, mathematics, and physics). Project EBIPs are based on an interactive lecture environment combined with a studio workshop-based cooperative recitation or laboratory environment; targeted outcomes are students' well-connected conceptual knowledge structures and abilities to non-linearly and iteratively solve problems utilizing conceptual understanding. The courses we have initially selected for implementation of EBIPs are calculus-based introductory courses. Normalizing effort across these courses ensures that there are opportunities for students to have multiple synergistic experiences (especially in years 1 and 2) early in demanding STEM majors.

Kosciuk, S. (1997). *Impact of the Wisconsin Emerging Scholars first-semester calculus program on grades and retention from Fall 1993-1996*. Unpublished manuscript. University of Wisconsin-Madison. Madison, WI.

The Emerging Scholars Program (ESP) at the University of Wisconsin-Madison was evaluated between 1993 and 1996. The ESP was designed to increase the academic success of students enrolled in several first-semester calculus and persist at higher rates in science, math, engineering, or technology academic majors. The success rate was increased for participating students.

Leopard, B. B. (2001). Affective, metacognitive, and conceptual effects of an Emerging Scholars program on elementary teacher preparation: An application of the Treisman workshop model [Dissertation, The University of Toledo, 2000]. *Dissertation Abstracts International*, 61(10), 3958.

This study addresses the problem of preservice elementary mathematics teaching preparation. It analyzes the effects of an Emerging Scholars program utilizing the Treisman model. The basic

principles of this model include reconceptualization of mathematical ideas for the under-prepared mathematics student and the emphasis on the social aspect inherent in learning mathematical concepts. The study involves an elementary mathematics content course that was constructivist in nature and which emphasized the tenets of the NCTM Standards. Qualitative measures included in the study are student interviews, mathematical autobiographies and classroom observations. Quantitative measures consist of surveys on metacognition and mathematics anxiety and concept maps. Data concerning affective, metacognitive, and conceptual changes was analyzed both qualitatively and quantitatively. Results indicate an increase in metacognitive skills, measured both qualitatively and quantitatively and a decrease in mathematics anxiety levels measured qualitatively. Effects of the program on conceptual understanding are inconclusive. However, a significant increase in the preservice teachers' level of self-confidence in teaching is noted. The Emerging Scholars program appears to have a positive effect on preservice elementary teachers when considering affective and metacognitive attributes related to mathematics but appears to have a neutral effect on the reconceptualization of mathematical ideas. Improvement in affective variables related to teaching elementary mathematics are the most significant effects of the program.

Leggett, J. M. (1998). Linked case studies of the dissemination of the Emerging Scholars Programs in three community colleges [Dissertation, The University of Texas at Austin, 1997]. *Dissertation Abstracts International*, 59(01), 1998.

This dissertation study examined the dissemination attempts of three community colleges in adapting an Emerging Scholars Program (ESP) on their campuses. Using linked case studies, the study focused on the description of the role of faculty and administrators in implementing the Emerging Scholars Program. Of key significance was the perceived need for the ESP, the problem to be addressed, the combined effort used within the institution to adapt the program, how dissemination occurred, and the results obtained. The Emerging Scholars Program evolved from the work of Dr. Philip Uri Treisman, a University of California at Berkeley mathematician, who was intrigued by the success of Asian American students and the lack of success of African American students in freshman calculus. Treisman's study led to the development of a set of strategies and a framework for addressing the persistent under-performance of African American, Hispanic, and Native American students in introductory collegiate mathematics courses. The ESP is an academic excellence program with six characteristic elements. The Emerging Scholars Program focuses on students' strengths rather than their weaknesses. The existence of several well-established Emerging Scholars Programs at four-year institutions has permitted numerous studies on the program. In community colleges, however, the Emerging Scholars Program is still in its infancy, and additional research is needed. The dissemination of the ESP has evolved from a grass roots effort conducted by the Charles A. Dana Center at the University of California at Berkeley to its current broad dissemination through building connections among mathematicians to encourage underrepresented minority students to seek careers in mathematics. A major finding of this study of the dissemination of the ESP in three community colleges is that underrepresented minority and other students who participated in ESP workshops successfully completed courses in mathematics and the sciences consistently at a success rate up to a grade higher than non-ESP students. Other findings are: (1) the ESP model cannot be translated in its entirety across all sectors of higher education; (2) real creativity is needed to establish an ESP at a community college; (3) stable funding is key in establishing and institutionalizing an ESP; (4) institutional planning, evaluating, and customizing are required in establishing an Emerging Scholars Program; and (5) only a small number of students will be served.

MacGregor, J. (2000). Restructuring large classes to create communities of learners. In J. MacGregor, J. L. Cooper, K. A. Smith & P. Robinson (Eds.), *Strategies for energizing large*

classes, *New Directions for Teaching and Learning*, No. 81 (pp. 47-61). San Francisco: Jossey-Bass

This article provides an overview of a variety of programs for providing peer collaborative learning groups either inside or outside the classroom. The Emerging Scholars Program (ESP) and Supplemental Instruction (SI) have several pages of text devoted to both of them providing a basic program overview and several citations to research studies that support their program claims of effectiveness for improved student outcomes.

Martinez-Avila, Varona, E., Carlton, D. D., Thomas, A., & Schug, K. A. (2013). *Evaluating effects of the Arlington Undergraduate Research-based Achievement for STEM (AURAS) Program for the performance of engineering students in chemistry courses*. Conference Proceedings of the 2013 ASEE Gulf-Southwest Annual Conference, Arlington, TX. Available online: http://aseegsw.com/past%20Proceedings/2013%20Proceedings/Abst_martinez.pdf

Through the AURAS program, sessions of supplemental instruction were offered to students enrolled in the Chemistry for Engineers course for the fall 2011 semester. Only one class section was offered, therefore, all students compared in this study attended the same lecture taught by one instructor. One ESP section with a capacity of forty students was available. It was led by two teaching assistants (TAs) and two undergraduate Peer Academic Leaders (PAL) that were present at all times and stayed constant throughout the program. Subjects were recruited by advisors and registered for the program prior to the first session. Separately from regular classroom and laboratory sessions, students attended four hour sessions of supplemental instruction scheduled once a week, in which material was reinforced using the model of a Treisman-style Emerging Scholars Program (ESP)^{5,6}. In ESP, an emphasis is placed on building community among the students through active learning and fostering collective efforts aimed to solve challenging problems. Students enrolled in ESP, henceforth the ESP group, received the benefits of the AURAS program while the comparison non-ESP group did not. Our hypotheses were that the experimental group would attain higher marks on examinations and a higher percentage of students would pass the course (attaining marks of A, B, or C), compared to non-ESP students. The first hypothesis was proven. As shown in Figure 1, ESP students had statistically higher grades in the Exam 1, Exam 2, Exam 3, and the final exam ($p < 0.05$). ESP students retained a higher average for Exam 4, which approximated significant value ($p = 0.06$). Due to a holiday break mid-week, only one ESP session was administered to prepare students for Exam 4 and the exam covered two chapters in the textbook. This could be the reason that no significance was found on Exam 4. The second hypothesis was proven by comparing the passing rates in each group. The ESP group had a higher passing rate than the non-ESP group (85% versus 57%) From Pearsons' chi-square test we can say there is a minimal probability (0.5%) that the difference in grades is a result of random chance. Data on demographics and academic background variables (SAT/ACT scores) is currently being analyzed to decipher if the groups come from the same population. If the groups are comparable, we can safely say that attending AURAS and success in chemistry are dependent on one another ($\chi^2(1).005 = 7.88$, $\chi^2_{\text{calc}} = 10.57$, $p < 0.005$).

Mason, K. I., Hrbowski, F. A., & Schmitt, C. L. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching*, 37(7), 629-654.

This article describes the Meyerhoff Scholars Program at the University of Maryland, Baltimore County which was based on the Emerging Scholars Program (ESP). Outcomes for the participating students are higher grade point averages, higher rates of persistence in science and engineering degrees, and higher rates of admission to graduate schools than nonparticipating students. Critical factors cited by focus groups with participating students

included the following: program community, study groups, summer bridge program, financial support, program staff, research internships, and mentors.

Maton, K., Beason, T. S., Godsay, S., Domingo, M. R. S., Bailey, T. C., Sun, S., & Hrabowski, F. A. (2016). Outcomes and processes in the Meyerhoff Scholars Program: STEM PhD completion, sense of community, perceived program benefits, science identity, and research self-efficacy. *CBE-Life Education*, 15(3). doi: 10.1187/cbe.16-01-0062. Available online: <http://www.lifescied.org/content/15/3/ar48.full>.

Previous research has shown that the Meyerhoff Scholars Program at the University of Maryland, Baltimore County, is an effective intervention for high-achieving underrepresented minority (URM) students; African-American Meyerhoff students are significantly more likely to enter science, technology, engineering, and mathematics (STEM) PhD programs than comparison students. The first of two studies in this report extends the prior research by examining levels of PhD completion for Meyerhoff (N = 479) versus comparison sample (N = 249) students among the first 16 cohorts. Entering African-American Meyerhoff students were 4.8 times more likely to complete STEM PhDs than comparison sample students. To enhance understanding of potential mechanisms of influence, the second study used data from the 22nd (Fall 2010) to 25th (Fall 2013) cohorts (N = 109) to test the hypothesis that perceived program benefit at the end of freshman year would mediate the relationship between sense of community at the end of Summer Bridge and science identity and research self-efficacy at the end of sophomore year. Study 2 results indicated that perceived program benefit fully mediated the relationship between sense of community and both criterion measures. The findings underscore the potential of comprehensive STEM intervention programs to enhance PhD completion, and suggest mechanisms of influence.

McCreary, P. (1994). The Merit Workshop Program in calculus at the University of Illinois at Urbana-Champaign: Description of a successful intervention program for underrepresented groups in mathematics. In A. Solow (Ed.), *Preparing for a new calculus: Conference proceedings* (pp. 80-84). Washington, D.C.: National Academy Press, Mathematics Association of America

This paper reports on Merit Workshop Program at the University of Illinois at Urbana-Champaign. This program is based on the Emerging Scholars Program (ESP). Program participants earn nearly a full letter grade higher final course grades in calculus than similar nonparticipants. The target population for service are historically underrepresented student populations in the sciences. Typical program activities are described.

Merit Immersion for Students and Teachers (MIST). (2007). *Merit instructor mentoring manual*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: <http://merit.illinois.edu/documents/TA%20Mentoring%20Program%20Manual.pdf>
The 26-page manual is used for training new MERIT mentors for the Treisman-inspired program. Responsibilities include: (a) Participation in mandatory New Merit Instructor and Mentee Training; (b) Weekly observation by either Mentor or Merit Director for the first four weeks of the semester; (c) Observation once every three weeks thereafter by Mentor, or possibly more as deemed necessary by Mentor and Merit Director; (d) Observations will last approximately one hour each time; (e) Brief discussion (10 minutes) with Mentor at some time after each observation to discuss; observations, answer any questions, and set goals for subsequent class periods; and (f) Participation in two Performance Reviews with Mentor and Merit Director to discuss progress

Merit Immersion for Students and Teachers (MIST). (2007). *Merit teaching assistant training manual*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: <http://merit.illinois.edu/documents/TA%20Training%20Manual.pdf>
The 38-page manual is used for training new MERIT teaching assistants for the Treisman-inspired program. Topics for training include (a) relationships of the TA with the course professor and the students; (b) campus resources; (c) discussion questions to use during the sessions; (d) first day of the Merit workshop session, (e) evaluation; and (f) program resources.

Merit Immersion for Students and Teachers (MIST). (n.d.). *Other Merit programs based on the Treisman Model*. Unpublished manuscript. University of Illinois at Urban-Champaign. Champaign, IL. Available online: http://merit.illinois.edu/educators_treismanprograms.html
The academic support program developed by Dr. Uri Treisman at the University of California-Berkeley operates under a variety of names: Professional Development Program (University of California-Berkeley), Emerging Scholars Program (University of Texas-Austin), Merit Immersion for Students and Teachers (MIST, University of Illinois at Urbana-Champaign), Gateway Science Program (Northwestern University), Wisconsin Emerging Scholars (U of Wisconsin-Madison), Math Excel Program (University of Kentucky, Northeastern University., Oregon State University., and Portland State University), Louis Stokes Alliance for Minority Participation (San Fransico State University), Math Merit program (Prairie State College), Mathematics Education Reform Initiative for Teachers (West Virginia University), The Math Forum (Drexel University), and EOPS Project AIM (Achievement in Mathematics, Cerritos College). It is suggested to the reader to conduct their own online search of references for the Treisman program under the names described above.

Merit Immersion for Students and Teachers (MIST). (n.d.). *The Treisman's Model*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: http://merit.illinois.edu/educators_treisman.html
This short overview provides a summary of the program, several quotations from other articles, and links to ESP programs operating at other institutions.

Merit Immersion for Students and Teachers (MIST). (n.d.). *Merit-style questions for classroom use*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: http://merit.illinois.edu/educators_material.html
This web page provides work sheets and discussion questions to use during the Merit sessions. They are provided for chemistry, integrative biology, and math. The individual pages are downloaded as Word documents so they can be easily revised.

Merit Immersion for Students and Teachers (MIST). (n.d.). *Merit Program brochure*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: <http://merit.illinois.edu/documents/MIST%20hand-out%2008.pdf>
This two-page brochure provides an overview of the MIST Program with its mission, goals, and brief report of the program's evaluation with increasing student success

Merit Immersion for Students and Teachers (MIST). (n.d.). *Treisman Workshop Resources*. Unpublished manuscript. University of Illinois at Urbana-Champaign. Champaign, IL. Available online: http://bfc.sfsu.edu/cgi-bin/prob.pl?Treisman_Workshop_Resources
This web page provides work sheets, discussion questions, and other resources from Treisman Workshop programs across the U.S. The worksheet archive are in compressed .zip format and are searchable. Links are provides to other web resources.

Millar, S. B. (1996). A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an Emerging Scholars Program of Work. of Work. Department. University of Wisconsin-Madison. Madison, WI. Available online: ERIC database. (ED408180).

This article contains an evaluation of the Emerging Scholars Program (ESP) regarding its utility regarding learning calculus. In addition to focusing on helping students from historically underrepresented populations to be academically successful, ESP also provides a learning community that addresses the problems of isolation and lack of support that nontraditional students may experience.

Millar, S. B., Alexander, B. B., Lewis, H. A., & Levin, J. R. (1995). *Pilot Wisconsin Emerging Scholars Program*. Unpublished manuscript. The University of Wisconsin-Madison. Madison, WI. Available online: ERIC database. (ED408179).

This document provides the script for an audio-cassette that contains the final evaluation of the Wisconsin Emerging Scholars Program (ESP) for the year 1993-94. The evaluation report includes an executive summary, a discussion of the parameters of the evaluation including research questions and methods, implementation processes and outcomes for faculty and administrators, student learning processes and outcomes including those indicated by both qualitative and quantitative data; conclusions related to the use of the ESP program; and recommendations related to pedagogical issues, out-of-class issues, and implementation issues. Critical factors for ESP success included the student small group work, the careful construction of the problem worksheets, and the involvement of the faculty members.

Mills, S. R. (1999). Academic excellence workshops in chemistry and physics (Uri Treisman) [Dissertation, The Claremont Graduate University, 1999]. *Dissertation Abstracts International*, 60(06), 1968.

In the mid-1970's, Dr. Uri Treisman, at the University of California, Berkeley, developed an academic excellence workshop program that had important successes in increasing minority student achievement and persistence in calculus. The present dissertation research is an in-depth study of chemistry and physics workshops at the California State Polytechnic University, Pomona. Data for the first, longitudinal component of this study were obtained by tracking to Spring 1998 all workshop minority students, i.e., Latino, African American, and Native American workshop students, a random sample of non-workshop minority students, and a random sample of non-targeted students, i.e., Anglo and Asian students, enrolled in first-quarter General Chemistry or Physics during specific quarters of 1992 or 1993. Data for the second component were obtained by administering questionnaires, conducting interviews, and observing science students during Fall, 1996. Workshop participation was a significant predictor of first-quarter course grade for minority students in both chemistry and physics, while verbal and mathematics Scholastic Aptitude Test (SAT) scores were not significant predictors of beginning course grade for minority science students. The lack of predictive ability of the SAT and the importance of workshop participation in minority students' beginning science course performance are results with important implications for educators and students. In comparing pre-college achievement measures for workshop and non-targeted students, non-targeted students' mathematics SAT scores were significantly higher than chemistry and physics workshop students' scores. Nonetheless, workshop participation leveled the field as workshop and non-targeted students performed similarly in beginning science courses. Positive impacts of workshop participation on achievement, persistence, efficiency, social integration, and self-confidence support the continued and expanded funding of workshop programs. This research also studied how gender and ethnicity affect attitudes, achievement, and persistence in science courses and mathematics-based majors. College-level females, both minority and non-minority, in science showed no differences from males or were in fact more positive about science than males.

However, in interviews, minority females expressed concerns about gender and believed gender to be more important in their science experiences than ethnicity. This research suggests intervention programs to increase the number of females in the science- and technology-based job pipeline can be successful.

Mondisa, J.-L., & McComb, S. A. (2015). Social community: A mechanism to explain the success of STEM minority mentoring programs. *Mentoring & Tutoring: Partnership in Learning*, 23(2), 149-163. doi: 10.1080/13611267.2015.1049018.

Social community may be a mechanism that explains the success of minority mentoring programs. We define a social community as an environment where like-minded individuals engage in dynamic, multidirectional interactions that facilitate social support. In this conceptual article, we propose a social community model for science, technology, engineering, and mathematics minority mentoring programs to understand how a community's program values, resources, and activities play a role in the learning and enrichment of its members. Using a social exchange lens, we: (a) define social community relative to minority mentoring programs, (b) examine how program elements facilitate social community, and (c) discuss participant outcomes beyond programmatic outcomes. A summary of our continuing research, preliminary findings, and future research recommendations are also detailed.

Moreno, S. E. (2000). *Keeping the door open: Latino and African American friendships as a resource for university mathematics achievement*. (Ph.D. dissertation), University of Texas at Austin, Austin, TX.

The Emerging Scholars Program (ESP) is a critical factors in the academic success of historically underrepresented student populations in mathematics courses. This dissertation study delves into the critical factors that help explain the utility of ESP for supporting higher student achievement. The focus for the study is with students enrolled in a calculus course. The friendships and relationships among students are analyzed for their potential impact on encouraging higher student achievement. Results suggest that students who form strong bonds with fellow students within the ESP program are more likely to earn higher grades. An additional layer of analysis also takes into account cultural factors related to the students racial background for the importance of friendship bonds.

Moreno, S. E., & Muller, C. (1999). Success and diversity: The transition through first-year calculus in the university. *American Journal of Education*, 108(1), 30-57.

This article analyzes the influence at the University of Texas at Austin of calculus performance on choosing a mathematics, science, or engineering major, noting the role of diverse students' participation in the Emerging Scholars Program (ESP) at the University of Texas-Austin. Findings suggest that ESP students earn higher calculus grades than other students and are more likely to enroll in second-semester calculus. While targeted for African-Americans, Latinos, and females, the ESP program is open to all students.

Moreno, S. E., Muller, C., Asera, R., Wyatt, L., & Epperson, J. (1999). Supporting minority mathematics achievement: The Emerging Scholars Program at The University of Texas at Austin. *Journal of Women and Minorities in Science and Engineering*, 5(1), 53-66.

The Emerging Scholars Program (ESP) at the University of Texas at Austin works to improve the academic achievement of minorities and women in calculus, though it is open to all students. Research studies suggest that ESP students are more likely to earn A or B grades in calculus and pass the next course in the academic sequence than non-participants. Six elements of ESP include: increased class time on task; more personal interaction with peers, graduate students, and faculty; fostering of a student community that is supportive; explores more challenging aspects of mathematics; provides academic advising; and allows students to

concentrate on and excel in a smaller number of challenging classes since they receive academic credit for participation in the ESP program.

Murphy, T. J. (1986). College mathematics instruction in transition: A study of reform in a college algebra course for 'at-risk' students [Dissertation, University of Illinois at Urbana-Champaign, 1995]. *Dissertation Abstracts International*, 56(09), 3491.

This dissertation study investigates the Emerging Scholars Program. Historically, students from academically disadvantaged and minority populations have experienced disproportionately high dropout and failure rates in college mathematics. These students often place into courses considered remedial at the college level. The current national reform movement includes initiatives designed to address the failure of mathematics education to meet the needs of underrepresented populations. This research examined an effort to make a college algebra course more effective for 'at-risk' students, admitted to a research university through an academic support program. In particular, the study analyzed the extent of reform in this course and the impact of the course on student outcomes, and identified barriers and enhancers to implementing reform in this context. The reform efforts included employing active learning and student collaboration strategies and attempting to create a 'Treisman-style' workshop environment. These strategies challenge instructors to check their impulse to show and tell, and instead, to facilitate and coach; correspondingly, instructors design challenging activities that differ from the standard manipulation exercises often found in textbooks. This study followed an instructor through her first semester of attempting to implement these strategies. A combination of retrospective and prospective data was utilized. Admissions and transcript records enabled the calculation of background characteristics (demographic and academic) and persistence rates (university retention and course and career paths). Prospective data included classroom observations, instructor and researcher journals, a diagnostic pre- and posttest, and student interviews. The results indicated that (a) the academic support program provided a supportive, inclusive environment for both students and instructor; (b) the course employed active learning and student collaboration, but the content presented remained at lower cognitive levels; (c) the instructor experienced frustration in trying to balance content coverage with student involvement, in learning to release control to the students, and in discarding traditional notions of remediation; and (d) the treatment did not adversely affect student skills or attitude, and in some cases the course enabled students to pursue their chosen fields. Recommendations include upgrading the cognitive level of the course content, providing instructor development opportunities, and--most importantly--strengthening partnerships between the units involved (program, department, and instructor) in the conduct of the course.

Murphy, T. J., Stafford, K. L., & McCreary, P. (1998). Subsequent course and degree paths of students in a Treisman-style workshop calculus program. *Journal of Women and Minorities in Science and Engineering*, 4(4), 381-396.

The Merit Workshop Calculus Program, based on the Emerging Scholars Program (ESP), was created in 1989 to increase success rates of students from underrepresented populations in mathematics- and science-based academic majors at the University of Illinois, Urbana Champaign. The research study investigated academic performance in first-semester calculus courses, academic performance in courses that require first-semester calculus as a prerequisite, and persistence at the university. Analysis included gender and ethnicity. Positive results were reported for females, African-Americans, Caucasian, and Hispanic students. Dramatic results were reported for females and Hispanics.

Mwavita, M. (1994). *Factors influencing calculus course success among freshmen engineering students*. (Ph.D. dissertation), University of Central Florida, Edmond, OK.

The Emerging Scholars Program along with a Summer Bridger Program were important components for increasing student academic success.

Nelson, C. E. (1996). Student diversity requires different approaches to college teaching, even in math and science. *American Behavioral Scientist*, 40(2), 165-175.

The author argues that traditional teaching pedagogies are biased against many non-traditional student populations. Among the changes in the learning environment recommended by the author is the Emerging Scholars Program (ESP). The short description of ESP includes a discussion about the importance of changing the social system for the historically underrepresented students to succeed at the institution. Careful distinction is drawn between traditional recitation sessions which often evoke passive student involvement and structured sessions in ESP where students are highly participatory in the learning process.

Oppland, S. B. (2010). *The inextricability of identity, participation, and math learning among Latino/a undergraduate students*. (Ph.D. dissertation), University of Illinois at Chicago, Chicago, Illinois.

This study holistically explores the experiences of two Latino/a undergraduate freshman pursuing or interested in pursuing STEM majors as they engage in an Emerging Scholars Program (ESP) Calculus I workshop; a mathematical community of practice recognized for assisting culturally diverse student groups in realizing mathematical success. The study presents a theoretical framework for exploring intersections among participants' narrative and participative identities to gain knowledge about how and why relationships among their multiple identities, participation, and access to math learning opportunities unfold and strengthen as they engage in a particular mathematical community of practice. Using counter story-telling methodology and life story interviews, this study describes through the participants' voices how their math identities intersect with their racial, cultural, gender, and class identities, separately and collectively, as they negotiate intricate experiences in and across societal, community, school, and family contexts throughout their lives. By applying multiple data sources to Wenger's (1998) social ecology of identity framework, this study also describes how the participants construct identities of participation and marginalization as workshop members and as appropriators of mathematical knowledge. Using in-depth case studies, this study explores how and why strengthened relationships form among the participants' identities as math learners, their participatory trajectories, and opportunities to learn mathematics in the ESP workshop over the course of a semester. A model is presented for each student that explicates these relationships. This research raised important considerations regarding the relationships that exist among Latino/a students' multiple identities, participation, and math learning. This includes the roles of racialized, cultural, gendered, and classed experiences; racial, culture, gender, and class identities; and the influence of private and socially (e.g., societal) constructed meanings of what it means to "be Latino/a" in relation to math participation and learning. This research also aims to contribute to building momentum for shifting the focus in the math education community away from underrepresented students' math achievement and persistence outcomes towards viewing their math success as strengthened relationships among their multiple identities, their participatory trajectories, and their ability to access math learning opportunities within and across various communities of practice.

Oppland, S. B. (2013). Mathematics and racial identity co-construction in multiple sociopolitical contexts: A case study of a Latina undergraduate student from an urban community. *Journal of Urban Learning, Teaching, and Research*, 9, 89-99.

Although urban Latinas/os have participated in mathematics workshops in urban universities for over three decades as part of the Emerging Scholars Program (ESP), few studies have explored Latina/o students' perspectives of how and why these learning environments support

them in attaining mathematical success. This article presents an in-depth case study of how Vanessa, a Latina undergraduate student from an urban community, simultaneously constructed her mathematics and racial identities as she engaged in a culturally diverse, collaborative ESP Calculus I workshop situated within broader sociopolitical contexts. Vanessa's story was selected because she offered a unique perspective of how encountering identity-affirming workshop spaces aided her in constructing a strengthened self-perception as a Latina mathematics learner. Her counter-story challenges dominant ideologies that disregard the importance of viewing Latina/o students' mathematics participation and learning as racialized forms of experience.

Oppland-Cordell, S. B. (2014). Urban Latina/p undergraduate students' negotiations of identities and participation in an Emerging Scholars Calculus I Workshop. *Journal of Urban Mathematics Education, 7*(1), 19-54. Available online: <http://ed-osprey.gsu.edu/ojs/index.php/JUME/article/view/213/151>.

In this article, the author presents a qualitative multiple case study that explored how two urban Latina/o undergraduate students' emerging mathematical and racial identity constructions influenced their participation in a culturally diverse, Emerging Scholars Program, Calculus I workshop at a predominately White urban university. Drawing on critical race theory and Latina/o critical theory, cross-case analysis illustrates that participants' emerging mathematical and racial identities—co-constructed with their other salient identities—contributed to positively shifting their participation by: (a) changing their perceptions of their and peers' mathematics abilities, (b) allowing them to challenge racialized mathematical experiences, and (c) strengthening their comfort levels in the workshop environment. The Latina/o participants' counter-stories support that the sociopolitical nature of identity development and participation in mathematical learning contexts should be embraced because it provides additional knowledge regarding how and why Latina/o students attain mathematical success.

Oppland-Cordell, S. B., & Martin, D. B. (2015). Identity, power, and shifting participation in a mathematics workshop: Latina students' negotiation of self and success. *Mathematic Education Research Journal, 27*, 21-49. doi: 10.1007/s13394-014-0127-6.

This article describes and explains shifts in participation among eight mathematically successful Latin@ undergraduate students who were enrolled in a culturally diverse calculus I workshop that was part of a university-based Emerging Scholars Program. Two questions are explored: (a) How do students explain success-oriented shifts in participation that occurred over time in the workshop setting? and (b) How were these success-oriented shifts related to students' evolving mathematical and racial identities? Drawing on Wenger's (1998) social ecology of identity framework, the analysis shows that participants constructed strengthened identities of participation over time through three modes of belonging (engagement, imagination, and alignment) within two dimensions (identification and negotiability). Given the predominantly White university context, Latin@ Critical Theory was used to help uncover how strengthened participation was related to what it meant for participants to be Latin@. Findings also support intentional collaborative learning environments as one way to foster mathematics success and positive identity development among Latin@ students.

Oppland-Cordell, S. B., Roskamm, D., Bilyk, R., Echevarria, R., & Allen, N. (2014). *Peer leaders' perspectives of their involvement in a mathematics enrichment workshop program: A comparison of motivations and outcomes*. Conference Proceedings of the Proceedings of the 2014 Conference of the Peer-Led Team Learning International Society, Carson, CA. The purpose of this paper is to present Peer Leaders' (PLs) perspectives of their involvement in the Mathematics Enrichment Workshop Program (MEWP) at a Hispanic-serving, urban, Midwestern University. The MEWP utilizes undergraduate and graduate students as PLs to

facilitate optional mathematics workshops that run parallel to required mathematics courses ranging from the developmental level through calculus II. PLs were asked to complete an open-ended survey that aimed to capture their perspectives of their PL experiences. This study examines participants' motivations for becoming involved with the MEWP as PLs and critical outcomes they experienced due to this involvement. In particular, this study addresses the following questions: (1) What are PLs' perceptions of their primary motivations for becoming involved in the MEWP? and (2) How do PLs' perceptions of such motivations compare to the outcomes they experience due to their MEWP involvement? Findings indicate that participants' motivations and outcomes were related to three overlapping themes: (a) educational philosophy, educational goals, and/or career goals, (b) the implementation of peer group work, and (c) reciprocal benefits related to their engagement with students.

Perry, A. L. (2018). *Black male student success in higher education: A case study of the Meyerhoff Scholars Program*. (Ph.D. dissertation), Regent University.

Black males face many challenges as college students. The effects of those challenges often manifest in many of them not graduating from college. Though there is no shortage of research and commentary concerning Black males not graduating from college, the issue lies in the relevancy of the research that is being presented. Scholars have continually discussed the myriad reasons why Black men do not graduate from college; however, the further purporting of such information is becoming increasingly derivative. Despite the abundance of research that has been completed concerning the obstacles that prevent Black males from graduating from college, there has been no significant progress made to thwart their lack of progress or research concerning the same. The purpose of this qualitative study was to determine some of the factors that have led to Black males being successful in the Meyerhoff Scholars Program. Data were collected by interviewing Black males who had graduated from the Meyerhoff Scholars Program within the past 2 years. The major finding in this study was that the causal condition of attending Summer Bridge and Selection Weekend helped the participants in many ways to become successful in the Meyerhoff program. The context of family support is where the men were first motivated to be successful. The culture of success, which emerged as the central phenomenon of the study, was prevalent throughout the program and helped to influence success. The strategies of success implemented by the University of Maryland, Baltimore County (UMBC) came by way of support from the administration of UMBC, and the consequence of these success activities resulted in the formation of a Meyerhoff community within the UMBC community.

Peterson, L., Epperson, J., Lopez, R., Schug, K., & Tiernan, C. (2013). *Experience with a modified Emerging Scholars Program in high-loss mathematics and chemistry courses*. Conference Proceedings of the 5th First Year Engineering Experience (FYEE) Conference, Pittsburg, PA.

The University of Texas at Arlington (UTA) was awarded an NSF STEP grant in 2009 for a project called AURAS, the Arlington Undergraduate Research based Achievement for STEM. The overall goal of the NSF STEP program is to increase the number of graduates in science, technology, engineering and math (STEM) majors. Clearly, success in entry-level courses was a necessary first step in moving on to graduation for students majoring in Chemistry / Biochemistry, Physics, Mathematics and Engineering. A number of freshman-level courses in math and chemistry were targeted for intervention because of their high drop and failure rates that were predictive of student exit from the STEM major: Pre-calculus, Calculus I, Calculus II, General Chemistry I, and Chemistry for Engineers. The Emerging Scholars Program (ESP) model was used to develop courses that were then offered to incoming freshmen beginning in Fall 2010. This extended abstract presents an overview of the AURAS program to date and

ongoing efforts to make the program sustainable by the university at the termination of NSF funding.

Peterson, L. L., Tiernan, J. C., Schug, K. A., Lopez, R., & Álvarez, J. A. M. (2018). *Board 117: Lessons Learned: Using Modified Emerging Scholars Program Concepts in the Development of STEP Grant – Funded Initiatives* Paper presented at the 2018 ASEE Annual Conference & Exposition, Salt Lake City, UT.

AURAS, the Arlington Undergraduate Research-based Achievement for STEM, is a project undertaken at The University of Texas at Arlington (UTA) under an NSF STEP grant. Since the goal of the NSF STEP program is to increase the number of graduates in science, technology, engineering and math (STEM) majors, it was recognized that success in entry-level courses was a necessary first step in improving graduation rates of students majoring in Chemistry / Biochemistry, Physics, Mathematics and Engineering. Freshman-level courses in math and chemistry were targeted for intervention because of their high drop and failure rates: Pre-calculus, Calculus I, Calculus II, General Chemistry I, and Chemistry for Engineers. The Emerging Scholars Program (ESP) model was used to develop courses that were then offered to incoming freshmen beginning in Fall 2010. The central features of ESP are a problem-based approach to learning with a focus on high-level work rather than remediation, a welcoming community with shared academic interests, collaborative learning and small group interaction, with an underlying goal of increasing diversity by increasing minority student successes. In addition to the regular lecture and labs associated with the courses, ESP students were required to attend two two-hour ESP seminar/workshops per week for Pre-calculus and Calculus I, one two-hour session for Calculus II, and one four-hour ESP workshop per week for Chemistry. Marked improvements in pass rates and a decrease in the drop rates for the participants in the AURAS classes were noted during the first three semesters. Since plans for institutionalization was a requirement of the STEP funding, efforts were made to make the AURAS classes less costly, so that they could be sustained in the institution only by the funds generated from tuition of students retained. However, it became apparent at the beginning of year 3 that major revisions were needed with a focus on sustainability if the promise of the grant funding was to be attained. Three initiatives were begun: mathematics course redesign, institution of an engineering problem-solving class, and further development of research methods components. Each of these initiatives was successfully completed and fully institutionalized. Now, at the conclusion of the AURAS project, the team is looking back to extract lessons learned as a result of this work, including culture changes in the colleges of engineering and science, classroom modifications which resulted from demonstrated improvements, and recognition of a role for science and engineering education per se. The poster will detail lessons learned which have applicability to the community as a whole.

Pilgrim, M. E., & Gehrt, J. (2016). An alternative calculus I course. *Mathematics and Computer Education*, 50(2), 120-129.

The article describes their version of the ESP program for their campus.

Raspberry, W. (1999, 1999, February 8). Mechanics of a 'miracle', *The Washington Post*, p. A19.

This newspaper article describes the Emerging Scholars Program (ESP) and its historical origins.

Reid, A. G. (2016). *Understanding the underrepresented minority experience in undergraduate calculus courses*. (Ph.D. dissertation), University of Delaware.

The purpose of the study was to investigate the experiences of underrepresented minority (URM) students enrolled in calculus courses at the University of Delaware. Coupling qualitative

research methodology with critical race theory and social cognitive theory, the researcher chronicled the experiences of seven students negotiating the achievement gap in mathematics at this primarily white institution. The study allowed the students to explore their perceptions of access to mathematics, academic achievement in mathematics, and the effect of race and/or racism on their performance in college mathematics. While the national trend shows that underrepresented students earn lower overall grade point averages than their nonunderrepresented counterparts, there is little specific information about their performance and experience in these courses (Nettles et al., 1986). A survey conducted by Treisman (1992) found that there are four widely held beliefs about the causes of minority (underrepresented) student failure in college calculus: low motivation, poor academic preparation, lack of family support, and low family income. Research by Bressoud, Carlson, Mesa, & Rasmussen (2013) indicates that students at research institutions offering Calculus I courses are least likely to maintain student confidence in their mathematical abilities, enjoyment of mathematics, and interest in continuing in the mathematics needed to pursue their intended careers. In order to capture the perspectives of underrepresented students taking calculus courses, interviews were conducted with participants targeted through an electronic survey instrument. Data analysis was performed through narrative inquiry, using the interview transcripts through a number of lenses such as stories simultaneously situated within a particular context and within a wider cultural context. Subsequently, analysis of the data indicated that students desire a number of changes within the curriculum, pedagogy, and calculus sequence, including more one-on-one interaction with the course instructor, as well as more collaborative work in the classroom. While microaggressions were also explored in these settings, they were shown not to have a significant impact on the success of the targeted participants.

Rose, S. J. (2013). *The effectiveness of pre-course and concurrent course interventions on at-risk college physics students' mechanics performance*. (Ph.D. dissertation), University of Illinois at Urbana-Champaign, Urbana-Champaign, IL.

Students at risk for poor performance or withdrawal in post-secondary education, and particularly in scientific fields, are the focus of educators interested in improving retention and persistence rates in college science studies, as well as equity and diversity of their institutions' graduates and the overall workforce. This study aimed to assess the effectiveness of two intervention courses—one prior and one concurrent to the course of interest—on at-risk students' performance in an introductory college physics course. Participants were engineering freshman with prerequisite calculus credit enrolled in an introductory mechanics course—the target course—at a large Midwestern university. Students at different levels of risk were identified by logistic regression analysis on collected measures of prior education, national exam scores, university diagnostic scores, as well as demographic and socio-economic information. The study had a quasi-experimental, posttest only, non-equivalent control group design, which utilized propensity score matching to assess the differential impacts of the two approaches on at-risk student performance and persistence in the target course. Data analysis gauged the size and nature of the interventions' impact on participants' performance. By controlling for additional factors, analyses allowed for making generalizations related to the characteristics of students at risk for poor or failing performance in, or withdrawal from, college-level physics. Analyses indicated that students from both interventions performed better on the target course's assessments. The students who participated in the concurrent course instruction, which is focused on metacognitive skill development, saw twice the performance gain than the Pre-Course students when compared to their peers who received no intervention

Schneiders, B. B. (2014). *The effectiveness of calculus workgroup on student performance in calculus: A mixed-methods approach*. (Ph.D. dissertation), University of Colorado at Boulder, Boulder, CO.

Workgroup is an optional pass/fail supplemental course to Calculus that emphasizes collaborative work in a small group setting. We conduct a mixed-methods study to evaluate the effectiveness of Calculus 1 Workgroup on student performance in Calculus 1 for Engineers. We analyze a dataset that contains 733 observations and 35 predictor variables. We use AnswerTree software by SPSS to create decision trees to assess the biggest predicting factors for Calculus 1 course-grades. We then compare Workgroup students and non-Workgroup students based on factors resulting from AnswerTree, including predicted grade point average (PGPA), to evaluate the effectiveness of Workgroup on student performance. We find that in the academic year of 2013 -2014, Workgroup did not significantly improve performance in Calculus. We also analyze a survey taken by Workgroup students to have a better understanding of student attitudes toward Calculus, Workgroup, and Oral Assessments, a large component of Workgroup. Within the subgroup of Workgroup students, we compare students who are required to enroll in Workgroup to those who choose to enroll. We show that students who enroll in Workgroup have a higher PGPA on average than those who do not enroll. Further, we show that students who are required to take Workgroup (by scholarship) have a significantly higher PGPA than students who choose to enroll in Workgroup. Yet, we find no significant difference in course grade between required Workgroup students, non-required Workgroup students, and non-Workgroup students. Lastly, we note a correlation between the requirement to take Workgroup and attitude toward Workgroup.

Staff. (1995, August 6). Emerging Scholars Program produces success: Students seeking to improve grades get support, guidance, *Syracuse Herald American*, p. C1.

This newspaper article describes the use of the Emerging Scholars Program (ESP) at the State University of New York-Morrisville to improve student success in math courses by historically underrepresented students.

Staff. (1999). So much for the theory that Blacks can't do mathematics. *The Journal of Blacks in Higher Education*(25), 48-49.

This article provides the rationale for the Emerging Scholars Program (ESP). It provides an interview with Dr. Treisman who originated the ESP approach to increasing the success of Blacks and other historically underrepresented populations in math courses. A summary of the success of ESP at the University of California-Berkeley is provided.

Stoelinga, T. M. *Students' Identification with discursive obligations in a Calculus workshop*. (Ph.D. dissertation), University of Illinois at Chicago, Chicago, IL. Available online:

https://dspace-prod.lib.uic.edu/bitstream/handle/10027/22073/DISSERTATION_FINAL_STOELINGA_07-26-2017.docx?sequence=2&isAllowed=y

Research on equity in mathematics education has documented the benefits of group work and classroom discourse, both of which can support learning of mathematics content (e.g., Freeman, et al., 2014; Kilpatrick, Swafford, & Findell, 2001; Webb, et al., 2013) and the development of identities of participation among students in discourse-rich classroom environments (e.g., Boaler & Greeno, 2000; Cobb, Stephan, & Gravemeijer, 2001; Gresalfi, 2009; Hand & Gresalfi, 2015). Less is known, however, about how and why individual students vary in the ways they take up opportunities to participate in discourse within a given classroom ecology. These issues are particularly salient for students of color and female students whose marginalization from mathematics classroom discourse has been well documented in the literature (e.g., Chizhik, 2001; Cohen & Lotan, 2014; Spencer, Logel, & Davies, 2016; Steele, Spencer, & Aronson, 2002). In this phenomenological case study, I examine a diverse group of students' descriptions and explanations of their participation in discourse in an Emerging Scholars Program (ESP) calculus workshop, an undergraduate-level, elective course where

group work is emphasized in support of students' success in the concurrent calculus course. A localized, explanatory theory is generated for the patterns and differences in discourse participation that emerge among students. Instances of discourse are analyzed from a sociocultural perspective in terms of students' moment-to-moment identifications with discursive obligations, defined by the socially constructed norms of what it means to be a successful contributor to mathematical conversations in the workshop community. Identifications emerge through students' fulfillment (or non-fulfillment) of these obligations occurring in modes of affiliation, compliance, avoidance, or resistance. Variations in identification are primarily explained in terms of the situational roles students describe themselves occupying relative to other participants. Furthermore, students often interpret these roles in connection to identity-related factors acting at sociocategorical, community, school, classroom, and intrapersonal levels (c.f., Martin, 2000, 2012). Implications for ESP workshop design and mathematics classroom discourse are discussed, with focus on supporting equitable mathematics discourse in workshop settings among students from marginalized groups.

Treisman, P. U. (1983). Improving the performance of minority students in college-level mathematics. *Innovation Abstracts*, 5(17). Available online: ERIC database. (ED234874). This article provides an overview to the Emerging Scholars Program (ESP) developed at the University of California, Berkeley. ESP has five functions: Building a community of minority freshmen that is academically oriented and a source of peer support; Providing minority students with an extensive orientation to the University, and with ongoing academic advising; Monitoring of student academic progress and their adjustment to the University environment, and advocating students; collective and individual interests; Providing minority freshmen with ongoing supplementary instruction in reading the technical language of mathematics; and linking high school-level and undergraduate-level affirmative action efforts.

Treisman, P. U. (1985). A model academic support system. In R. B. Landis (Ed.), *Improving the retention and graduation of minorities in engineering handbook*. Available online: ERIC database. (ED259042).

This chapter provides an overview to the Emerging Scholars Program (ESP) developed at the University of California, Berkeley. The program has four objectives: build a community of minority freshmen that focuses on achieving academic excellence and that becomes a source of peer support; provide extensive, year-long supplementary instruction for minority students; orient minority students to the university and to assist their adjustment, where necessary, to advocate their collective and individual interests; and monitor the students' academic progress and to furnish ongoing academic advising. The mechanics of establishing the program, recruiting students, training facilitators, and monitoring the workshop activities is provided. The chapter concludes with several data studies concerning academic achievement of the Chicano and African-American students. A sample worksheet is provided in the appendix.

Treisman, P. U. (1986). A study of the mathematics performance of Black students at the University of California, Berkeley [Dissertation, University of California, Berkeley, 1985]. *Dissertation Abstracts International*, 47(05), 1641.

The following is a dissertation study from the University of California, Berkeley. Freshman mathematics courses have all-too-often been a burial ground for the aspirations of many minority students who have entered college with the goal of majoring in some area of engineering, medicine, or natural or mathematical science. The Professional Development Program (PDP) Mathematics Workshop, a project of the U.C. Berkeley faculty, challenges remedial approaches to assisting such students and provides instead a novel honors program promoting academic excellence and the development of leadership skills. The PDP program was be renamed on other campuses: Emerging Scholars Program, Treisman model, Gateway

Science workshop, among others. Specifically, students obtain instruction, sympathetic and knowledgeable academic and personal counseling, intensive study experience in a peer group, and aid in threading the bureaucratic maze. Since its inception in 1978, the Workshop has had a dramatic effect both on minority students' performance in mathematics and on their persistence in the University. Chapter I of this dissertation describes the development of the PDP Workshop Program and explains the author's assumptions and methods. The status of black students in University mathematics courses is analyzed; their isolated studying behavior is contrasted with the collective studying of identified groups of successful students. Additional barriers to blacks' success in mathematics courses are enumerated. A pilot project, conducted in 1977-78 and involving both academic and non-academic support for a small number of black students is described. Chapter II describes the PDP mathematics Workshop. It details the Workshop's basic elements: a focus on excellence rather than on avoiding failure, an emphasis on collaborative learning, and faculty sponsorship. The recruitment and orientation procedures and instructional strategies employed during the Workshop sessions are described. Chapter III describes the extent to which the Workshop program has met its goals. It concludes that the average Math 1A grade earned by black Workshop participants is consistently above one full grade higher than that earned by black students who did not participate in the program. Moreover, this finding holds true in comparisons involving the following categories of students: regular vs. special admits, Educational Opportunity Program (EOP) vs. non-EOP, College of Engineering vs. others, males vs. females, and low vs. medium vs. high mathematics Scholastic Aptitude Test scores. Other evidence of the program's success includes elevated rates of graduation from the University, and graduation with a math-based degree.

Treisman, P. U. (1989). Mathematics workshop revamped. *UME Trends*, 8-9.

This short article describes the Emerging Scholars Program (ESP) and how it has been redesigned to meet current needs of students. Changes in ESP included permitting non minority students to participate, increasing the frequency of the workshops meetings from two to five times weekly, and the use of teaching assistants to facilitate the sessions. These changes were made in response to the need to produce more math, science, and engineering students.

Treisman, P. U. (1990). *Improving academic performance in mathematics*. Conference Proceedings of the Freshman year in science and engineering: Old problems, new perspectives for research universities, Ann Arbor, MI. Available online: ERIC database. (ED352249). This chapter provides a short overview to the Emerging Scholars Program (ESP) developed at the University of California, Berkeley.

Treisman, P. U. (1992). Studying students studying calculus: A look at the lives of minority mathematics students in college. *College Mathematics Journal*, 23(5), 362-372. Available online: http://bfc.sfsu.edu/cgi-bin/prob.pl?Uri_Treismans_Dolciani_Lecture.

This article describes a project that addresses the problem of the failure of African-America and Hispanic students in calculus. The proposed solution is offering students of color a combination of workshops with intensified sections of the calculus course that challenges the students. The author reviews the history of the Emerging Scholars Program (ESP) developed at the University of California, Berkeley. The early part of the article describes his findings that led to creation of ESP: many Black and Latino students desired to major in math and science but few completed their introductory courses; prevailing ideas about why minority students failed were inaccurate; affirmative action programs were not producing math and science majors; and many minority students did not use the academic services designed to serve them. As a result of the author's research, the ESP program was crafted to meet the needs of minority math and science students. Rather than trying to change students, the author concluded that it was the institution that needed to make significant changes in the learning environment.

Vandenbussche, J., Ritter, L., & Scherrer, C. (2018). An incentivized early remediation program in Calculus. *International Journal of Mathematical Education in Science and Technology* doi: 10.1080/0020739X.2018.1458340

Strong prerequisite skills are essential to student success in the calculus sequence; however, many students arrive in Calculus I with weaknesses that are difficult for them to overcome. In this paper, we describe an approach to early incentivized remediation of prerequisite material in a Calculus I course. We present data that supports the idea that a lack of prerequisite knowledge is a significant hurdle for students, but also that participation in the remediation program is correlated with student success. In addition, the program allows for the very early identification of students at high risk of failing. The program is easy to implement, and it would be adaptable to a variety of other courses for which prerequisite knowledge is essential for success including science courses, engineering courses and other mathematics courses.

Walker, D. R. (2003). *Combating isolation, enhancing success: Emerging Scholars Program in chemistry*. Conference Proceedings of the 226th American Chemical Society National Meeting, New York, NY. For more information, contact the author at the Chemistry Department and Biochemistry, The University of Texas at Austin, A5300, Austin, TX 78712, drwalker@austin.cc.tx.us

The Emerging Scholars Program (ESP) was implemented with an introductory chemistry course at the University of Texas at Austin. The paper discusses positive student outcomes as well as program implementation challenges.

Watkins, B. T. (1989). Many campuses now challenging minority students to excel in math and science. *Chronicle of Higher Education*, 35(40), A13, 16-17.

This newspaper story describes the adoption of the Emerging Scholars Program (ESP) at other institutions to increase the academic achievement of students of color enrolled in math and science courses. It provides a short history of the development of ESP by Uri Treisman at the University of California, Berkeley.

Watkins, C. H. (2017). *Quantitative study of Math Excel Calculus courses*. (Ph.D. dissertation), Oregon State University. Available online: <http://hdl.handle.net/1957/60588>

About twenty years ago, a large, rural, doctoral granting institution with an undergraduate population of approximately 24,000 in the pacific northwest of the United States established the Math Excel program. Students would attend lectures three times a week for 50 minutes like a traditional course, and they would also attend two workshops per week that are two hours each, in contrast to traditional courses with a 50 minute recitation once per week. For several years the university would offer a few sections of Math Excel for several 100- and 200-level mathematics courses each term. During the 2013-2014 academic year, the university dedicated all sections of Math Excel to a particular section of calculus and implemented a Math Excel section of a calculus every quarter with the sequence of courses consisting of differential calculus, integral calculus, and vector calculus. A Math Excel version of differential calculus, integral calculus, and vector calculus were offered during fall term, winter term, and spring term respectively. The purpose of this thesis is to investigate how students in the Math Excel calculus courses performed compared to students in traditional calculus courses. First, a logistic regression model will be used to model the relationship between pass rates and enrollment in a Math Excel calculus course after controlling for predictor variables and a two-sample t-test will be performed to compare pass rates of students in a Math Excel calculus course and a traditional calculus course. Next, a linear regression model will be used to model the relationship between grade points and enrollment in a Math Excel calculus course and a two-sample t-test will be performed to compare grade points of students in a Math Excel calculus

course and a traditional calculus course. Finally, a two-sample t-test will be performed to examine if there is a difference in average grade earned for students that took a Math Excel calculus course in the previous term and students that did not. In each of these cases I found that there is not significant evidence that the Math Excel program has a greater effect on student pass rates, grades, or future grades in calculus courses than traditional versions of the calculus courses. Based on these results, I suggest that more data is gathered to see if there is a change in the results, an in depth analysis of students' demographics and activities outside the classroom, and looking at the instructor effect and execution in the classroom in order to understand how and whether the Math Excel program benefits students in different ways.

Watkins, J., & Mazur, E. (2013). Retaining students in Science, Technology, Engineering, and Mathematics (STEM) majors. *Journal of College Science Teaching*, 42(5), 36-41.
The article describes lessons learned from using ESP for more than three decades.

Wheeler, D. L. (1992). Teaching calculus to minority students helps them stay in college. *Chronicle of Higher Education*, A15.

This short account about the Emerging Scholars Program (ESP) describes its impact upon student persistence. It was estimated that 125 colleges have implemented some form of ESP to improve academic achievement of students.

Zumdahl, S. A. (1996). Mission impossible? Improving retention of science majors among minorities and women. *Journal of Chemical Education*, 73, 266-267.

This article describes the Merit Program for Emerging Scholars (MPES) in chemistry at the University of Illinois at Urbana-Champaign. MPES was established to improve retention of science majors among students of color and women. Research studies suggests that participants outperform nonparticipants.

Peer Assisted Learning (PAL)

Peer Assisted Learning (PAL) was developed at the University of Minnesota in 2006 to meet needs of students enrolled in STEM and other historically-difficult courses. The PAL program drew upon best practices from ESP, PLTL, and SI along with emerging learning practices to develop a model to meet high expectations placed upon it by the faculty and administrators. SI influenced the PAL approach through its procedures for conducting study review sessions. ESP influenced PAL through intensive use of problem-solving sessions for courses in STEM majors and mandatory attendance at weekly sessions. PLTL influenced PAL with its practice of embedding study review sessions as part of a companion class. Quantitative and qualitative studies reveal not only academic benefits for participating students, but also academic, vocational, and personal benefits for the students who serve as the PAL facilitators. More on PAL at <http://www.sciedu.ca/journal/index.php/ijhe/article/view/4151/2498>.

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online: <https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

2 - Homepage of the Peer Assisted Learning (PAL) Program developed at the University of Minnesota-Twin Cities. Available online: <https://www.arendale.org/peer-learning-resources>
This website contains publications and training materials used with the Peer Assisted Learning (PAL) program developed at the University of Minnesota-Twin Cities. The PAL program draws upon best practices from Emerging Scholars Program (developed by Dr. Uri Treisman at UC-Berkeley), Peer-Led Team Learning (developed at City University of New York), and Supplemental Instruction (developed at the University of Missouri-Kansas City). The program has been adopted for use at a small number of U.S. institutions..

7 - Homepage of YouTube videos related to Supplemental Instruction; Peer-Led Team Learning; and Peer Assisted Learning Program. Available online: <https://z.umn.edu/peerlearningyoutube>

This YouTube channel aggregates posted videos by peer learning programs related to Supplemental Instruction (UMKC model), Peer-Led Team Learning (CUNY model), and Peer Assisted Learning (UMN model). SI is also known by other names including PAL and PASS. Click on "playlists" tab in the main menu bar to locate the particular peer learning program or topic of interest. This YouTube channel is not formally associated with SI or PLTL but is managed by David Arendale who helped with a larger team to create the UMN PAL model. It is also a location where David Arendale posts videos of his scholarly interests with peer learning and includes interviews with student peer study group leaders and others.

Arendale, D., R. (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>

This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2014). Seminar course approach for study group leader training. *NADE Digest*, 6(2), 1-11. Available online: University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/200362>

At the University of Minnesota during fall 2006, a college-credit course was created to help group leaders apply educational theories during their study group sessions with the campus Peer Assisted Learning (PAL) program. This course was required of all new group leaders starting during fall semester. Rather than a didactic class format led by me as the instructor, a collaborative seminar model was employed. In the class, these students studied education theory articles and discussed how to apply this information to their weekly sessions. This understanding helped them create new learning activities not contained in the formal training program. It also made better sense of dynamics within the group and how to employ culturally-sensitive learning activities. This course was part of a larger required professional development component for the study group leaders. The course has seven learning objectives: (1) Identify and discuss the application of learning theories with peer-assisted learning groups. (2) Increase skill in small group management skills to achieve learning objectives. (3) Contextualize learning strategy modeling and instruction within the specific academic context area supported by PAL. (4) Learn to analyze the learning needs of others and make modifications to the learning environment. (5) Grow as an independent learner and build upon their current strengths through development of new learning strategies. (6) Further develop intellectual skills of analysis, synthesis, critical evaluation, and application through completion of course activities. (7) Adopt new strategic learning strategies to successfully apply with course material. The course requires students to make weekly journal entries through the course web site which is only viewable by the course instructor. The entries focus on the reflections about their academic and personal changes as a result of this experience. In addition, the PAL facilitators complete an extensive

end-of-term experience survey as a capstone reflection of their experience and how they changed academically and personally.

Arendale, D. R. (2014). Understanding the Peer Assisted Learning Model: Student study groups in challenging college courses. *International Journal of Higher Education*, 3(2), 1-12. Available online: University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/200361>

The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. This article provides a detailed overview of the PAL model and how variations of it are implemented at the institution. Quantitative and qualitative studies reveal not only academic benefits for participating students, but also academic and personal benefits for the students who serve as the PAL facilitators.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*.

Department of Curriculum and Instruction, University of Minnesota. Available online:

<https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational, something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Arendale, D. R., & Hane, A. R. (2014). Holistic growth of college peer study group participants: Prompting academic and personal development. *Research & Teaching in Developmental Education*, 31(1), 7-29. Available online: University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/200358>.

This qualitative study focused on observed changes in personal and professional attitudes and behaviors by the students that participated in the Peer Assisted Learning (PAL) group at the University of Minnesota. The Peer Assisted Learning (PAL) program at the University of

Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. The PAL model is based on best practices from several national peer learning models including Supplemental Instruction, Peer-led Team Learning, and the Emerging Scholars Program. Arthur Chickering's Comprehensive Theory of Personal Change was used to analyze the data. Four themes emerged: higher levels of engagement, higher confidence, increased interpersonal skills, and improved critical thinking skills. Higher engagement with the learning process was manifested through them talking more, displaying more comfort while speaking, and asking questions of the PAL facilitators and others in the group. Increased confidence was evidenced by a reduction of frustration and fear and replaced with displays of new cognitive and metacognitive thinking, expressions of self-confidence in ability to solve problems and learn new academic content independently. Increased interpersonal skills was higher rates of interaction within the study group, helping others during small group activities and within the large group discussions, making friends with the participating students and the facilitator, and actively working with fellow students to solve problems rather than preferring self-reliance and working alone. The final theme of improved critical thinking was displayed by increased ability to understand and explain the reasoning behind concepts. The article concludes with several recommendations how study group programs could become more intentional with fostering personal and professional growth of the study group participants and also areas for further research in this area.

Arendale, D. R., & Hane, A. R. (2016). Adaptability and flexibility when conducting and planning peer study group review sessions. *The Learning Assistance Review, 21*(2), 9-37. Available online: University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/200331>. While many research studies have analyzed the effectiveness of study group programs for the participants, few have examined the process that the study group leaders employ in offering effective sessions. This manuscript focuses on the decisions the study group leaders make before, during, and after these study group sessions. Connections are made between the behaviors of the study group leaders and that of novice and experienced teachers. Understanding the processes that the study group leaders employ provides insights that could be enhanced by additional training by the study group program administrators. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. This manuscript is currently under review by a journal and is not available for review.

Arendale, D. R., & Hane, A. R. (2016). Peer study groups as catalyst for vocational exploration. *Journal of Developmental Education, 39*(2), 2-4, 6, 10-11, 26-27. Available online: University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/200357>. Peer assisted learning programs generate more outcomes than increasing academic achievement for participants. Studies, including this one, document impact with personal, vocational interest exploration, and job skill development for facilitators. This study explores why these programs generate these outcomes through linking leading theorists to the research outcomes. Peer learning programs present an untapped cocurricular experience that could be more powerful if it was intentional rather than serendipitous with professional development outcomes. The peer learning program occupies the intersection between student academic assistance and teacher candidate preparation. The program can serve a valuable role as a learning experience before traditional student teaching as well as generator of more students interested in pursuing a teaching career. With the highly competitive job market for today's

graduates, institutions must use every opportunity to increase job readiness skills of its graduates. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Arendale, D. R., Hane, A. R., & Fredrickson, B. S. (2019). *College credit training and professional development course for PAL facilitators*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN.

At the University of Minnesota during fall 2006, a college-credit course was created to help group leaders apply educational theories during their study group sessions with the campus Peer Assisted Learning (PAL) program. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. This course was required of all new group leaders starting during fall semester. Rather than a didactic class format led by me as the instructor, a collaborative seminar model was employed. In the class, these students studied education theory articles and discussed how to apply this information to their weekly sessions. This understanding helped them create new learning activities not contained in the formal training program. It also made better sense of dynamics within the group and how to employ culturally-sensitive learning activities. This course was part of a larger required professional development component for the study group leaders. The course has seven learning objectives: (1) Identify and discuss the application of learning theories with peer-assisted learning groups. (2) Increase skill in small group management skills to achieve learning objectives. (3) Contextualize learning strategy modeling and instruction within the specific academic context area supported by PAL. (4) Learn to analyze the learning needs of others and make modifications to the learning environment. (5) Grow as an independent learner and build upon their current strengths through development of new learning strategies. (6) Further develop intellectual skills of analysis, synthesis, critical evaluation, and application through completion of course activities. (7) Adopt new strategic learning strategies to successfully apply with course material. The course requires students to make weekly journal entries through the course web site which is only viewable by the course instructor. The entries focus on the reflections about their academic and personal changes as a result of this experience. In addition, the PAL facilitators complete an extensive end-of-term experience survey as a capstone reflection of their experience and how they changed academically and personally.

Arendale, D. R., Hane, A. R., & Fredrickson, B. S. (2019). *Professional identity development for PAL facilitators*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN.

Research studies with study group leaders discovered that they constructed their own professional identity beyond what was contained in their official job description for work in the peer academic support program. These study group leaders developed professional identities more congruent with new teachers than with fellow student paraprofessionals. Insights from this study help explain behaviors exhibited by the study group leaders and provide opportunities for enhanced training and professional development growth in their peer study program experiences. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. This manuscript is currently under review by a journal and is not available for download at this time.

Arendale, D. R., Hane, A. R., & Fredrickson, B. S. (2020). *Academic skill and knowledge growth of PAL facilitators*. Unpublished manuscript. Department of Curriculum and Instruction, Minneapolis, MN.

This manuscript focuses on the academic skill and knowledge growth of PAL facilitators. While most peer learning publications focus on outcomes of the study group participants, this article examines the impact of participation on the study group leaders. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Arendale, D. R., Hane, A. R., & Fredrikson, B. S. (2020). *Emergence of leadership self-concept for PAL facilitators*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN.

While many publications have indicated preliminary findings that participation in a peer learning program as the study group leader produces new leadership skills, understanding the mechanism for this change is not heavily explored. This manuscript connects theory and practices to understand their relationship with one another and how this experience could be enhanced for the study group leaders. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves. This manuscript is under review by a journal and not yet available for review.

Arendale, D. R., & Lilly, M. (Eds.). (2014). *Guide for Peer Assisted Learning (PAL) facilitators*. Minneapolis, MN: Department of Postsecondary Teaching and Learning, College of Education and Human Development, University of Minnesota. Available online: ERIC database (ED546634) and <http://z.umn.edu/facilitatortoolkit>

The 180+ training workbook is used with the student facilitators of the Peer Assisted Learning (PAL) program at the University of Minnesota. Following a basic overview of the PAL model, the workbook is organized around the basic principles upon which the PAL program operates: (a) theory guides PAL learning activities; (b) express multicultural competency; (c) facilitate a blend of PAL session activities; (d) shift PAL session authority and ownership to the participating students; (e) both facilitators and participants model productive learning behaviors during the study sessions; (f) PAL sessions vary in different academic content areas; (g) model student self-monitoring strategies; and (h) engage students with each other regarding the academic content. The workbook also incorporates stories from the PAL facilitators and their experiences in the program. These stories are excerpted from a longer book edited by Lana Walker in 2010, *Two (or more) heads are better than one: Adventures in leading group learning, a facilitator storybook*. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Benson, J., & Lilly, M. (2017). *Peer-Assisted Learning Program: Guide for team leaders*. Minneapolis, MN: SMART Learning Commons, University of Minnesota. Available online: University of Minnesota Digital Conservancy, <https://z.umn.edu/PALleaderguide>

The Guide for Team Leaders is designed to inspire personal exploration of leadership within PAL, SI, and related academic support programs. Depending on the program, there may already be an existing structure in place where an experienced facilitator/leader mentors their

own team of peers functioning in a similar role. These team leaders can create opportunities for members to interact, share knowledge, and promote the professional growth of their peers. This guide was originally designed to support the growth of such team leaders within the Peer-Assisted Learning (PAL) Program at the University of Minnesota. However, as this work progressed, it became clear that the ideas were applicable to a variety of team leadership roles. This hands-on guide delves into such topics as meta-cognition, team member identity and participation, meeting/discussion topics and activities, and much more. Interactive activities encourage readers to reflect on these topics, while providing ample space for them to record their insights. It complements the Guide for Peer Learning Facilitators and utilizes activities in *Tried and Tweaked*, both of which are works developed by the University of Minnesota's PAL Program.

Cheng, D., & Walters, M. (2009). Peer-Assisted Learning in mathematics: An observational study of student success. *Australasian Journal of Peer Learning*, 2(1), 22-39. Available online: <http://ro.uow.edu.au/ajpl/vol2/iss1/3>.

The Peer Assisted Learning (PAL) program at the University of Minnesota includes design features from the Supplemental Instruction (SI), Structured Learning Assistance (SLA), Peer-led Team Learning (PLTL), and the Emerging Scholars Program (ESP). The PAL program requires mandatory attendance of each weekly PAL session. To estimate the impact of attending weekly math PAL sessions has on students' chances of successful course completion, an observational study was conducted fall 2008 of 534 University of Minnesota students enrolled in two undergraduate math courses. In addition to measuring PAL attendance, 16 other factors were considered in this analysis. Success was defined as passing the class with a C- or above, and failure as receiving a D+ or below, including withdrawals. In addition to PAL attendance, 16 other factors were considered in their analysis. Attending all PAL sessions during the semester corresponded with ten times higher odds of success than attending one. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Ediger, K.-A. (2007). *Peer Assisted Learning sessions: Building a community of learning and achievement*. Unpublished manuscript. Department of Postsecondary Teaching and Learning, University of Minnesota. Minneapolis, MN.

This study examined the first two years of the Peer Assisted Learning (PAL) program developed at the University of Minnesota. The PAL program is based on several national peer learning programs including Supplemental Instruction, Peer-led Team Learning, and the Emerging Scholars Program. The evaluation revealed benefits for both the PAL participants and the facilitators. Some of the PAL courses examined had a mandatory attendance policy and others were available to enrollees who attended voluntarily. For PAL courses where attendance was mandatory, a student was deemed a nonparticipant if they failed to attend at least half of the PAL sessions during the academic term. Both a quantitative and qualitative study was conducted. The quantitative study revealed statistical significance for the PAL participants at the $p < .05$ or lower for earning a higher percentage of A grades and lower rates of C, D, F, and course withdrawal as compared with PAL nonparticipants. The qualitative study of the PAL facilitators identified five outcome themes in their own experience in the PAL program (a) enhanced personal learning and study skills, (b) increased group facilitation and decision making skills, (c) increased confidence and enjoyment during learning, (d) positive relationships with participating students, and (e) sense of community in helping others grow and learn. The PAL facilitators also perceived changes among their PAL participants (a) increased analytical skills; (b) increased confidence and risk taking behaviors; (c) increased importance and

effectiveness of working in small groups; (d) increased comfort when engaging and sharing ideas with other students; and (e) increased academic autonomy, diversity of study strategies, and self-reliance. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Lilly, M. (2018). *Cultural competence*. Paper presented at the 10th International Conference on Supplemental Instruction, Seattle, WA. Available online: <https://info.umkc.edu/si/wp-content/uploads/2018/06/Cultural-Competence-Mary-Lilly.pdf>.

In the classroom, being culturally competent involves an understanding of how cultures differ under the surface and how cultures respond differently to similar situations

Lilly, M., & Goergen, K. (2011). *Peer Assisted Learning: Consistency goes with success*. Unpublished manuscript. SMART Learning Commons, University of Minnesota-Twin Cities. Minneapolis, MN.

This study examined academic outcomes for PAL participants in college algebra and precalculus in the 2009, 2010, and 2011 academic years, focusing on the variable of PAL session attendance. Students attending nine or fewer sessions were considered nonparticipants. Attending PAL sessions ten or more times placed them in the participant category. For purposes of the study, a high threshold was established to qualify as a PAL participant. Two different introductory mathematics courses were examined repeatedly over the three-year period. The PAL participants earned a higher final course grade that was statistically significant ($p < .05$). The difference in grades between the PAL participants and nonparticipants ranged between one-half to a full-letter grade higher for the PAL participants. These findings reinforced the UMN model for the PAL program of requiring attendance so students will realize PAL's maximum positive benefits. The Peer Assisted Learning (PAL) program at the University of Minnesota is a primary academic support program for historically difficult, introductory college courses that serve as gatekeepers to academic degree programs. Based upon operating principles of other programs and educational theories, PAL is integrated into the courses it serves.

Lilly, M., & Sands, J. (2019). *Guide for Peer Learning Facilitators*. SMART Learning Commons. University of Minnesota-Twin Cities. Available online: University of Minnesota Digital Conservancy, <https://z.umn.edu/PALfacilitatorguide>

The Guide for Peer Learning Facilitators is the foundation of a formal training program at the University of Minnesota, in which undergraduate students learn how to lead weekly study sessions for their peers in a classroom setting for specific courses – primarily ones with high enrollment and prone to higher than average D,F, Withdrawal rates. Training and professional development throughout the academic year have been the cornerstones to the success the facilitators have realized. The eight principles that govern the program – crafted by Dr. David Arendale in his original publication of the same name – address topics such as cooperative learning theory, multicultural competency, metacognition, study strategies, and group dynamics. The book, updated in April 2019, also provides a directory of useable forms and worksheets and a bibliography of related publications.

Paz, J., & Lilly, M. (Eds.). (2014). *Tried and tweaked: Activities to re-energize peer learning sessions*. Minneapolis, MN: SMART Learning Commons, University of Minnesota. Available online: University of Minnesota Digital Conservancy, <https://z.umn.edu/PALactivities>
“Tried and Tweaked: Activities to re-energize peer-learning sessions” is a collection of activities designed and conducted by undergraduate students at the University of Minnesota to use in

their role as facilitators leading study sessions in the University's Peer-Assisted Learning (PAL) Program. The activities were developed and tested during their weekly sessions and focus on two particular guiding principles of the PAL program (there are eight): modeling productive learning behaviors, and engaging students with each other. Each activity offers suggestions for preparation, supplies needed, appropriate courses, and the type of student grouping used in the activity. The spirit in which these session activities are designed is one of creating an informal, social, and welcoming environment. This is a companion volume to the Guide for Peer Learning Facilitators, which details all eight principles.

Sands, J., Lilly, M., Arendale, D. R., & (Eds). (2017). *Guide for Peer-Assisted Learning (PAL) facilitators*. Minneapolis, MN: SMART Learning Commons, University of Minnesota. For more information <https://www.lib.umn.edu/smart/guide-peer-learning-facilitators>
This training manual is used with the Peer Assisted Learning (PAL) program at the University of Minnesota. It is organized around eight principles for the student paraprofessionals to guide their work with assisting students to excel in historically-difficult courses.

Walker, L. (Ed.). (2010). *Two (or more) heads are better than one: Adventures in leading group learning, a facilitator storybook*. Minneapolis, MN: SMART Learning Commons, University of Minnesota. Available online: University of Minnesota Digital Conservancy, <https://z.umn.edu/PALadventures>

Whether as study group leaders, undergraduate TA's, or tutors, college students working in peer-led academic support programs have a unique role in the learning environment - acting as model students and sharing their productive study behaviors. Along the way, these students gather wisdom and insight into what works and what doesn't when assisting their fellow undergrads. The Peer-Assisted Learning (PAL) Program at the University of Minnesota has compiled a storybook to capture some of that wisdom so that those who follow can benefit from their predecessors' experiences - some positive, some challenging, but all "learning opportunities". Two (or More) Heads are Better than One: Adventures in leading group learning is a collection of first person narratives, told by peer facilitators and recorded and edited by one of the PAL program's undergraduates - Lana Walker. What began as her thesis project, the collection turned into a book that has become a staple in the pre-semester training workshops and weekly team meetings. The stories are a springboard for discussions of program policies, the particulars of cooperative learning, and a clearer understanding of roles and boundaries. The format is engaging; peer leaders find some of the stories "funny" and laugh along with the narrators about their experiences. Anyone working with undergrads will see how they can benefit from these honest and thoughtful reflections, carefully grouped by topic, with stimulating, open-ended questions at the end of each chapter.

Peer-Led Team Learning (PLTL)

The program was developed at the City University of New York in the 1990s. Support through a grant from the National Science Foundation has assisted in the model being adopted by more than 100 institutions. Student-leaders (peers) guide the activities of small groups of students in weekly Workshop meetings. The students work through challenging problems that are designed to be solved cooperatively. The peer leaders are trained to ensure that the students are actively and productively engaged with the material and with each other. This methodology offers a number of educational opportunities: the supportive format encourages questions and discussions that lead to conceptual understanding; students learn to work in teams and to communicate more effectively; peer leaders learn teaching and group management skills. The following are guiding principles of PLTL: the program is integral to the course through required attendance at two hours of workshop time weekly; peer leaders are trained in group leadership and course content; activities and materials are challenging yet accessible (e.g., worksheets, supplemental workbook); faculty are deeply involved in the program; physical space and environments are conducive to discussion and learning; and the program has strong support from the institution (Roth, Goldstein, & Marcus, 2001). The Peer-Led Team Learning International Society supports practitioners and institutions implementing PLTL, both in the U.S. and internationally. They host an annual conference that rotates around the globe, <http://ptlis.org/>

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online:
<https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

2 - Homepage of the Peer-Led Team Learning International Society. Available online:
<http://ptlis.org/>

PLTLIS Vision: Our vision is that Peer-Led Team Learning is integral to excellent educational practice. PLTLIS Mission: Our mission is to foster student learning through peer-led teams by supporting practitioners and institutions. PLTLIS Goals: To achieve our mission and vision we will transform formal education by: Training practitioners and students; Establishing and maintaining an international organization; Disseminating content, research, and best practices; Supporting PLTL programs across disciplines/ departments/ campuses; Examining and addressing hindrances to adoption; Providing ideas for PLTL implementation; and Supporting institutional strategic plans through PLTL implementation

3 - Homepage of the Peer-Led Team Learning Program. Gosser, David K (Ed.).
<https://sites.google.com/site/quickptl/>

This is the internet web page for the Peer-Led Team Learning (PLTL) Program originally developed at the City University of New York in the mid-1990s. Information and materials

available through this website include: program overview, research studies, workshop training and conference schedule, available materials to purchase, grant program to assist with PLTL implementation, PLTL newsletter, calendar of upcoming events, contact information for PLTL program staff and persons from adopting institutions across the U.S., and other information resources. PLTL has been funded by the National Science Foundation to support its national dissemination.

4- Homepage of PLTL Advances in Peer-Led Learning Journal. Available online:
<https://journal.pltlis.org>.

The Advances in Peer-Led Learning Journal is published by the Peer-Led Team Learning International Society (PLTLIS). It is an online, bi-annual journal publishing original, peer-reviewed articles on research, evaluation, and instructional practices related to peer-facilitated models of learning. PLTLIS encourages the inclusion of content from all academic disciplines at all levels of education. The goal of this journal is to communicate research and innovations in peer-facilitated models of learning, like PLTL. The editorial board and the journal editor, Dr. Jim Becvar, will oversee a transparent and streamlined process to ensure a fair and informative peer-review process. The first issue of the journal is planned for online publication in winter 2020. Please see the author guidelines for full details about the submission process and requirements. You can contact the editorial team with any questions you may have using journal@ptlis.org.

5 - Homepage of the PLTL Progressions Newsletter. City University of New York. New York City, NY. Available online: <https://sites.google.com/site/quickptl/>
Progressions is the official newsletter of Peer-Led Team Learning. It provides program overview information, data studies, and information about training workshops.

7 - Homepage of YouTube videos related to Supplemental Instruction; Peer-Led Team Learning; and Peer Assisted Learning Program. Available online:
<https://z.umn.edu/peerlearningyoutube>

This YouTube channel aggregates posted videos by peer learning programs related to Supplemental Instruction (UMKC model), Peer-Led Team Learning (CUNY model), and Peer Assisted Learning (UMN model). SI is also known by other names included PAL and PASS. Click on "playlists" tab in the main menu bar to locate the particular peer learning program or topic of interest. This YouTube channel is not formally associated with SI or PLTL but is managed by David Arendale who helped with a larger team to create the UMN PAL model. It is also a location where David Arendale posts videos of his scholarly interests with peer learning and includes interviews with student peer study group leaders and others.

Acosta, C., Becvar, J. E., & Saupe, G. B. (2012). *Workshop bonding via the group project*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Acosta-2012.docx>

Peer-Led Team Learning Program at the University of Texas at El Paso (UTEP) encourages peer leaders to develop many different methodologies to guide the students to better understand the subject material and to utilize the resources available to make students in Workshop better students. This is especially important because the majority of the students taking the course are freshman students. Each student learns in a slightly different way. For four semesters, the first author utilized a strategy called the 'Group Project' to promote student learning and personal review of the material. The Group Project provided a mechanism for students to learn how to employ resources beyond the text and how to work in a group as a

team. The Group Project served as a tool for students to develop long-term study groups that the first author often observed working as functional study units in later semesters.

Adamczeski, M., Ibrahim, S., Santos, P., Castille, A., Kreig, M., & Tran, L. (2004). *Peer-led Team Learning: Implementation into the first and second semester of general, organic, and biological chemistry curriculum at San Jose City College*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Math and Science, San Jose City College, 2100 Moorpark Ave., San Jose, CA 95128, email: madeline.adamczeski@sjcc.edu

Peer-led Team Learning (PLTL) was used in introductory courses in general, organic, and biological chemistry courses at San Jose City College. Research studies suggest higher student grades, higher levels of persistence,.

Akhter, F. (2019). *Exploration of the lessons learned by students attending peer-led workshops*. CUNY New York City College of Technology. New York, NY. Available online: https://academicworks.cuny.edu/ny_pubs/398/

The study is conducted with students attending an additional one-hour a week peer-led workshop associated with their Pre-Calculus class. The study focuses on the following research questions: Do peer-led workshops help students become better at problem solving? What are the lessons learned from peer-led workshops that can be useful and applicable in future courses? Data will be collected through administrating surveys to the students in the peer-led workshop. The data will be organized, analyzed and presented at the poster session.

Akinyele, A. F. (2010). Peer-led Team Learning and improved performance in an allied health chemistry course. *The Chemical Educator*, 15, 353-360.

Alberte, J., Cruz, A., Rodriguez, N., & Pitzer, T. (2012). *Hub n' spokes: A model for centralized organization of PLTL at Florida International University*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Alberte-2-2012.docx>

Peer-Led Team Learning (PLTL) at Florida International University (FIU) is an active learning component added to several courses within the Department of Biological Sciences. Since its inception in 2000, the program's model has evolved to accommodate a large volume of students and courses. FIU utilizes a centralized model in the administration of the program. This office manages every aspect of the PLTL workshops, ensuring the standardization and overall quality of workshops across all course subjects. The model reduces faculty's time commitment and allows for a student-centered administration. This model of administration is a key factor in FIU PLTL becoming a self-sustaining, institutionalized component of undergraduate biology education.

Alberte, J. L., Cruz, A., Rodriguez, N., & Pitzer, T. (2012). *PLTL in pajamas: Lessons learned*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Alberte-2012.docx>

Peer-Led Team Learning (PLTL) in the Biology Department at Florida International University (FIU) incorporates the use of "cyber" learning (cPLTL). Using laptops and cameras, students and Peer Leaders communicate in real time, fulfilling the requirements of the standard model of PLTL. Participants are trained in the use of required software and technology. Initial observations indicate that students perform at least as well in cPLTL as in traditional workshops. Students who cannot or will not attend in-person PLTL workshops are able to take advantage of

the boost. FIU is successfully moving toward cPLTL institutionalization alongside the in-person model.

Alberte, J. L., Cruz, A., Rodriguez, N., & Pitzer, T. (2012). *The PLTL leader boost*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Alberte-3-2012.docx>

Qualitative data has demonstrated the impact of PLTL on a Peer Leader's academic performance. In this paper we quantitatively show the presence of the Peer Leader boost at Florida International University. Just as in any apprenticeship role, Peer Leaders undergo an extensive training program and it is this experience which provides an advantage. Training includes pedagogy, classroom dynamics, science concepts, and critical thinking skills equipping Peer Leaders with the necessary skills to manage a productive active learning environment. Initial observations and feedback indicate that participation as a Peer Leader adds value such as enculturation in the discipline, increased performance in traditionally assessed learning outcomes, and increased retention within the discipline. Preliminary data demonstrates a significant difference in the academic success of Peer Leaders in their own course work. This analysis was performed on large enrollment upper-level courses which indicated up to a letter grade difference between Peer Leaders and non-Peer Leaders.

Aldridge, J. N. (2011). *From access to success in science: An academic-student affairs intervention for undergraduate freshmen biology students*. (Ed. D. dissertation), University of Delaware.

The first year experience is known to present an array of challenges for traditional college students. In particular, freshmen who major in a STEM discipline have their own unique set of challenges when they transition from high school science and math to college science and math; especially chemistry. As a result, students may encounter negative experiences which lower academic and social confidence. This project was designed as a pilot study intervention for a small group of freshmen biology students who were considered academically at-risk due their math SAT scores. The study occurred during the fall semester involving an enhanced active learning component based on the Peer-led Team Learning (PLTL) general chemistry supplemental pedagogy model, and a biology-focused First Year Experience (FYE). PLTL workshops took place in freshmen residence halls, creating a live-n-learn community environment. Mid-term and final chemistry grades and final math grades were collected to measure academic progress. Self-reporting surveys and journals were used to encourage participants to reconstruct their experiences and perceptions of the study. Descriptive analysis was performed to measure statistical significance between midterm and final grade performance, and a general inductive qualitative method was used to determine academic and social confidence as well as experiences and perceptions of the project. Findings of this project revealed a statistically significant improvement between chemistry midterm and final grades of the sample participants. Although academic confidence did not increase, results reveal that social confidence progressed as the majority of students developed a value for studying in groups.

Aline, F., Zeng, S., & Yu, Y. M. (2012). *Using Bloom's Taxonomy in a peer-led workshop in probability and statistics*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Aline-2012.docx>

Bloom's Taxonomy goes hand in hand with the peer-led workshop's methods by providing us as peer leaders with a structured order of the learning levels taken to extend our learning capabilities. We, the Peer Leaders, assist students into progressing to the next level in

mathematics by going beyond recalling, understanding and applying (Levels 1-3 of Bloom's Taxonomy). In our Probability and Statistics I and II workshop, we apply Bloom's Taxonomy to help the students, especially with the application of comprehension, application, and analysis (Levels 2-4). By proposing questions to the students, we initiate the recollection of the subject at hand. As a result, these questions help the establishment and encouragement of critical thinking for the students, especially in the higher levels. The Analytical level (Level 4) specifically shows that an individual can know whether what he or she is doing allows them to perform well in the subject.

Allen, D., & Tanner, K. (2005). Infusing active learning into the large-enrollment biology class: Seven strategies, from the simple to complex. *Cell Biology Education*, 4(4), 262-268. Available online: <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1305885>.

This article describes seven approaches to improving the quality of learning in a large biology class. Peer-led Team Learning (PLTL) is one of the seven. The narrative provides a basic overview of the program.

Allen, D. E., & White, H. B. (2001). Peer facilitators of in-class groups: Adapting problem-based learning to the undergraduate setting. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student assisted teaching: A guide to faculty-student teamwork*. Bolton, MA: Anker Publications

Amaral, K. E., & Vala, M. (2009). What teaching teaches: Mentoring and the performance gains of mentors. *Journal of Chemical Education*, 86(5), 630-633. Available online: <https://pdfs.semanticscholar.org/2091/a11832b7ca92270be374c0bb4276889abf2c.pdf>.

The benefits of mentoring were determined by comparing the mentors' performance in chemistry to the β and γ groups of students (students who were prepared for general chemistry and those who were under-prepared for general chemistry, respectively). The influence of previously acquired mathematical prowess on the grade attained in the mainstream chemistry course was determined by a linear regression analysis of the quantitative SAT scores versus course grade. Neither the average, first, or highest course grades were found to correlate with quantitative SAT scores. Both the mentors and the students in the γ group had enrolled in a minimum of one semester of chemistry prior to their enrollment in the first-semester general chemistry course, while first-semester general chemistry course was the first chemistry course for the students in the β group.

Anderson, T. L. (2008). What can we do about 'Parker'? A case study of a good student who didn't 'get' organic chemistry. *Chemistry Education Research and Practice*, 9, 93-101. doi: 10.1039/b806223b. Available online: https://www.researchgate.net/publication/244553407_What_can_we_do_about_%27Parker%27_A_case_study_of_a_good_student_who_didn%27t_%27get%27_organic_chemistry.

This paper is based on a qualitative study of seven students enrolled in a two-semester organic chemistry course for chemistry and chemical engineering majors that focused on the reasoning the students had used to answer questions on the course exams. Narrative analysis was applied to create case records for each participant that were then subjected to a cross-case analysis of similarities and differences among the participants. The data were found to be consistent with a theoretical framework that differentiates between instrumental and relational learning. The intense speed with which material was covered and the complexity of the material was found to drive even those students who valued a relational understanding towards functioning as instrumental learners. Particular attention is paid to one participant in the study, Parker, who had been a successful chemistry major until he entered the second year organic course.

Aponie, Y., Castro, L., Naldik, Y., Melendex, D., & Feliu, L. (2002). *Organic chem-e-chem, a Peer-led Team Learning mentoring/tutoring program in organic chemistry at Universidad Metropolitana*. Conference Proceedings of the 223rd American Chemical Society National Meeting, Orlando, FL.

Peer-led Team Learning (PLTL) has been used at the Metropolitan University of Puerto Rico to support higher student achievement in introductory chemistry courses. The institutional name for the program is Chem-2-Chem. Participating students earn higher rates of quality grades (A, B, C) and lower rates of D, F, or withdrawals. Both participants and student peer leaders report improved morale and self-esteem.

Arendale, D., R. (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>
This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing.

These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*.

Department of Curriculum and Instruction, University of Minnesota. Available online:

<https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational,

something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Avila, L., Fine, L., Alizadeh, A., blohm, M., Buckley, D., & Ku, A. (2010). The Columbia-GE Workshop: A constructivist approach to materials science for high school students. *Journal of Nano Education*, 2(1-2), 27-36. doi: 10.1166/jne.2010.1010.

A two-day workshop designed to expose 11th and 12th grade students to industrial applications of Materials Science and Nanotechnology is described. This workshop has been taught to seven 32-student cohorts since 2004 at the Materials Science and Nanotechnology Summer High School program at Columbia University. During the first day, teams of five to six students were trained to evaluate the connection between structure, properties, processing, and performance of materials using examples from the Nanotechnology program at GE Global Research. During the second day, the teams were given Problem-Based Learning/Peer-Led Team Learning (PBL/PLTL) exercises based on the mechanical and thermal properties of a variety of polymeric materials and candy products. Finally the teams prepared and presented a poster for evaluation purposes. A formative evaluation questionnaire and a SALG (Student Assessment of their Learning Gains) instrument were used to evaluate individual learning. The results of the SALG instrument corroborated the formative evaluation questionnaire findings about the benefits of the workshop as an outreach activity. Most students claimed to have solidified their knowledge of materials' performance, besides learning budgeting and how to trade off, as we expected.

Baez, R., & Restro, W. (2002). *Is E.Q. a factor in the success of chem-2-chem Peer-Led Team Learning?* Conference Proceedings of the 223rd American Chemical Society National Meeting, Orlando, FL.

Peer-led Team Learning (PLTL) has been used at the University of Puerto Rico to support higher student achievement in introductory chemistry courses. A study was conducted with the PLTL program regarding the impact of the emotional quotient (E.Q.) as a determining part of why PLTL is successful.

Báez-Galib, R., Colón-Cruz, H., Resto, W., & Rubin, M. R. (2005). Chem-2-Chem: A One-to-One Supportive Learning Environment for Chemistry. *Journal of Chemical Education*, 82, 1859-1863.

Baker, G. A., Noether, D. L., Patterson, W. J., Ramstrom, O., Schiraldi, D. A., & Xiu, S. Z. (2000). The Workshop Project builds team savvy. *Chemical Innovation*, 30(12), 12. This short article provides information about Peer-led Team Learning (PLTL).

Barker, L. J., & Cohoon, J. M. (2007). *Peer-led Team Learning: Retaining women through collaborative learning*. Boulder, CO: National Center for Women & Information Technology. This short article describes how the Peer-led Team Learning (PLTL) program supports the persistence of women in the science curriculum. Female students involved in the Computing

Alliance for Hispanic-Serving Institutions found that the learning environment that was enriched through PLTL was more supportive for both learning and persistence. The authors state that the collaborative learning activities must be carefully planned and facilitated to maximize the learning benefit for participating students.

Barlow, A., Dreyfuss, A. E., Sears, J., Bonhomme, A., Clarke, R., Moon, S., . . . Younge, L. (2012). *PLTL in the developmental writing classroom*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Barlow-2012.docx>
Writing placement exam preparation can be broken down into small tasks overseen by Peer Leaders, following (though not precisely) patterns set out by Fred Keller in “Good-bye Teacher” in 1968. The mechanical aspect of writing, however, is never enough for the production of essays that communicate, something that requires audience and a desire to “speak.” Students in developmental classrooms often have problems beyond the writing itself: they may be test shy and may not be prepared to take on even college entry tasks without careful direction. Working with Peer Leaders, the developmental program can address the problems of mechanics and testing demands, the Peer Leaders taking on some of the responsibility for guiding students through the tasks. PLTL can also help address the broader problems of preparation for college and even for critical thinking, the Peer Leaders serving as role models. The pilot program at New York City College of Technology (CUNY) was discussed.

Bartow, D. S. (2000). Peer-Led Team Learning in the community college. *Communitas*, 11, 3. Available online: <http://www.afacct.csmd.edu/communitas/communitasv11no3sept00.htm>. Prince George's Community College is a participating institution in a three-year \$3 million National Science Foundation (NSF) project based on the Peer-Led Team Learning (PLTL) instructional model. Peer-Led Team Learning had its origins in one of the five NSF-sponsored national systemic reform initiatives in chemistry - the Workshop Chemistry Project. In the workshop model, the traditional lecture component is complemented by collaborative student groups that provide a unique leadership role for undergraduate students. Students who have done well previously in the course are recruited to become guides and mentors to small groups of six to eight students meeting for one to two hours each week to work together in a problem-solving mode. The student workshop leader ensures that all members of the team are actively engaged and helps guide the application of fundamental concepts to solving challenging problems. The peer leaders receive training prior to the start of classes and meet weekly with the faculty to discuss the content and goals of the workshop problems. The success of the model has been demonstrated by a five-year evaluation in first and second year chemistry courses. The major outcomes are greater student motivation, active involvement in the learning process, and improved performance in the course.

Batz, Z., Olsen, B. J., Dumont, J., Fastoor, F., & Smith, M. K. (2015). Helping struggling students in introductory biology: A peer-tutoring approach that improves performance, perception, and retention. *CBE-Life Education*, 14(2). doi: 10.1187/cbe.14-08-0120.
The high attrition rate among science, technology, engineering, and mathematics (STEM) majors has long been an area of concern for institutions and educational researchers. The transition from introductory to advanced courses has been identified as a particularly “leaky” point along the STEM pipeline, and students who struggle early in an introductory STEM course are predominantly at risk. Peer-tutoring programs offered to all students in a course have been widely found to help STEM students during this critical transition, but hiring a sufficient number of tutors may not be an option for some institutions. As an alternative, this study examines the viability of an optional peer-tutoring program offered to students who are struggling in a large-enrollment, introductory biology course. Struggling students who regularly attended peer

tutoring increased exam performance, expert-like perceptions of biology, and course persistence relative to their struggling peers who were not attending the peer-tutoring sessions. The results of this study provide information to instructors who want to design targeted academic assistance for students who are struggling in introductory courses.

Bauer, C. F., Rickert, K. A., & Langdon, L. B. (2004). *Peer-Led Team Learning at the University of New Hampshire: Contrasts in student achievement, self-concept, attitudes, and implementations*. Paper presented at the Abstracts of Conference Papers for the 227th American Chemical Society National Meeting, Anaheim, CA.

Peer-led Team Learning (PLTL) was used in a general chemistry course at the University of New Hampshire since 2000. Data has been collected on students concerning what they learned, changes in self-concept attitudes, and social networks. Comparisons were made for student performance in a variety of instructional settings.

Becvar, J. E. *Advances in Peer-Led Learning Journal: Peer-Led Team Learning International Society*. Available online: <https://journal.pltlis.org>

Advances in Peer-Led Learning is published by the Peer-Led Team Learning International Society (PLTLUS) bi-annually (<https://journal.pltlis.org/>). APL publishes original, peer-reviewed articles on research, evaluation, and instructional practices related to peer-facilitated models of learning. PLTLIS encourages the inclusion of content from all academic disciplines at all levels of education. The goal of this journal is to communicate research and innovations in peer-facilitated models of learning, like PLTL. The editorial board and the journal editor, Dr. Jim Becvar, will oversee a transparent and streamlined process to ensure a fair and informative peer-review process. The first issue of the journal is planned for online publication in winter 2020. Please see the author guidelines for full details about the submission process and requirements. You can contact the editorial team with any questions you may have using journal@pltlis.org.

Becvar, J. E. (2004). *Two plus two equals more: Making room for Peer-led Learning*. Paper presented at the 227th American Chemical Society National Meeting, Anaheim, CA.

Peer-led Team Learning (PLTL) was used in a general chemistry course at the University of Texas at El Paso. Due to problems with extending the credit hours for the course to incorporate the required PLTL attendance, the number of hours in lecture each week were reduced from three to two.

Becvar, J. E., Saupe, G. B., Noveron, J. C., & Narayan, M. (2011). *Plus two Peer-Led Team Learning for large introductory STEM classes: Improved study skills, increased retention, and higher graduation rates*. The University of Texas at El Paso. El Paso, TX. Available online: <http://www2.ed.gov/documents/college-completion/plus-two-peer-lead-team-learning-for-large-introductory-stem-classes.doc>

A new approach for transforming undergraduate learning in science, technology, engineering, and mathematics (STEM) has been empirically validated in a ten-year pilot program that involved 7,231 students conducted at the University of Texas at El Paso (UTEP). The approach improves student study skills leading to increased retention and higher graduation rates. UTEP's Plus Two Workshop¹ replaces one hour of lecture in a large STEM course (>300 students) with many small two-hour Peer-Led Team Learning (PLTL) Workshops. The Workshops are led by intensively trained undergraduate students in their junior and senior years that have previously done well in the course. Workshops focus on PLTL strategies that promote cooperative learning, content exploration, hands-on activities, academic networking, validation of multiple-learning styles among students, and academic skills development. Workshops

provide a small-class organizational environment emphasizing the continuous progress of individual students. The study shows a greater than 15% increase in the weighted average of the passing rate (A + B + C) in first semester general chemistry, and a 300% increase in the number of Chemistry majors for the period of 2001-11. Although the program received a 5-year NSF grant (2007-12) to expand the model to other STEM courses, due to budget restrictions, the institutional support for the Workshop Model for the 2012-3 school year is uncertain. We are currently seeking extramural funding for its continuous implementation.

Becvar, J. E., Valdez, M., & Aimeida, V. (2003). *Peer-led Team Learning: Explorations*. Paper presented at the 225th American Chemical Society National Meeting, New Orleans, LA. The Peer-Led Team Learning (PLTL) program is used with the general chemistry courses for STEM majors at the University of Texas El Paso.

Beneteau, C., Fox, G., XU, X., Lewis, J. E., Ramachandran, K., Campbell, S., & Holcomb, J. (2016). Peer-led guided inquiry in calculus at the University of South Florida. This paper describes the development of a Peer-Led Guided Inquiry (PLGI) program for teaching calculus at the University of South Florida. This approach uses the POGIL (Process Oriented Guided Inquiry Learning) teaching strategy and the small group learning model PLTL (Peer-Led Team Learning). The developed materials used a learning cycle based on three phases of inquiry: exploration of a model, concept invention, and application. Fifty minutes weekly of lecture in Engineering and Life Sciences Calculus were replaced by the PLGI curriculum, where students worked in groups with peer leaders as instructors. The main outcomes measured were pass and withdrawal rates for sections using this approach compared to historical and concurrent sections not using PLGI. Our results showed higher pass rates in Life Sciences Calculus (18% gain in comparison to historical sections and 8.2% gain in comparison to concurrent non-PLGI sections). In Engineering Calculus, we also saw higher pass rates for PLGI sections (18.2% gain in comparison to historical rates and 4.0% gain in comparison to concurrent non-PLGI sections). Withdrawal rates also declined for both Life Sciences and Engineering Calculus. Both sexes had greater pass rates and lower withdrawal rates in both types of calculus. PLGI sections showed higher pass rates for African-American students in life sciences (16.5% gain in comparison to historical sections and 8.7% gain in comparison to concurrent non-PLGI sections). The impact of PLGI for African-American students was more dramatic in Engineering Calculus (24.9% gain in comparison to historical sections and a 17.6% gain in comparison to concurrent non-PLGI sections).

Berke, T. (2003). Peer-Led Team Learning: An active learning strategy that works: Good students become great student leaders. *Strategies for success*, 39(10), Article 1. This short article provides an overview of the Peer-led Team Learning (PLTL) program. The author is professor of chemistry at Broodkale Community College.

Biggers, M., Yilmaz, T., & Sweat, M. . (2009). *Using collaborative, modified Peer Led Team Learning to improve student success and retention in intro computer science*. Conference Proceedings of the 40th ACM Technical Symposium on Computer Science, New York, NY. It is common knowledge that enrollments in computer science have plummeted and educators are challenged to find ways to engage and promote success and retention of students while maintaining standards in introductory computer science courses. This study focuses on the implementation of a collaborative, modified peer-led team learning (PLTL) instructional approach in a large sized introductory computer science course. The site is a major southeastern university in the United States where all students are required to take one of three introductory computer science classes. The course version selected for this study specifically targets computer science majors and the study spans three years of data, and involves 591

students. Students who experienced the student-centered instruction and worked in small groups facilitated by a peer leader (treatment) in years 2006-07 and 2007-08 were compared with students who experienced a traditional recitation lecture section (control) in 2005-06. The content and the course owner was the same for all three years. Quantitative data analysis show marked and statistically significant improvements in student performance, for both male and female students. These findings suggest that using undergraduate leaders to implement a peer-led team learning model can be as effective in promoting achievement and retention in computer science education as it has shown to be in math and science classes over the past several years.

Bjorkquist, R. (2019). *Women in physics in the United States: Reaching toward equity and inclusion*. Conference Proceedings of the 2019 AIP Conference. Available online: <http://aip.scitation.org/doi/pdf/10.1063/1.5110114?class=pdf>

The United States has a major deficit in the proportion of women earning degrees in physics, peaking around 20%. To promote excellence and maximize creativity, additional efforts to diversify the physics community must be implemented. Challenges to improving the proportion of female physicists include microaggressions, active discouragement, poor advising or mentoring, inadequate acknowledgement of achievements, sexual harassment, and many others. The latest research on gender bias suggests two main underlying psychological themes that explain much of the behavioral bias: implicit (unconscious) bias and stereotype threat. To ensure that excellence is not compromised, we need to guarantee that our entire population has access to adequate resources and the necessary support structures for success. To fully understand women in physics, we must also examine the many obstacles that women of various identities face in efforts to navigate their academic and professional careers. These identities may be related not only to gender but also to race, ethnicity, language, religion, social class, or sexuality. Increasing women's participation in physics requires increased access to high school physics courses, funding opportunities to attend college, availability of research opportunities, and access to and support from professional societies. These approaches will enhance the culture in physics, leading to gender equity, social equity, and improved social justice for many people.

Black, A. E., & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory. *Science Education*, 84, 740-756. Available online: https://selfdeterminationtheory.org/SDT/documents/2000_BlackDeci.pdf.

This prospective study applied self-determination theory to investigate the effects of students' course-specific self-regulation and their perceptions of their instructors' autonomy support on adjustment and academic performance in a college-level organic chemistry course. The study revealed that: (1) students' reports of entering the course for relatively autonomous (vs. controlled) reasons predicted higher perceived competence and interest/enjoyment and lower anxiety and grade-focused performance goals during the course, and were related to whether or not the students dropped the course; and (2) students' perceptions of their instructors' autonomy support predicted increases in autonomous self-regulation, perceived competence, and interest/enjoyment, and decreases in anxiety over the semester. The change in autonomous self-regulation in turn predicted students' performance in the course. Further, instructor autonomy support also predicted course performance directly, although differences in the initial level of students' autonomous self-regulation moderated that effect, with autonomy support relating strongly to academic performance for students initially low in autonomous self-regulation but not for students initially high in autonomous self-regulation

Bonicamp, J. M. (2002). Who's minding the store? Or how a team of undergraduate teaching interns rejuvenated an ACS certified program. *The Chemical Educator*, 7(6), 324-327. doi: 10.1007/s00897020629a.

Improvements resulted at all levels in an ACS-certified chemistry program when a team of undergraduate teaching interns began consulting in the laboratories. The author describes the problems and teaching philosophies that led to the institution of the Chemistry Instruction Internship Program, the goals of the program with some preliminary assessments, and how to recruit outstanding undergraduate teaching interns.

Bonner, S. M., Keiler, L. S., & Mills, P. A. (2012). *PERC: A model for peer-facilitated learning in urban secondary school classrooms*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Bonner-2012.docx>

This report describes a research-based, peer-facilitated instructional approach that supports academic skill development among urban high school students. The Peer Enabled Restructured Classroom (PERC) is the product of a National Science Foundation (NSF)-funded partnership of high schools, higher education institutions, district administration, and school support organizations called the Math and Science Partnership in New York City 2 (MSPinNYC2). PERC places average-performing students in leadership roles in mathematics and science classrooms that have been restructured around learning teams. Development of academic competency in high school Science, Technology, Engineering, and Mathematics (STEM) disciplines is a prerequisite for college admission and success, and a national concern (Adelman, 2006; Porter, McMaken, Hwang, & Yang, 2011). Recent reports continue to demonstrate shallow conceptual understanding and applications of STEM content among k-12 students (National Center for Education Statistics, 2012). Essential objectives of the project are to improve mathematics and science performance among historically under-performing groups, to raise graduation rates, and to increase the number of graduates ready to succeed in college. The five-year project is expected to reach nine (9) public high schools in the five boroughs of New York City (NYC) by 2015, which equates to approximately 12,000 students. This report describes the social context of our program, our model and its research base, and early evidence about outcomes.

Bradford, B., Brier, M. E., Wolf, M., McSpedon, M., & Taylor, M. (2019). *STEM bridge program participation predicts first and second semester math performance*. Conference Proceedings of the 2019 ASEE Annual Conference & Exposition, Tampa, FL. Available online: <https://peer.asee.org/board-20-stem-bridge-program-participation-predicts-first-and-second-semester-math-performance.pdf>

To combat math underperformance among incoming STEM majors, Rice University designed a summer bridge program with National Science Foundation (NSF) S-STEM funding that included an intensive calculus course. Students invited to participate in the program were identified as being underprepared for STEM classes based on their standardized test scores, high school STEM coursework, and socioeconomic status. One of the program's goals is to improve students' preparation for the advanced math courses required for all STEM majors at Rice. The bridge program is designed to teach the material that has historically been most challenging for underprepared students, meaning the math content covered primarily second-semester calculus topics. We explored the impact of bridge program participation on math performance in first and second-semester math. First, we examined group differences in math preparation. Though program administrators attempt to create equivalent bridge and comparison groups, the bridge program is optional, meaning group assignment is not completely random. Bridge students were less prepared than comparison students on number of high school calculus AP (or equivalent) credits received. We analyzed group differences in final class grades from 2012-2017 among

the comparison group, the bridge group, and the rest of the class (i.e. non-comparison and nonbridge), standardizing grades using Z-scores. Planned contrasts found that bridge students performed slightly better than, but not significantly different from, comparison students in first semester math. Conversely, planned contrasts found that the bridge group significantly outperformed the comparison group in second-semester math. These results suggest that bridge program exposure to calculus may improve performance relative to a comparison group, which is especially noteworthy because bridge students are the least math-prepared STEM students entering the university. Future research will analyze outcomes in more advanced math classes. We will use these findings to refine the bridge program's approach to teaching students how to succeed at collegiate-level math classes and, ultimately, as STEM majors at Rice.

Bradley, A. Z., Ulrich, S. M., Jones, M., & Jones, S. M. (2002). Teaching the sophomore organic course without a lecture. Are you crazy? *Journal of Chemical Education*, 79(4), 514-519. An experimental approach to the sophomore organic course in which the lecture is almost completely replaced by small-group problem-solving sessions is described. Peer-led Team Learning (PLTL) was the program that was used in this approach. The course was monitored by a control group in the traditional lecture course taught by a traditional faculty member. The control group took exactly the same exams under exactly the same conditions as the 60-person experimental section. There was no significant difference in test scores--the experimental section did at least as well as the control. The students' evaluation of the experimental course was unusually positive. The small-group method appears to be a viable alternative to the traditional lecture-based course.

Bradley, A. Z., Ulrich, S. M., Maitland, J., & Jones, S. M. (2002). Teaching the sophomore organic course without a lecture: Are you crazy? . *Journal of Chemical Education*, 79(4), 514. doi: 10.1021/ed079p514.

An experimental approach to the sophomore organic course in which the lecture is almost completely replaced by small-group problem-solving sessions is described. The course was monitored by a control group in the traditional lecture course taught by one of us. The control group took exactly the same exams under exactly the same conditions as the 60-person experimental section. There was no significant difference in test scores--the experimental section did at least as well as the control. The students' evaluation of the experimental course was unusually positive. The small-group method appears to be a viable alternative to the traditional lecture-based course.

Branan, D., & Morgan, M. (2010). Mini-lab activities: Inquiry-based lab activities for formative assessment. *Journal of Chemical Education*, 87(1), 69-72. doi: 10.1021/ed8000073. Students everywhere love chemistry demonstrations, especially if they involve explosions. But have you ever wanted to move beyond the "wow" factor and find a way to incorporate active student learning into your demos? What if you could get them to think more deeply about what they're observing, and then find out if they really understand what they've experienced? Those questions initiated our quest to create "interactive demos" at the US Air Force Academy Department of Chemistry. Over the past year and a half, this effort has evolved into inquiry-based learning activities. We now refer to these activities as "mini-labs", because they also contain the additional dimension of a simple formative assessment of a student's knowledge and awareness of chemical principles. The "Mini-Lab" was conceived of as an idea to help instructors easily add inquiry-based learning activities to their curriculum by providing an array of activities that are easy to implement and not supply-intensive and that are designed around sound pedagogical principles. This program originated at the United States Air Force Academy, but was further developed in collaboration with colleagues at Hamline University.

Brant, S. (2002). Organic chemistry made (relatively) easy - By students' own pers. *University of Rochester Review*, 60(3).

Brown, P. J. (2010). Process-oriented guided-inquiry learning in an introductory anatomy and physiology course with a diverse student population. *Advances in Physiology Education*, 34(3), 150-155. doi: 10.1152/advan.00055.2010. Available online:

<http://advan.physiology.org/content/34/3/150.full.pdf+html>.

Process-oriented guided-inquiry learning (POGIL), a pedagogical technique initially developed for college chemistry courses, has been implemented for 2 yr in a freshman-level anatomy and physiology course at a small private college. The course is populated with students with backgrounds ranging from no previous college-level science to junior and senior biology, biochemistry, and forensic science majors. Fifty percent of the lectures in the course were replaced with POGIL activities, performed in class by students working collaboratively in small groups. The introduction of POGIL pedagogy into the second half of a two-semester anatomy and physiology course significantly improved student performance on summative evaluations. Overall course scores increased from a mean score of 76% to 89% in the three semesters after POGIL was introduced. Performance on the same multiple-choice final exam rose from a mean of 68% to 88% over the same time period. Most significantly, the rate of students earning a D or F in the course was halved in the first two semesters after POGIL was introduced and was 0% in the third semester. Student satisfaction with the method was high, and most students perceived the value of this form of instruction.

Brown, T. P., Becvar, J. E., Noveron, J. C., & Saupe, G. (2012). *No stupid questions*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Brown-2012.docx>

In general chemistry peer-led workshops at the University of Texas at El Paso, we place great emphasis on the establishment of mutual trust between students and the peer leader from the get-go. This generates a positive learning team where students develop a high degree of comfort and are not afraid to ask questions, even questions so basic as to be referred with the ugly expression 'stupid questions'. Workshops include hands-on, experimental activities called Explorations. These spark curiosity and lead to many questions. Students are generally not comfortable enough to ask questions in lecture; providing PLTL workshops directly addresses this issue. Comfort and trust in Workshop creates a learning environment where students are not afraid to ask questions of any type, where those student-led questions help eliminate the simple memorization of facts, and where students are able to think and act as problem-solvers to comprehend concepts.

Buckles, E. I., Haydel, N. w., Thompson-Sanchez, J., & Page, Y. W. (2019). Implementing a corequisite algebra gateway course. *Peer review*, 21(1/2), 42-45.

Dillard University, a private liberal arts institution located in New Orleans, has a mission "to produce graduates who excel, become world leaders and are broadly educated, culturally aware and concerned with improving the human condition" (Dillard University, n.d.). The university serves approximately 1,290 students, 91 percent of whom are African Americans and 75 percent of whom are women. Over the years, Dillard has taken a leadership role in national STEM higher education reform to enhance the quality and competitiveness of undergraduate STEM education for African Americans. These efforts include, at their core, a group of dedicated faculty members from various STEM disciplines at Dillard working in partnership on programs to provide contemporary instructional processes and enriching research experiences for Dillard students who major in STEM. One example of this partnership exists within and among the faculty of the Dillard mathematics program. Often used as a gateway course for

STEM majors, College Algebra holds an important position in the mathematics field. However, in many US colleges and universities, nearly 60 percent of all entering first-year students require remediation (Grubb et al. 2011). The vast majority of the required remediation is in the area of mathematics. Because of this need for further preparation to successfully study college-level math, which may consume two or three semesters of additional coursework, there is a high drop-off of students who initially intended to pursue a STEM major and career. As a result, remedial math has now become a filter from, rather than a pipeline to, STEM careers. There are several factors that influence remedial math education, and thereby also influence undergraduate STEM enrollment. The first is the national research, which has increasingly shown that the standardized tests used as math placement tools are poor analysts of student ability (Attewell et al. 2006; Belfield and Crosta 2012).

Burke, K. A., Greebhowe, T. J., & Gelder, J. L. (2004). The multi-initiative dissemination project workshops: Who attends them and how effective are they? *Journal of Chemical Education*, 81(8), 897-902.

This article reviews several National Science Foundation dissemination grants, including Peer-Led Team Learning (PLTL) regarding their effectiveness in assisting other institutions to adopt transformative learning practices. The following areas were analyzed: participant demographics, training techniques, workshop goals, participant evaluations of the training workshops

Butcher, D. J., Brandt, P. F., & Norgaard, C. J. (2003). Sparking IntroChem: A student-oriented introductory chemistry course. *Journal of Chemical Education*, 80(2), 137-139.

At Western Carolina University (Cullowhee, North Carolina), the Peer-Led Team Learning (PLTL) approach was adopted for an introductory chemistry course to shift it from the traditional instructor-led model to a student-oriented model. PLTL was helpful not only for the students, but also the student instructors.

Caldwell, C. (2008). First-time feelings. Peer-Led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 10(1). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Caldwell-First-Time-Feelings.pdf>.

Firsts are special – a first rollercoaster ride... a first concert – and the reason these firsts are special is because the person experiencing that first thing, whatever it is, is super sensitive to that experience. She must be because she does not know what to expect so in order to react appropriately, she must be 'on her toes.' This higher state of awareness is valuable for the workshop leader

Cancado, L., Reisel, J. R., & Walker, C. M. (2018). Impact of first-year mathematics study groups on the retention and graduation of engineering students. *International Journal of Mathematical Education in Science and Technology*, 49(6), 856-866. doi: 10.1080/0020739X.2017.1423120.

Many interventions have been proposed to improve the retention and graduation rates of engineering students. One such intervention is to use study groups for first-year college students; such groups provide a structured environment in which the students can learn course material from each other outside of class and can provide the students with a sense of community. In this paper, we report on the impacts fostered by study groups in first-year mathematics courses on the odds of retaining and graduating engineering students. Students who participated in the study groups are compared to students of similar academic preparation who did not participate in such groups. It is found that student participation in study groups is significantly associated with the higher odds of being retained in engineering studies through the first 3 years of college. The results reported here are not as certain for the effect of study group

participation on 5-year graduation odds for engineering students and some possible reasons for this are discussed.

Carlson, K., Celotta, D. T., Curran, E., Marcus, M., & Loe, M. (2016). Assessing the impact of a multi-disciplinary Peer Led-Team Learning program on undergraduate STEM education. *Journal of University Teaching & Learning Practice*, 13(1), article 1. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1570&context=jutlp>.

There has been a national call to transition away from the traditional, passive, lecture-based model of STEM education towards one that facilitates learning through active engagement and problem solving. This mixed methods research study examines the impact of a supplemental Peer-Led Team Learning (PLTL) program on knowledge and skill acquisition for students in introductory biology, chemistry, calculus and applied statistics courses. Results indicate program participants reliably outperform their matched pairs in courses that emphasize quantitative reasoning. Moreover, program participants report acquiring important insights about learning, collaboration, and engagement in undergraduate STEM education. These results are consistent with previous findings on PLTL and also provide insight into the roles of course context and student population on program outcomes.

Cauthen, M. (2012). *How is the peer leader experience enhanced through a community of practice?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Cauthen-2012.docx>

Because of my experiences facilitating a math workshop this semester, I chose this question to explore how the skills needed to encourage team learning could be developed by using the ideas of Community of Practice theory regarding the social nature of learning, as a foundation to create a productive workshop experience for the students and the Peer Leaders.

Chan, J. K., & Bauer, C. F. (2015). Effect of Peer-Led Team Learning (PLTL) on student achievement, attitude, and self-concept in college general chemistry in randomized and quasi experimental designs. *Journal of Research in Science Teaching*, 52(3), 319-346. doi: 10.1002/tea.21197.

This study investigated exam achievement and affective characteristics of students in general chemistry in a fully-randomized experimental design, contrasting Peer-Led Team Learning (PLTL) participation with a control group balanced for time-on-task and study activity. This study population included two independent first-semester courses with enrollments of about 600. Achievement was measured by scores on exams written by an instructor blind to student participation. Established instruments were used to assess changes in attitude to chemistry and self-concept as a chemistry learner. No differences were found in achievement, attitude, or self-concept for students who participated in PLTL vs. those who participated in documented alternative study activities. Overall, certain aspects of attitude and self-concept showed a slight but significant decline from beginning to end of semester, consistent with previous studies. Males have higher positive attitude and self-concept than females, and first-year students have higher positive attitude, self-concept, and achievement than non first-year students. In a quasi-experimental comparison of 10 other course sections over seven years, students who self-selected into PLTL showed stronger exam achievement than those who did not choose to participate. These findings suggest that past reports of improved student performance with PLTL may in part be a consequence of attracting students who are already motivated to take advantage of its value.

Chang, J. Y. K., & Bauer, C. F. (2016). Learning and studying strategies used by general chemistry students with different affective characteristics. *Chemistry Education Research and*

Practice, 27, 675-684. doi: 10.1039/C5RP00205B. Available online: <http://pubs.rsc.org/en/content/articlehtml/2016/rp/c5rp00205b>.

Students in general chemistry were partitioned into three groups by cluster analysis of six affective characteristics (emotional satisfaction, intellectual accessibility, chemistry self-concept, math self-concept, self-efficacy, and test anxiety). The at-home study strategies for exam preparation and in-class learning strategies differed among the three groups. Students in the high group (strongly positive affective characteristics) were more autonomous learners, reporting they understood the notes they took in lecture more frequently than the group with low (more negative) affective characteristics. The high group also relied less on tutors and teaching assistants for help when preparing for exams. Participating in explanatory behavior (with self or other students) was correlated positively with stronger exam performance, whereas rapt attention or assiduous note-taking in lecture was negatively correlated. The high and low affective groups were indistinct in their reports of amount of quality time spent studying, but did differ in their approach to using a practice exam as a resource.

Chesney, T. D. (2011). Transforming science education through Peer-Led Team Learning. *peerReview*, 13(2). Available online: <http://162.249.107.162/publications-research/periodicals/transforming-science-education-through-peer-led-team-learning>.

In the fall of 2008, a remarkable transformation in undergraduate education was initiated at the University of Texas at Dallas (UT Dallas)—an emerging research university that had only been admitting freshmen since 1991, following a progression from its roots as a research institute to a graduate institution within the University of Texas System to the addition of upper-division students only. Initially crafted as a response to an accreditation requirement of the Commission on Colleges of the Southern Association of Colleges and Schools, the Gateways to Excellence in Math and Science initiative (GEMS) was formally launched at UT Dallas as a comprehensive quality enhancement plan (QEP) with ambitious goals for improving the quality of student learning in science, technology, engineering, and mathematics (STEM) by providing students with innovative, intensive, and active learning experiences both inside and outside the classroom. At its core the project—now in its fourth year—targets success, retention, and persistence in gateway science and mathematics courses that play a critical role in influencing student decisions not only to continue their studies in related degree programs but also to continue their college careers. Originally designed for a five-year rollout, in its first three years GEMS has included a series of interventions, including curriculum alignment and realignment, course redesign, new course design, the introduction of new modes of curriculum delivery, and faculty development. Its overall objectives are to provide a foundation and center for sustainable faculty and administrative activities that increase the retention of students in STEM fields, decrease the number of D and F grades and withdrawals in STEM classes, and create supportive, engaging learning opportunities.

Cole, C. S., & Blake, B. (2003). *Peer-led Team Learning: The student leader's perspective*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the author at the Department of Chemistry and Biochemistry, Texas Tech University, Lubbock, TX 79409, starcsc22@hotmail.com

The Peer-Led Team Learning (PLTL) program is used with the general chemistry courses at Texas Tech University beginning in Fall 2002. The intent of the program is to improve grades of participating students and provide leadership development for the student PLTL peer facilitators. Peer leaders write a weekly journal entry to describe their experience with the program. This paper reports on the impact with the student leaders.

Collins, R. (2009). Reflections of a reserved workshop leader. Peer-Led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 10(2).

Available online: <http://ppltis.org/wp-content/uploads/2012/10/Experience-of-Leading-Collins-Reflections-by-a-Reserved-Workshop-Leader.pdf>.

The Workshop sessions helped me to interact with different kinds of students with various strengths, shortcomings and different attitudes, whom I wouldn't have generally come across due to my reserved nature. It was an opportunity for me to mix and mingle with all kinds of people, develop my interpersonal, leadership and communication skills. As time went by, I think I got better in explaining things to people and being more comfortable speaking in front of large groups of students. As time went by, I also got over the feeling that I was a minority Peer Leader with an accent that Americans students are not used to, and this boosted my confidence as a leader and consequently increased my comfort level with the students.

Cox, C. T. (2006). *An investigation of the effects of interventions on problem solving strategies and abilities*. (Ph.D. dissertation), Clemson University, Clemson, SC.

This dissertation investigated a number of intervention for improving student academic performance in science courses. One of the interventions considered was Peer-led Team Learning (PLTL). Results were mixed concerning its effectiveness with students. Complications of the analysis were caused by student choice regarding participation. The researcher speculated that PLTL worked with students who had lower academic preparation than the comparison student population. Problem-solving has been described as being the "heart" of the chemistry classroom, and students' development of problem-solving skills is essential for their success in chemistry. Despite the importance of problem-solving, there has been little research within the chemistry domain, largely because of the lack of tools to collect data for large populations. Problem-solving was assessed using a software package known as IMMEX (for Interactive Multimedia Exercises) which has an HTML tracking feature that allows for collection of problem-solving data in the background as students work the problems. The primary goal of this research was to develop methods (known as interventions) that could promote improvements in students' problem-solving and most notably aid in their transition from the novice to competent level. Three intervention techniques that were incorporated within the chemistry curricula: collaborative grouping (face-to-face and distance), concept mapping, and peer-led team learning. The face-to-face collaborative grouping intervention was designed to probe the factors affecting the quality of the group interaction. Students' logical reasoning abilities were measured using the Group Assessment of Logical Thinking (GALT) test which classifies students as formal, transitional, or concrete. These classifications essentially provide a basis for identifying scientific aptitude. These designations were used as the basis for forming collaborative groups of two students. The six possibilities (formal-formal, formal-transitional, etc.) were formed to determine how the group composition influences the gains in student abilities observed from collaborative grouping interventions. Students were given three assignments (an individual pre-collaborative, an individual post collaborative, and a collaborative assignment) each requiring them to work an IMMEX problem set. Similar gains in performance of 10% gains were observed for each group with two exceptions. The transitional students who were paired with concrete students had a 15% gain, and the concrete students paired with other concrete students had only a marginal gain. In fact, there was no statistical difference in the pre-collaborative and post-collaborative student abilities for concrete-concrete groups. The distance collaborative intervention was completed using a new interface for the IMMEX software designed to mimic face-to-face collaboration. A stereochemistry problem set which had a solved rate of 28% prior to collaboration was chosen for incorporation into this distance collaboration study.

Cracolice, M. S. (2000). *Constructivist models for teaching chemistry: Applying Vygotsky's theories to Peer-led Team Learning*. Conference Proceedings of the 219st American Chemical

Society National Meeting, San Francisco, CA. For more information, contact the author at the Department of Chemistry, University of Montana, Missoula, MT 59812, markc@selway.umt.edu Peer-led Team Learning (PLTL) is used at the University of Montana in chemistry courses. This paper explores Vygotsky's constructivist theories as they relate to the effective operation of P:T.

Cracolice, M. S. (2000). Vygotsky's Zone of Proximal Development: A theory base for Peer-Led Team Learning. *Progressions: The Peer-Led Team Learning Project Newsletter*, 1(2). Available online: <http://pltlis.org/wp-content/uploads/2012/10/PLTL-and-Vygotsky-Vygotsky-ZPD-Cracolice.pdf>.

The most important concept from Vygotsky's works, as applied to PLTL, is the zone of proximal development, or ZPD. Vygotsky defined this concept as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." The lower end of the ZPD is defined by what the student is capable of doing independently. This is what would be measured by a classic IQ test. The high end of the ZPD reflects what a student can do when given hints and guidance during the problem-solving process.

Cracolice, M. S., & Deming, J. C. (2001). Peer-Led Team Learning. *The Science Teacher*, 68(1), 20-25.

This article provides an overview of Peer-Led Team Learning (PLTL) program. The six components of PLTL are discussed. A model is provided for scheduling of classroom activities to allow for integration of the PLTL program activities. The three biggest challenges to implementing PLTL cited by the authors were: finding peer leaders, training the leaders, and selecting appropriate materials for the PLTL sessions. Recommendations are provided to overcome these challenges in providing an effective program. Data comparisons between PLTL and non-participants are provided for six institutions that have implemented the program.

Cracolice, M. S., & Deming, J. C. (2002). The Sky's the Limit: Learning through PLTL Teams at Big Sky High School. Peer-Led Team Learning: Implementation in high schools. *Progressions: The Peer-Led Team Learning Project Newsletter*, 3(2). Available online: <http://pltlis.org/wp-content/uploads/2012/10/High-School-Implementation-Cracolice-Deming-The-Skys-the-Limit-Big-Sky-High-School.pdf>.

Brett Taylor, a teacher at Big Sky High School in Missoula, Montana, was enthusiastic about his initial experience with a peer-led team learning workshop: "I was apprehensive at first, and as I walked around students kept coming to me for the answers," he said. "I finally had to leave the room to get them to interact with their groups. When I returned, every student was 'on task' and engaged in the subject. In fact, every student stayed engaged for 50 to 60 minutes." He could not believe how effective this method was at encouraging active learning and keeping students interested. High school peer leaders at Big Sky High School also believe that PLTL is an effective learning tool. When asked whether participating in PLTL affected how students solve problems, one leader answered, "PLTL forces them to learn on their own and not have the teacher hold their hand every step of the way. The students must come up with their own answers and work together to figure problems out. The groups helped build student confidence because I didn't have all the answers and so they had to rely on each other for help."

Cracolice, M. S., & Deming, J. C. (2005). *Peer-led Team Learning: Promoting conceptual understanding and reasoning ability*. Conference Proceedings of the Trends and New Ideas in Chemical Education On-line Conference, On-line.

At the University of Montana (Missoula) the authors have successfully used Peer-led Team Learning (PLTL) in general chemistry courses. Six critical elements are identified for successful

PLTL implementation: (1) integration of PLTL assignments with the total course. (2) involvement of the PLTL instructor to integrate the lecture, laboratory, and PLTL sessions. (3) PLTL leaders must be appropriately trained. (4) PLTL worksheets and learning materials must be challenging and designed for group work. (5) PLTL groups must be mandatory and meet two-hours weekly. (6) PLTL requires resources from the institution that continue after initial pilot testing and support by external funds.

Cracolice, M. S., Deming, J. C., & Ehlert, B. (2008). Concept learning versus problem solving: A cognitive difference. *CBE-Life Education*, 85(6), 872. doi: 10.1021/ed085p873.

An initial sample of 94 students enrolled in a first-term general chemistry course was tested with paired algorithmic–conceptual questions, which included questions first used by Nurrenbern and Pickering. The topics of these questions were density, stoichiometry, gas laws, and molarity. Scientific reasoning skill was measured with the Classroom Test of Scientific Reasoning. The skills assessed by this instrument are conservation of weight, conservation of displaced volume, proportional thinking, identification and control of variables, probabilistic thinking, correlational thinking, and hypothetic-deductive reasoning. Results showed that success on algorithmic questions was always higher than on conceptual questions, verifying the results of previous studies. Additionally, the students with better reasoning ability outperformed students with poorer reasoning ability on all question types, and the scores of the better reasoners were significantly higher than those of the poorer reasoners on three of the four conceptual questions administered, as well as on the ACS final examination. The results indicate that variation in scientific reasoning skills is one cause of the gap between algorithmic and conceptual problem-solving ability.

Cracolice, M. S., Deming, J. C., Taylor, B., & Jones, D. (2001). *Adapting Peer-led Team Learning to high school chemistry*. Conference Proceedings of the 222nd American Chemical Society National Meeting, Chicago, IL. For more information, contact the authors at the Department of Chemistry, The University of Montana, 32 Campus Drive, Missoula, MT 59812, markc@selway.ymt.edu

Peer-led Team Learning (PLTL) has been used at institutions to support higher student achievement in chemistry courses. It has been adapted for use at the high school level by heavy emphasis on interpreting experimental data.

Darnell, A., Becvar, J., Flores, B., Knaust, H., Lopez, J., & Tinajero, J. (2012). *Achieving student success using Peer-Led Team Learning (PLTL)*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Darnell-2012.docx>

This paper presents the results of a five year implementation of peer-led team learning at the University of Texas at El Paso (UTEP) in five freshmen and sophomore chemistry, physics, and mathematics courses. The intervention was designed to improve retention and success of these students in their undergraduate program. The imperative for this work, to fulfill the University of Texas at El Paso's mission of "access and excellence," provided a new option to the traditional large-lecture course of yesteryear. Students indicated they learned more in their small group workshops than by any other modality offered.

Dennis, S. M. (2013). *Improving student achievement in introductory computer science courses using Peer-Led Team Learning*. (Ph.D. dissertation), Walden University.

There has been a steady decline of majors in the disciplines of science, technology, engineering, and mathematics (STEM majors). In an effort to improve recruitment and retention in STEM majors, an active-learning methodology—peer-led team learning (PLTL)—was implemented by the participating college in the fall of 2005. This methodology was guided by the

tenets of learning theory, which holds that new knowledge can be learned in such a way that it can be transferred to other applications through designed learning environments and hands-on projects. The purpose of this quantitative simple experimental study was to examine the impact of PLTL on student achievement in computer science. Students enrolled in CSC 110–Programming I were recruited and the impact of PLTL on their achievement was assessed. PLTL methodology was infused in groups of 6 to 8 students enrolled in CSC 110–Programming I at the participating college. A survey, which addressed the effectiveness of PLTL and how it enhanced critical-thinking skills and academic achievement in students, was administered electronically via SurveyMonkey. Results were analyzed through a 1-sample t test to compare the mean for each research question using a test value of 3 and a confidence interval percentage of 95. According to the study results, there was a significant improvement in academic achievement and critical-thinking skills with the use of PLTL. Based on the survey responses, students' ability to define, analyze, and solve problems improved significantly, as did students' understanding of concepts learned through lessons and course materials. This study may lead to positive social change by informing educators about the implementation of alternative learning styles, such as PLTL, which can lead to increased numbers of students who major and graduate in the STEM majors.

Detchen, J. C., Hershberger, S. A. S., & Sarquis, J. L. (2004). *PLTL research explorations at Miami University*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Chemistry and Biochemistry, Miami University, 501 E. High Street, Oxford, OH 45056, detchenc@muohio.edu

Peer-led Team Learning (PLTL) was used in a general chemistry course at Miami University (OH). PLTL was first used in 1998. A research study compared the impact of PLTL and Supplemental Instruction on different sections of the same course. All students in the different sections took the same ACS Examinations Institute exam as a final exam and each section was administered the Group Assessment of Logical Thinking instrument (GALT), and were surveyed using the Student Assessment of Learning Gains (SALG) instrument.

Diegelman-Parente, A. (2012). *The scholarship of Peer-led Team Learning: My progression from student leader to faculty*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Parente-2012.docx>

Twenty years ago, I was an undergraduate majoring in Biology and Chemistry, struggling with the desire to integrate the details I had learned in my Chemistry courses with the 'big picture' philosophy stressed in my Biology curriculum. These early educational experiences fostered my passion for curricula geared towards interdisciplinary learning and in programs designed to increase awareness of alternative learning styles and pedagogies for instruction. My Workshop journey began shortly thereafter with PLTL's inception at the University of Rochester. Now as a faculty member, I have implemented PLTL and two other pedagogies into my General Chemistry, Organic Chemistry, and Biochemistry curricula with a "full-circle" perspective that has been nearly two decades in the making. This article will examine the evolution of my educational philosophy as I progressed from student leader to faculty as well as some strategies I have found useful for its implementation and means to involve these alternative pedagogies in my scholarly activities for promotion and tenure.

Dill, D. (2004). *Implementing PLTL in the quantum concepts semester of physical chemistry*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Chemistry, Boston University, 590 Commonwealth Avenue, Boston, MA 02215, dan@bu.edu

Peer-led Team Learning (PLTL) has been implemented in a physical chemistry course at Boston University. The professor found that the allocation of time for course preparation, student discourse, the use of regular class time, and student performance have all changed from prior years. From the students' point of view, they have the opportunity and responsibility to work with methods and explore concepts more deeply. The course professor identified four primary effects. First, the creation and then revision of the workshops based on input from the peer leaders takes significant time. Second, interaction in lecture is more sophisticated and students are more likely to steer lectures in interesting, unanticipated directions. Third, PLTL has provided a good balance of challenge and accessibility. Finally, PLTL has helped solidify for students foundation quantum concepts and so allowed the course instructor to present material at a richer level. <http://quantum.bu.edu/courses/ch352/workshops.html>.

Dobson, G., Frye, R., & Mantena, R. (2013). Leadership training in an MBA program using Peer-Led Team Learning. *American Journal of Business Education*, 6(2). Leadership training is an important part of any MBA program, but is often difficult to provide in an effective way. Over the last three years, we implemented a program of Peer-Led Team Learning in two core courses of our MBA curriculum, which we believe provides a good solution. The program combines leadership training with practical hands-on application of the ideas taught, and provides for an effective feedback loop. Response to the program has been overwhelmingly positive. The program and benefits for learning leadership are discussed in this paper. Eaching innovations in undergraduate and graduate education are nothing new. The spread of teaching and learning centers across the country at many colleges and universities demonstrates this. Active learning, which engages students in the learning process, is often the centerpiece of new and popular methods (for example, Svinicki & McKeachie, 2010; Fink, 2002; Bain, 2004; Bean, 1996). An especially salient active learning technique is the use of student peers as mentors, facilitators, and leaders (for example, Libarkin & Mencke, 2001, 2002; Triesman, 1992; Sawada et al., 2002; Platt, Roth and Kampmeier, 2003). Peer-led team learning is one such practice that has been used successfully in the U.S., particularly in the Northeast, with undergraduates for over a decade (Tien, Roth & Kampmeier, 2002 and 2004; Platt, et al, 2008). The model is incorporated widely and very successfully on the University of Rochester campus, principally in large undergraduate lecture courses, including Chemistry and Biology. The program has been so successful that it has expanded over the years to include a wide variety of courses such as Optics, Computer Science, Physics, and Philosophy, among others. While the main goal of this approach is to improve student learning with difficult subject material, peer leaders have consistently and repeatedly reported considerable positive benefits of being a peer leader (Gafney & Varma-Nelson, 2007). MBA programs, which emphasize the development of future business leaders, seem ideally suited for such a model. In their extensive study of business education, Datar, Garvin & Cullen (2010) argue, quite cogently, that business education is at a crossroads. Based on interviews with business school deans, executives and MBA students, they conclude that in order to remain relevant, business education needs to emphasize the development of leadership skills and more broadly utilize new pedagogies, including hands-on or experiential learning. Peer-led team learning, which we refer to as the Workshop Model, has the potential to achieve both of these goals. Weekly workshop sessions are interactive by design and workshop leaders develop leadership skills by attending weekly leader training seminars and immediately putting the ideas into practice leading the weekly workshops.

Dominguez, N., Salazar, J., Narayan, M., & Becvar, J. E. (2012). *Peer leading helps more than the students being led*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ppltlis.org/wp-content/uploads/2012%20Proceedings/Dominguez-2012.docx>

Workshops help the peer leaders learn the content in their own STEM majors' courses by enhancing the understanding of the basic concepts taught in introductory science courses. Because each peer leader teaches at least two 2-hour workshops a week and spends a minimum of three hours preparing for those workshops, the leaders have a more in-depth understanding and command of the basic principles. Because of this better grounding in the discipline, the peer leaders have an advantage when it comes to taking standardized entrance exams for higher education such as MCAT, GRE, PCAT, and DAT. In addition, peer leaders have the further advantage that Workshops force them to continue to review the material for years after taking the course. Peer leaders improve leadership and communication skills; skills they will continue to use throughout their lifetimes in whatever career they pursue.

Drane, D., Micari, M., & Light, G. (2014). Students as teachers: Effectiveness of a Peer-Led STEM Learning Program over 10 years. *Educational Research and Evaluation, 20*(3), 210-230. doi: 10.1080/13803611.2014.895388.

Peer-led small group learning has been used quite extensively in the US as a strategy to enhance performance and retention of undergraduate students in science, math and engineering classes. This study presents the results from an evaluation of a peer-led small group program at a selective research university in the US over a 10 year period across five disciplines (biology, chemistry, engineering, physics and math) and seven courses. Data suggest that the program had a positive impact on participants' grades in 5 of the 7 courses and on participant retention in the 4 courses that require students to take a consecutive course sequence. Effects of the program were investigated across gender and ethnic groups. Participants benefited from the program regardless of their gender or ethnicity. However, effect sizes were often larger for students from under-represented groups. This was particularly true in the case of course retention where effect sizes for females were larger than those for males in biology, organic chemistry and engineering courses.

Drane, D., Smith, H. D., Light, G., Pinto, L., & Swarat, S. (2005). The Gateway Science Workshop Program: Enhancing student performance and retention in the sciences through peer-facilitated discussion. *Journal of Science Education and Technology, 14*(1), 337-353. This article describes an adaptation of the Emerging Scholars Program (ESP) called the Gateway Science Workshop (GSW) Project used at Northwestern University in Evanston, IL. The GSW Project was analyzed regarding its effectiveness of increasing academic performance and retention in biology, chemistry and physics courses at a selective research institution. GSW participants earned higher final grades and persistence rates than nonparticipants in biology and chemistry, but not in physics. The researchers discuss the factors favoring and challenging effectiveness of GSW in each of the three academic content areas. The results are analyzed and disaggregate on the basis of ethnicity as well. The benefits of GSW are especially helpful to students of color for whom the program has a major emphasis. However, the evaluation study found usefulness for students of a wide range of demographic backgrounds.

Dreyfuss, A. E. (2012). *Exploring the phenomenon of leading through the experiences of peer leaders*. (Ed. D. dissertation), Columbia University, New York City, NY. Available online: ERIC database. (ED548984)

The concept of leadership has been explored in many contexts, yet it is not a role that is expected as part of a college education. Peer Leaders are in a unique position because they are responsible for leading a group of students to learn. This phenomenological case study explored the experience of leading by Peer Leaders, college students who are selected and trained in adult learning theory to lead a group of students to learn the course material in an introductory science course, in a Peer-Led Team Learning program at an urban commuter public college. Seventeen of the 22 study participants served more than one semester, averaging four, over the

past ten years. In-depth interviews were conducted and three emergent metaphors were identified. These are the "Older Sibling," a role based in prior learning of family with informal authority; the "Faces of the Mountain," a more traditional view of leadership combining positional authority and entity attributes; and the "Catalyst" who manages several small groups of learners, giving power back to the group members. The essence of leading by Peer Leaders is proposed as the following: Leading a workshop group is drawn from prior experience, perhaps a familial role of a sibling, or tacit assumptions and expectations of the role of a leader. It has a cognitive foundation in the task of helping students learn course material yet it is in the dynamics of interacting with the students that a relational process occurs. Emergent relational leadership roles are based in communication, discourse, emotions, diversity of learners' needs and abilities. It is through this experiential process that leading becomes a catalytic activity whereby the leader manages smaller groups to enable each group member to help others learn. Relational leadership is inclusive, challenging, and carries with it the burden of responsibilities to fellow students, fellow Peer Leaders, faculty, and the department. It can also be fun, and may flow with energy, and most importantly, it can be transformational in the ways the Peer Leader views being a follower, learning and leadership.

Dreyfuss, A. E. (2012). *A history of Peer-Led Team Learning: 1999-2012*. Conference Proceedings of the Inaugural Conference of the Peer-Led Team Learning International Society, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/Dreyfuss-History-of-PLTL-2012-rev.docx>

This conference paper provides a comprehensive history of the development and dissemination of the Peer-Led Team Learning model for academic support of students in science and mathematics courses.

Dreyfuss, A. E., & Fraiman, A. (2015). *Peer-Led Team Learning: An active learning method for the 21st century*. Conference Proceedings of the 8th International Conference of Education, Research and Innovation, Seville, Spain.

Peer-Led Team Learning (PLTL) is a strategy to further education reform and improvement. PLTL increases retention in courses in the sciences, mathematics, and engineering, as well as in other disciplines; improves the learning process and prepares students to work in teams, and creates outstanding student leaders. PLTL engages an experienced and trained student as the overseer of a small group of learners in the capacity of Vygotsky's "more capable peer." PLTL has been recognized as a strategy to help students emulate the peer leaders as role models, to reduce student anxiety and build confidence in the learners. PLTL builds strong study skills, develops such critical workplace skills as working in teams, listening, critical thinking, leadership development, and fosters communities of learners who approach learning as a way of life. The peer leaders, generally undergraduate students who are trained for this role, understand the challenges that students have with the material; in a new initiative peer leaders are creating and developing workshop material in conjunction with faculty, augmenting their metacognition. PLTL is an internationally recognized curriculum enhancement strategy adopted at over 150 universities and colleges across the United States, and in the United Kingdom and Jamaica, West Indies. Initially started as Chemistry Workshop, PLTL is coordinated by the Peer-Led Team-Learning International Society (www.pltlis.org). This paper will present the basics of the PLTL instructional model and the practicalities of the six critical components which distinguish the model: integration of the workshop component into the course structure, involvement of the teaching faculty, training and supervision of the peer leaders, creation of challenging materials, and provision of appropriate institutional resources. In addition, the paper will present the results of assessment conducted on student performance and experiences with the PLTL program. Published PLTL data over the past 20 years have shown that using successful peer leaders in

small group workshops boost performance in critical first-year courses including core math, science and engineering courses.

Dreyfuss, A. E., & Gosser, D. K. (2006). In their own words: Learning to be a peer leader. In D. B. Lundell, J. L. Higbee, I. M. Duranczyk & E. Goff (Eds.), *Student standpoints about access programs in higher education* (pp. 143-157). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, College of Education and Human Development, University of Minnesota-Twin Cities. Available online: <http://www.education.umn.edu/CRDEUL/monographs.html>.

This chapter focuses on the experience of the student facilitators who serve in the Peer-led Team Learning (PLTL) program. The beginning of this chapter provided an overview of the PLTL program. Then the narrative focused on the training program for the student facilitators. As a continuation of the initial training, all facilitators maintain a weekly log for them to reflect upon the growth of the students as well as their own personal and professional development. Analysis of the journals identified nearly ten themes that dominated the conversation of the participating students and the inner minds of the facilitators.

Dreyfuss, A. E., Villatoro, M. L., Loui, M. C., Becvar, J., Saune, G. B., & Johnson, W. (2015). *Getting past the first year: Retaining engineering majors*. Conference Proceedings of the Frontiers in Education Conference, El Paso, TX.

Peer Led Team Learning (PLTL) is a nationally recognized curriculum enhancement strategy adopted in various forms by over 150 universities and colleges across the United States. Consistent with the outcomes and the vision of ABET Engineering Criteria 2000 and the National Academy of Engineering Engineer 2020, PLTL prepares students to work in teams; apply knowledge of mathematics, science, and engineering to solve problems; communicate effectively; engage in life-long learning; and develop leadership skills. Published PLTL program data have shown that using peer leaders in small group workshop settings boosts performance in critical first-year courses including core math, science and engineering courses. The PLTL model promotes the growth of critical workplace skills for students and peer leaders such as working in teams, listening, critical thinking and leadership. This paper will present the basics of the PLTL instructional model, including sample materials developed for engineering workshops. Consideration of the practicalities of the six critical components will be discussed: integration of the workshop component into the course structure, involvement of the teaching faculty, training and supervision of the peer leaders, creation of challenging materials, and provision of appropriate institutional resources.

Dries, D. r. (2019). Gains in affect and in scientific literacy from Peer-Led Team Learning in a literature-based first-semester biochemistry course. *FASEB Journal*, 33(1).

Science is a social endeavor that requires communication and collaboration with scientists of various expertise and background. Traditional lecture, however, can cast learning as a passive, individualized task. To model the scientific community for students, a sophomore-level biochemistry course was redesigned using the primary literature as the principal content from which biochemical concepts were extracted. Working in groups alongside a peer facilitator, students constructed their own knowledge by interrogating the literature, researching answers to their questions, and sharing with their group, while instructor-led activities and just-in-time mini-lectures grounded the class in a common experience. Attitudinal post-surveys showed student affective gains in teamwork, inquisitiveness, and scientific literacy. Moreover, graduates self-reported greater preparation for post-graduate work than peers in their program. Together, these results suggest that peer-led team learning using the primary literature can lead to gains in competencies and skill development while still accruing knowledge of biochemistry content.

Dubey, H., Kaushik, L., Sangwan, A., & Hansen, J. L. (2016). A speaker diarization system for studying Peer-Led Team Learning groups of Work. of Work. Department. The University of Texas at Dallas. Richardson, TX. Available online: <https://arxiv.org/pdf/1606.07136.pdf>

Peer-led team learning (PLTL) is a model for teaching STEM courses where small student groups meet periodically to collaboratively discuss coursework. Automatic analysis of PLTL sessions would help education researchers to get insight into how learning outcomes are impacted by individual participation, group behavior, team dynamics, etc.. Towards this, speech and language technology can help, and speaker diarization technology will lay the foundation for analysis. In this study, a new corpus is established called CRSS-PLTL, that contains speech data from five PLTL teams over a semester (10 sessions per team with 5-to-8 participants in each team). In CRSS-PLTL, every participant wears a LENA device (portable audio recorder) that provides multiple audio recordings of the event. Our proposed solution is unsupervised and contains a new online speaker change detection algorithm, termed G3 algorithm in conjunction with Hausdorff-distance based clustering to provide improved detection accuracy. Additionally, we also exploit cross channel information to refine our diarization hypothesis. The proposed system provides good improvements in diarization error rate (DER) over the baseline LIUM system. We also present higher level analysis such as the number of conversational turns taken in a session, and speaking time duration (participation) for each speaker.

Dubey, H., Sangwan, A., & Handon, J. H. L. (2017). Using speech technology for quantifying behavioral characteristics in peer-led team learning sessions *Computer Speech & Language*. doi: 10.1016/j.csl.2017.04.002.

Peer-Led Team Learning (PLTL) is a learning methodology where a peer-leader co-ordinate a small-group of students to collaboratively solve technical problems. PLTL have been adopted for various science, engineering, technology and maths courses in several US universities. This paper proposed and evaluated a speech system for behavioral analysis of PLTL groups. It could help in identifying the best practices for PLTL. The CRSS-PLTL corpus was used for evaluation of developed algorithms. In this paper, we developed a robust speech activity detection (SAD) by fusing the outputs of a DNN-based pitch extractor and an unsupervised SAD based on voicing measures. Robust speaker diarization system consisted of bottleneck features (from stacked autoencoder) and informed HMM-based joint segmentation and clustering system. Behavioral characteristics such as participation, dominance, emphasis, curiosity and engagement were extracted by acoustic analyses of speech segments belonging to all students. We proposed a novel method for detecting question inflection and performed equal error rate analysis on PLTL corpus. In addition, a robust approach for detecting emphasized speech regions was also proposed. Further, we performed exploratory data analysis for understanding the distortion present in CRSS-PLTL corpus as it was collected in naturalistic scenario. The ground-truth Likert scale ratings were used for capturing the team dynamics in terms of student's responses to a variety of evaluation questions. Results suggested the applicability of proposed system for behavioral analysis of small-group conversations such as PLTL, work-place meetings etc.

Dubey, H., Sangwan, A., & Hansen, J. L. (2016). *A robust diarization system for measuring dominance in Peer-Led Team Learning groups*. Conference Proceedings of the Spoken Language Technology Workshop (SLT), 2016 IEEE, San Diego, CA.

Peer-Led Team Learning (PLTL) is a structured learning model where a team leader is appointed to facilitate collaborative problem solving among students for Science, Technology, Engineering and Mathematics (STEM) courses. This paper presents an informed HMM-based speaker diarization system. The minimum duration of short conversational-turns and number of participating students were fed as side information to the HMM system. A modified form of Bayesian Information Criterion (BIC) was used for iterative merging and re-segmentation.

Finally, we used the diarization output to compute a novel dominance score based on unsupervised acoustic analysis.

Eberlein, T., Kampmeier, J. A., Minderhout, V., Moog, R. S., Platt, T., Varma-Nelson, P., & White, H. B. (2008). Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL. *Biochemistry and Molecular Biology Education*, 36(4), 262-273. doi: 10.1002/bmb.20204. Available online: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2665262/>.

Problem-based learning, process-oriented guided inquiry learning, and peer-led team learning are student-centered, active-learning pedagogies commonly used in science education. The characteristic features of each are compared and contrasted to enable new practitioners to decide which approach or combination of approaches will suit their particular situation.

Eren-Sisman, E. N., Cigdemoglu, C., & Geban, O. (2018). The effect of peer-led team learning on undergraduate engineering students' conceptual understanding, state anxiety, and social anxiety. *Chemistry Education Research and Practice*, 19, 694-710. Available online: <http://pubs.rsc.org/en/content/articlehtml/2018/rp/c7rp00201g>.

This study aims to compare the effectiveness of a Peer-Led Team Learning (PLTL) model with that of traditional college instruction (TCI) in enhancing the conceptual understanding and reducing both the state anxiety and social anxiety of undergraduate engineering students in a general chemistry course in a quasi-experimental design. 128 engineering students taking the course participated in the study. One of the course sections was randomly assigned to the experimental group and the other section was assigned to the control group. Both sections were taught by the same instructor. The control group was instructed using traditional college instruction, while the experimental group was instructed using the PLTL model. Throughout this study, six peer-led chemistry workshops and leader training sessions were performed simultaneously. The General Chemistry Concept Test, the State-Trait Anxiety Inventory, and the Social Anxiety Questionnaire for Adults were administered before and after the treatment to both groups. One-way Multivariate Analysis of Covariance (MANCOVA) indicated that after controlling students' university entrance scores, trait anxiety scores and pre-test scores of both the General Chemistry Concept Test and state anxiety, the PLTL model was more effective in improving the conceptual understanding and reducing the situational anxiety of engineering students in undergraduate general chemistry. However, it was not so effective in lessening their social anxiety when compared to traditional college instruction.

Feder, E., Khan, I., Mazur, G., Vernon, T., Janke, T., Newbrough, J., . . . Varma-Nelson, P. (2016). Accessing collaborative online learning with mobile technology in Cyber Peer-Led Team Learning. Available online: <http://er.educause.edu/articles/2016/4/accessing-collaborative-online-learning-with-mobile-technology-in-cyber-peer-led-team-learning>.

Using mobile devices in online collaborative learning models offers many potential advantages for students and faculty. However, while the technology can reduce costs and increase mobility for students, replacing traditional devices with mobile devices can result in a loss of functionality. To address this functionality loss and investigate workarounds, a group of researchers at Indiana University-Purdue University Indianapolis tested mobile platforms for use in the institution's Cyber Peer-Led Team Learning model. The study found three platforms that offer a viable choice for institutions looking to implement online PLTL programs.

Finn, K., & Campisi, J. (2015). Implementing and evaluating a Peer-Led Team Learning approach in undergraduate anatomy and physiology. *Journal of College Science Teaching*, 44(6).

This article describes how a Peer-Led Team Learning (PLTL) program was implemented in a first-year, undergraduate Anatomy and Physiology course sequence to examine the student perceptions of the program and determine the effects of PLTL on student performance.

Flintoff, N. L., Shoop, K., Sommers, B., Wittwer, J., & Cavinato, A. G. (2001). *Peer-led Team Learning: Active learning strategies to support success in introductory chemistry courses*. Conference Proceedings of the 221st American Chemical Society National Meeting, San Diego, CA. For more information, contact the authors at the Department of Chemistry, Eastern Oregon University, One University Boulevard, La Grande, OR 97850, flinton@eon.edu
Peer-led Team Learning (PLTL) is used at Eastern Oregon University in chemistry courses. PLTL is offered as a separate one credit pass/no pass course. Studies regarding student achievement have been conducted.

Foroudastan, S. (2009). *Enhancing undergraduate performance through peer-led team learning (PLTL)*. Conference, Austin, TX.
Description of the PLTL program used at one institution.

Fortier, A. S. (2009). Peer-Led Team Learning and teaching high school – a letter. Peer-Led Team Learning: Implementation in high school. *Progressions: The Peer-Led Team Learning Project Newsletter*, 10(2). Available online: <http://pltlis.org/wp-content/uploads/2012/10/High-School-Implementation-Fortier-PLTL-and-Teaching-in-HS.pdf>.

I spent the past year as a Grade 9 IPC (Integrated Physics & Chemistry) and Grade 11 Chemistry teacher at an El Paso, Texas, high school. After graduating from college, I thought it would be fun and exciting to teach high school science before going on to pursue my graduate studies. Unfortunately, I found the job to be much more challenging than I initially thought. If it had not been for my experience as an undergraduate Peer Leader, I would not have been able to make it through the school year. Considering that my degree is in Chemistry and not Education, I chose to get my probationary teaching certificate through Texas Alternative Certification Process (ACP). I needed a fast track option to getting a probationary license and the only true requirements at Texas ACP is that you have the appropriate college credits and enough money to pay the fees. The program is also very flexible about attending their night classes so long as these are completed within one year of entrance to the program.

Frey, R., Brown, P. L., & Sawyer, R. K. (2009). *An Analysis of discourse in Peer-Led Team Learning*. Paper presented at the DivCHED CCCE. Available online: https://cptl.iupui.edu/doc/Frey%20et%20al_2009.pdf.

Peer-Led Team Learning (PLTL) is a structured method for helping students engage actively in collaborative conversations. The method originated in undergraduate chemistry courses, but is now used in math and in other science classes as well. Previous studies have shown that PLTL results in improved learning in undergraduate chemistry. However, researchers have not studied the group mechanisms and discourse processes that lead to this improved outcome. This study is the first to explore those mechanisms and processes. We observed videotapes of PLTL sessions and analyzed the actions and interactions of peer leaders and of students. We found that peer leaders used two distinct interactional styles, which we call instructional and facilitative. The effects of these two interactional styles on the students' dialogue, participation, and knowledge building will be presented.

Frey, R., Fink, A., Cahill, M. J., McDaniel, M. A., & Solomon, E. D. (2018). Peer-Led Team Learning in General Chemistry I: interactions with identity, academic preparation, and a course-based intervention. *Journal of Chemical Education*, 95(12), 2103-2113. doi: 10.1021/acs.jchemed.8b00375.

Robust evidence shows that Peer-Led Team Learning (PLTL) improves the academic success of first-year college students in introductory Science, Technology, Engineering, and Mathematics (STEM) courses. Less clear is the extent to which this positive PLTL effect varies across different subgroups of the population. The current study aims to deepen our understanding of the overall PLTL effect by extensively evaluating an optional PLTL program associated with General Chemistry I at a private, research university. Using five years of exam data, this study disaggregates the PLTL effect by demographics (sex and race), academic preparation (math skills, chemistry content knowledge, and experience with college-preparatory coursework), and participation in another curricular innovation (a growth-mindset intervention). Results revealed that the positive effect of PLTL was comparable across demographic identity groups. Thus, the PLTL program benefitted all participants but did not reduce the pre-existing performance disparity between underrepresented minority and white students (no sex-based disparity was observed). In terms of academic preparation, the PLTL effect interacted with students' level of experience with college-preparatory coursework but not with their math or chemistry knowledge. This pattern suggests that PLTL may help develop students' self-management or reasoning skills, without necessarily narrowing knowledge gaps. Finally, PLTL interacted with participation in a growth-mindset intervention: the difference between PLTL participants and nonparticipants was smaller among students who received the mindset intervention. Implications for chemical education researchers and practitioners are discussed, with an eye toward fostering equity in introductory STEM courses.

Freyvogel, C. (2006, 2006, February 1). Model students: Area teacher sold on team-learning process, *The Tribune-Democrat*. Available online: http://www.tribune-democrat.com/features/local_story_032154327.html.

Ray Trybus, a science teacher at Portage Area High School, uses Peer-Led Team Learning (PLTL) with his high school students. The article provides interviews with the teacher as well as some of the high school students.

Froyd, J. E. (2008). *Evidence for the efficacy of student-active learning pedagogies*. Conference Proceedings of the CCLI Conference. Available online:

http://ccliconference.org/files/2010/03/Froyd_Evidence.pdf

Although many resources have been published on improvements in student retention and/or learning as a result of using what can be referred to as student-active pedagogies, the resources are published in a variety of journals or on various websites. As a result, it may be difficult for an individual to locate and assemble these resources to support an argument in favor of using these alternative pedagogies. Over a period of eight years, including my time as the Project Director for the Foundation Coalition, one of the Engineering Education Coalitions supported by NSF, I have tried to assemble many of these resources in one place for easy reference.

Gafney, L. (2002). PLTL and secondary school teaching, Peer-Led Team Learning: leader training. *Progressions: The Peer-Led Team Learning Project Newsletter*, 3(2). Available online: <http://ptlis.org/wp-content/uploads/2012/10/High-School-Implementation-Gafney-PLTL-and-Secondary-School-Teaching.pdf>.

This report is an excerpt from a telephone interview conducted by Leo Gafney as part of the study of former peer leaders at St. Xavier University in Chicago. It provides a dramatic illustration of how the peer leader experience inspired Yvonne O'Connell in her work as a secondary school teacher at a private school for boys.

Gafney, L. (2004). Peer leader and Rhodes Scholar: Peer-led Team Learning, The experience of learning. *Progressions: The Peer-Led Team Learning Project Newsletter*, 5(3). Available

online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Gafney-Peer-Leader-Rhodes-Scholar.pdf>.

Rick Malins, a senior at Boston University, was awarded a Rhodes Scholarship and will study for a doctoral degree in neuroscience at Oxford University. He was a workshop leader for two different courses at Boston University. The following is based on a phone interview with him, conducted by Leo Gafney in January 2004

Gafney, L., & Varma-Nelson, P. (2003). *Impact of being a peer-leader on undergraduate students*. Conference Proceedings of the 226th American Chemical Society National Meeting, New York, NY. For more information, contact the author at the PLTL Workshop Project, 147 Wells Hill Road, Lakeville, CT 06039, gafney@pop3.discovernet.net

The Peer-Led Team Learning (PLTL) is dependent upon the student peer facilitators who conduct the sessions. A survey of the effects of serving as a peer leader regarding personal mastery of chemistry concepts, impact on career and graduate education options, and interpersonal skill development.

Gafney, L., & Varma-Nelson, P. (2007). Evaluating Peer-Led Team Learning: A study of long-term effects on former workshop peer leaders. *Journal of Chemical Education*, 84(3), 535-539. Available online: <http://pubs.acs.org/doi/pdf/10.1021/ed084p535>.

This article describes a study that examined the impact of the Peer-led team learning (PLTL) program with the student facilitators who had direct contact with the students. With a decade of data available on 600 student leaders from 9 institutions, the PLTL facilitators were studied as they took subsequent steps into graduate work and careers. A survey was developed, piloted, revised, and placed online. There were 119 leaders who completed the survey. Respondents reported that leading the workshops reinforced the breadth and depth of their own learning, helped them develop personal qualities such as confidence and perseverance, and fostered a variety of presentation and team-related skills. The respondents offered rich insights into issues in implementing workshops.

Gardner, L. M. (2015). *Analysis of student performance in peer led undergraduate supplements*. (Ph.D. dissertation), University of Kansas, Lawrence, KS. Available online:

https://kuscholarworks.ku.edu/bitstream/handle/1808/19159/Gardner_ku_0099D_14264_DATA_1.pdf?sequence=1&isAllowed=y

Foundations of Chemistry courses at the University of Kansas have traditionally accommodated nearly 1,000 individual students every year with a single course in a large lecture hall. To develop a more student-centered learning atmosphere, Peer Led Undergraduate Supplements (PLUS) were introduced to assist students, starting in the spring of 2010. PLUS was derived from the more well-known Peer-Led Team Learning with modifications to meet the specific needs of the university and the students. The yearlong investigation of PLUS Chemistry began in the fall of 2012 to allow for adequate development of materials and training of peer leaders. We examined the impact of academic achievement for students who attended PLUS sessions while controlling for high school GPA, math ACT scores, credit hours earned in high school, completion of calculus, gender, and those aspiring to be pharmacists (i.e., pre-pharmacy students). In a least linear squares multiple regression, PLUS participants performed on average one percent higher on exam scores for Chemistry 184 and four tenths of a percent on Chemistry 188 for each PLUS session attended. Pre-pharmacy students moderated the effect of PLUS attendance on chemistry achievement, ultimately negating any relative gain associated by attending PLUS sessions. Evidence of gender difference was demonstrated in the Chemistry 188 model, indicating females experience a greater benefit from PLUS sessions. Additionally, an item analysis studied the relationship between PLUS material to individual items on exams. The research discovered that students who attended PLUS session, answered the items

correctly 10 to 20 percent more than their comparison group for PLUS interrelated items and no difference to 10 percent for non-PLUS related items. In summary, PLUS has a positive effect on exam performance in introductory chemistry courses at the University of Kansas.

Garmon, L. (2012). *Why attendance is mandatory in workshops: Comparison of course grades of workshop attendees vs. non-attendees with similar GPA and SAT scores*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pctlis.org/wp-content/uploads/2012%20Proceedings/Garmon-2012.docx>

Records of test scores and course grades going back over ten years are available for approximately 5400 students in first-semester general chemistry and 3300 students in second-semester general chemistry at the University of West Georgia. In this project those attending workshops regularly throughout a semester were matched in GPA (prior to taking general chemistry) and SAT scores with those not attending regularly. Most students were enrolled in sections in which workshop attendance was an integral part of the course. Those not attending fell into three categories: those in sections that included workshop but who chose not to attend and thus not to meet that requirement; those who were enrolled in an honors section, which did not include workshops; and those taking the course online, as the sections offered online have up to now not included workshops. In all cases, those with similar GPA/SAT scores who attended workshop outperformed those who did not.

Garmon, L., Otwell, D. D., Brown, C. M., Rittgers, B. M., Downes, D. R., Robinson, Z. B., & Geisler, R. (2015). *Peer-Led Team Learning at the University of West Virginia*. Conference Proceedings of the Interdisciplinary STEM Teaching & Learning Conference.

Peer-Led Team Learning (PLTL) has been a part of general chemistry at the University of West Georgia (UWG) for over fifteen years. PLTL is a collaborative and innovative learning model that supplements the classroom lecture, typically in STEM courses. In PLTL at UWG, approximately fifteen students meet weekly for ninety minutes to actively work together to solve chemistry problems under the guidance of a peer leader. Results at UWG have shown that students who consistently attend and participate in PLTL attain higher grades and better student learning outcomes such as student engagement, motivation and performance than students who fail to attend. At this session we will model a sample workshop and actively involve participants.

Gates, A. Q., Casas, C., Servin, C., & Slattery, M. (2015). *Using Peer-Led Team Learning to build university-community college relationships*. Conference Proceedings of the Frontiers in Education Conference, El Paso, TX.

Through support from the National Center for Women & Information Technology (NCWIT), the University of Texas at El Paso (UTEP) and the El Paso Community College (EPCC) began a program to collaborate on adoption of Peer-Led Team Learning (PLTL) at EPCC. The NCWIT-funded effort aims to transfer this effective retention practice to the EPCC in order to establish early connections with female students, create community, and provide activities that improve students' problem-solving skills. PLTL provides an active learning experience for students and creates leadership roles for undergraduates. For the peer leaders, the experience of working with faculty and guiding their peers through a challenging course is rewarding, and they learn communication, teaching, leadership, and interpersonal skills. Peer leaders become more confident about their career path, and many continue to be involved in the department through undergraduate research positions. This is important for retention and advancement efforts, since the peer-leading experience influences the students' motivation to attend graduate school. This paper describes how the UTEP-EPCC partnership was structured, how the practice was transferred, and the challenges that were encountered. It also presents the evaluation results.

Ghezzi, L., Ahmed, M., Cauthen, M., Chan, C., Hendricks, T., & Tran, T. (2012). *A peer-led workshop experience in an introductory mathematics class* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. In this paper the Instructor and the Peer Leaders share their experience with the Peer-Led Workshop embedded in an introductory Mathematics class at the New York City College of Technology in the spring 2012 semester.

Gibbons, R. E., Xu, X., Villafane, S. M., & Raker, J. R. (2018). Testing a reciprocal causation model between anxiety, enjoyment and academic performance in postsecondary organic chemistry. *Educational Psychology: An International Journal of Experimental Educational Psychology* 38(6), 838-856. doi: 10.1080/01443410.2018.1447649
Affective factors such as the achievement emotions are considered critical for students' academic performance in STEM degree programmes and careers. In this study, a reciprocal causation model was tested between two affective factors: enjoyment and anxiety, and organic chemistry course performance. Each variable was measured three times in four sections of a first semester organic chemistry course. This study investigates a reciprocal causation relationship between anxiety, enjoyment and achievement as measured by exam performance compared to unidirectional structures of performance and affect relationships. Results show that the reciprocal causation model with an exam snowballing effect best fits data among the alternative models. There is a small and significant negative relationship between anxiety and performance contrasted with a positive relationship between enjoyment and performance throughout the semester. The evidence of the reciprocal relationship between anxiety, enjoyment and achievement indicates that instructors of organic chemistry can work to eliminate factors associated with low performance. Gathering information regarding anxiety and enjoyment along with performance can inform educators about the emotional state of their classrooms. Future research should consider achievement emotions in light of educational reforms to ensure that innovative curricula or pedagogies are functioning in the classroom as intended.

Gillmore, J. G. (2010). PLTL impacts a career - from peer leader to the professoriate. *Peer-led Team Learning: The experience of leading. Progressions: The Peer-Led Team Learning Project Newsletter*, 12(1). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Gilmore-PLTL-Impacts-a-Career.pdf>.
In August of 1998, the author arrived at the University of Rochester fresh from a five-year BS/MS at Virginia Tech. That fifth year to complete a master's thesis convinced the student of desire to be a physical organic chemist, and consider an academic career rather than the original pharmaceutical industry trajectory. At Rochester she joined Joe Dinnocenzo's group to study photoinduced charge transfer initiated cation radical reactions in polymeric media, and realized she would not teach for at least a semester or two. The experience as a Peer Led Team Learning (PLTI) facilitator solidified resolve to become a teacher.

Glenn, K. (1998). General chemistry teaching workshop: A student's view. *Journal of Chemical Education*, 75(2), 147-150. doi: 10.1021/ed075p147.
This article focuses on the reaction of the student facilitators who work in the Peer-led Team Learning (PLTL) program. Interviews with seven students from Saint Xavier University, Chicago, IL; The City College of CUNY; University of Kentucky; University of Montana; American University, and University of Rochester.

Glover, R., Hammond, N. B., Smith, J., & Guerra, D. (2018). Assessing peer leader skill acquisition and group dynamics in a first-year calculus course. *International Journal for the*

Scholarship of Teaching and Learning, 12(1). Available online: <https://digitalcommons.georgiasouthern.edu/cgi/viewcontent.cgi?article=1685&context=ij-sotl>. Peer-led team learning (PLTL), specifically the model known as 'Workshops', has been shown to contribute positively and significantly to student success in STEM courses across subjects (Gosser et al., 2001). Our research adds to the SOTL literature describing the effectiveness of Workshops by reporting on the changes in student leaders. We examine the level to which leaders acquired new skills in effective teaching and describe the pedagogical interactions in the groups they led as a result of the combination of training and experience facilitating first-year Calculus Workshop sections. This was a semester-long study on twenty-two Workshop leaders for two multi-section, introductory calculus courses at a small research university. Our method is a novel overlay of two metrics that allows, with some forethought, a robust analysis of Workshop leader outcomes that would complement any assessment of PLTL implementation faculty might choose to undertake.

Goodwin, J. A., & Barrett, J. (2002). *Electronic workshops: Development of computer-based activities for Peer-led Team Learning in general chemistry*. Conference Proceedings of the 224th American Chemical Society National Meeting, Boston, MA. For more information, contact the author at the Department of Chemistry and Physics, Coastal Carolina University, P.O. Box 261952, Conway, SC 29528, jgoodwin@coastal.edu. Peer-led Team Learning (PLTL) has been used at the Coastal Carolina University (SC) to support higher student achievement in introductory science courses. PLTL is supplemented with hybrid print and computer-based study materials. The program has been assessed through surveys, pre- and post-testing, and focus groups.

Goodwin, J. A., & Gilbert, B. D. (2001). Cafeteria-style grading in general chemistry. *Journal of Chemical Education*, 78(4), 490-493.

Self-selected individual course-grade weighting schemes allow students personal choice of course components in the general chemistry sequence at Coastal Carolina University. With the availability of a wide range of commercial and academically produced pedagogical resources, students can select materials that best suit their own learning styles, social situations, and motivation level. Our students use a signed contract to indicate their preferred grade-weighting schemes for determination of the course grade. In doing so, they choose from course components that include peer-led team learning (PLTL) in the Workshop Chemistry (WSC) model, computer-assisted instruction (CAI) using the ChemSkill Builder (CSB) software, a variety of in-class quizzes and group problem-solving exercises, written exams, and the final written exam. Minimum percentage values are required of all components except WSC and CSB, which have been completely optional graded course components at CCU since the summer of 1999. Comparison of student success in the course and content learning suggests that the improvements observed with introduction of a gamut of activities increase even more when the cafeteria-style grading is implemented.

Goroff, N. S. (1998). Report on "workshop chemistry". *The Chemical Educator*, 3(1), online article.

David Gosser (City College of New York) and Pratibha Varma-Nelson (St. Xavier University, Chicago) presented the Workshop Chemistry initiative, "a coalition of faculty, students, and learning specialists organized around a peer-led, team-learning model of teaching chemistry." Through presentations and small group discussions with undergraduates, participants learned about this program, how it has been implemented at two different schools, and how it might fit into their own curriculum.

Gosser, D. K. (1997). *The workshop chemistry project: Developing a Peer-led Team Learning model for chemistry instructors*. Conference Proceedings of the 213th American Chemical Society National Meeting, San Francisco, CA. For more information, contact the author at the Chemistry Department, The City College of New York, 138th Street and Covent Ave., New York, NY 10031, gosser@sci.ccnycuny.edu

Peer-led Team Learning (PLTL) was used with undergraduate chemistry students at the City College of New York.

Gosser, D. K. (2003). *Dynamics of peer-assisted active learning*. Paper presented at the 226th American Chemical Society National Meeting, New York, NY. For more information, contact the author at the Chemistry Department, The City College of New York, 138th Street and Convent Ave., New York, NY 10031, gosser@sci.ccnycuny.edu.

Peer-Led Team Learning (PLTL) was used with introductory chemistry courses of the City College of New York. Data from the national study of PLTL as well as recommendations for successful implementation of the program are provided.

Gosser, D. K. (2004). *Peer-led Team Learning: Development, dissemination, and research*. Paper presented at the 228th American Chemical Society National Meeting, Philadelphia, PA. For more information, contact the author at the Chemistry Department, The City College of New York, 138th Street and Covent Ave., New York, NY 10031, gosser@sci.ccnycuny.edu.

Peer-led Team Learning (PLTL) was used with undergraduate chemistry students at the City College of New York. The paper focused on the origins of PLTL, national dissemination of the program, and research studies on PLTL.

Gosser, D. K. (2006). PLTL in general chemistry: Scientific learning and discovery. In N. Pienta, M. Cooper & T. Greenbowe (Eds.), *The chemists' guide to effective teaching, volume 2*. Upper Saddle River, NJ: Prentice Hall

Gosser, D. K., Cracolice, M. S., Kampmeier, J. A., Roth, V., Strozak, V. S., & Varma-Nelson, P. (Eds.). (2001). *Peer-Led Team Learning: A guidebook*. Upper Saddle River, NJ: Prentice Hall
This book provides strategies for implementing the Peer-Led Team Learning (PLTL) program by other educators. This book explains the theory behind PLTL, offers suggestions for successful implementation (including how to write effective group problems and how to train peer leaders), discusses how to evaluate the success of the program, and answers to frequently asked questions.

Gosser, D. K., Cracolice, M. S., & Strozak, V. S. (Eds.). (2005). *Peer-Led Team Learning, the workshop project: General chemistry*. (2nd ed.). Upper Saddle River, NJ: Prentice Hall
This book provides strategies for implementing the Peer-Led Team Learning (PLTL) program by other educators in a general chemistry course. Each of the 24 units in the consumable workbook addresses a significant topic in chemistry by providing a short narrative summary, structured small-group learning activities, discussion questions, and self-test activities to monitor comprehension of the material.

Gosser, D. K., Dreyfuss, A. E., & Gafney, L. E. (2006). *Progressions: Peer-led Team Learning Newsletter*

Available online: <https://sites.google.com/site/quickpltl/>

This online newsletter provides an overview, implementation and research studies, and other resources related to Peer-led Team Learning (PLTL).

Gosser, D. K., Kampmeier, J. A., & Varma-Nelson, P. (2010). Peer-Led Team Learning: 2008 James Flack Norris award address. *Journal of Chemical Education*, 87(4), 374-380. doi: 10.1021/ed800132w.

This paper offers an overview of the development of the peer-led team learning (PLTL) model for teaching and learning chemistry, from the personal journeys of the authors in their classrooms to the national dissemination of the model to the full range of colleges and universities and to other STEM disciplines. In the PLTL model, students who have done well in the course serve as peer-leaders to facilitate Workshops that supplement the lecture part of the course for new students. In the weekly Workshops, 6–8 students engage in active debate, discussion, and problem solving under the guidance of the peer leaders. A diverse faculty team led the development of instructional materials for the Workshops, methods to train peer leaders, and tactics to institutionalize PLTL. Students and leaders value the peer-led Workshops, and results from within the PLTL project (as well as numerous independent studies) demonstrate significant gains in student learning for both groups. PLTL remains an active area of research and development. We discuss our insights into the larger issues of curricular and institutional change at the college level. A central finding of the PLTL project is that students are a significant untapped resource for teaching. They partner with us to form a community of learners that bridges the gap between faculty and students.

Gosser, D. K., & Mar, V. (2003). *Peer-Led Team Learning: An introduction*. Unpublished manuscript. City University of New York. New York, NY. Available online: <https://sites.google.com/site/quickpltl/>

This article provides an overview of the Peer-Led Team Learning (PLTL) program developed at the City University of New York. PLTL has been implemented at more than 100 institutions that seek to improve student achievement in science courses.

Gosser, D. K., & Roth, V. (1998). The workshop chemistry project: Peer-Led Team Learning. *Journal of Chemical Education*, 75(2), 185-187. doi: 10.1021/ed075p185.

This article provides an overview of Peer-Led Team Learning (PLTL) program. The program is supported through the National Science Foundation, Division of Undergraduate Education, Course and Curriculum Development Program, part 1. The project involves a new curriculum structure, a two-hour student-led workshop with six to eight students to replace the traditional recitation or a modest amount of lecture. The Workshop Chemistry model embraces dimensions of student experience that are essential for learning: the freedom to discuss and debate chemistry in a challenging but supportive environment, the connection to mentors, and the power of working as part of a team. The workshop model calls for the traditional recitation, or a modest amount of lecture, to be replaced by a new curricular structure: a two-hour student-led workshop. In the first two and a half years of the project, more than 6000 students have participated in workshop courses in allied health, general, and organic chemistry, conducted by 27 faculty and more than 800 workshop leaders.

Gosser, D. K., Roth, V., Gafney, L., Kampmeier, J., Strozak, V., Varma-Nelson, P., . . . Weiner, M. (1996). Workshop chemistry: Overcoming the barriers to student success. *The Chemical Educator Online*, 1(1), Article 1. Available online: <http://chemeducator.org/bibs/0001001/00010002.htm>.

Prevailing modes of instruction, often passive in nature, do not address crucial issues for student success in science: the need for students to become part of an intellectual community, the differences in the ways students learn, and the powerful role that mentoring can play in involving students in science. Furthermore, students who spend most of their instructional time listening to lectures seldom learn to communicate scientific ideas and to become part of a problem-solving team, skills that industry tells us are crucial to success in the workplace.

Workshop Chemistry is a peer-led team-learning model of instruction that provides an active learning experience for students, creates new leadership roles for those who have done well, and involves faculty in the process of reform. A modest reduction in lecture or recitation time is replaced by a 2-hour student-directed small group problem-solving and model-building workshop. The Workshop Chemistry Project is a coalition of faculty, learning specialists, and students from a variety of institutions organized around the theme of developing the workshop model as an integral part of the course structure. Several brief descriptions of the workshop courses offered in the Fall of 1995 are provided, along with some sample workshop problems. Surveys, focus groups, student logs, faculty interviews, and actual course results provide insight into the enhanced learning in the workshop and the progress of the project towards its goals.

Gosser, D. K., Strozak, V., & Cracolice, M. (Eds.). (2001). *Peer-led Team Learning: General chemistry*. Upper Saddle River, NJ: Prentice Hall

Gosser, D. K., Strozak, V., & Cracolice, M. (Eds.). (2006). *Peer-led Team Learning: General chemistry* (2nd ed.). Upper Saddle River, NJ: Prentice Hall

Guzman, J., Becvar, J. E., & Saupe, G. (2012). *Workshop adaptability*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Guzman-2012.docx> How often would a student in a course walk up to a professor and say: "Professor, I do not comprehend the material; would you mind changing your teaching style?" More than likely one would never see this scenario. Students generally are forced to adapt to their professor, not the other way around. At the University of Texas at El Paso the Peer-Led Team Learning program provides the ability to tailor a classroom to the students' needs. The peer leader directs students into self-learning using team-based activities and problem solving strategies. One advantage of this program is its ability to evolve to students' needs. The small classroom environment promotes a personal connection among peers. This personal connection allows students to feel comfortable to ask questions and even more important, to make suggestions. The format allows students to reflect on the activities for the day to make recommendations for following workshops and for improvements giving students a sense of ownership of their learning process. The relaxed learning environment focuses attention on learning the concepts at hand not the shortcomings of the professor.

Hagman, J. E. (2019). The eighth characteristic for successful calculus programs: Diversity, equity, & inclusion practices. *Problems, Resources, and Issues in Mathematics Undergraduate Studies*. doi: 10.1080/10511970.2019.1629555.

Through a multi-year, national calculus study, researchers have recently identified seven characteristics of successful college calculus programs. We identified these seven characteristics by visiting five doctoral-granting mathematics departments with successful calculus programs and uncovering the common traits among them. These seven traits common among the collection of five universities were: robust GTA teaching preparation, coordination of courses, support of active learning, comprehensive placement strategies, collection and attention to local data, abundant student supports, and rigorous content. Further analysis and reflection on the previously gathered data indicates that the earlier study actually identified characteristics of calculus programs that successfully serve a majority white or Asian and male population. In this article, I argue that attention to an eighth characteristic comprised of diversity, equity and inclusion practices along with the other seven can enable a department to create a truly successful calculus program by understanding and attending to the unique needs of historically marginalized populations.

Hambrusch, e. a. (2009). *Using peer-led team learning to increase participation and success of under-represented groups in introductory computer science*. Conference Proceedings of the 40th ACM Technical Symposium on Computer Science Education, Chattanooga, TN. Using peer-led team learning to increase participation and success of under-represented groups in introductory computer science courses

Han, S., Mejia, J., Bonhomme, A., Plaku, A., & Tavera, G. (2012). *This is not just tutoring*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Han-2012.docx>
MAT1175, the first credit-level math course at City Tech, covers topics in algebra and geometry. Many students at this level display a lack of skill and motivation. The embedded peer-led workshop provides a strong support to help students succeed. Led by trained peer leaders, students work diligently and collaboratively on new math concepts as well as fundamental skills. Faculty instructor and peer leaders integrate different techniques and creative ideas to cultivate a supportive environment and stimulate learning. The peer leaders and students share some of their favorite activities and reflections in this paper.

Hansen, J. H. L., Dubey, H., Sangwan, A., Kaushik, L., & Kothapally, V. (2018). UTDallas-PLTL:Advancing multi-stream speech processing for interaction assessment in peer-led team learning *The Journal of the Acoustical Society of America*, 143(3). doi: 10.1121/1.5036130
Robust speech processing for single-stream audio data has achieved significant progress in the last decade. However, multi-stream speech processing poses new challenges not present in single-stream data. The peer-led team learning (PLTL) is a teaching paradigm popular among US universities for undergraduate education in STEM courses. In collaboration with UTDallas Student Success Center, we collected CRSS-PLTL and CRSS-PLTL-II corpora for assessment of speech communications in PLTL sessions. Both corpora consist of longitudinal recordings of five teams studying undergraduate Chemistry and Calculus courses consisting of 300 hours of speech data. The multi-stream audio data has unique challenges: (i) time-synchronization; (ii) multi-stream speech processing for speech activity detection, speaker diarization and linking, speech recognition, and (iii) behavioral informatics. We used a 1 kHz tone at the start and end of each session for time-synchronization of multi-stream audio. We leveraged auto-encoder neural network for combining MFCC features from multiple streams into compact bottleneck features. After diarization, each speaker segment is analyzed for behavioral metrics such as (i) dominance; (ii) curiosity in terms of question inflections; (iii) speech rate; (iv) cohesion; and (v) turn-duration and turn-taking patterns. Results are presented on individual and team based conversational interactions. This research suggests new emerging opportunities for wearable speech systems in education research.

Hanson, D., & Wolfskill, T. (1997). Improving the teaching/learning process in general chemistry: Report of the 1997 Stony Brook General Chemistry Teaching Workshop. *Journal of Chemical Education*, 75(2), 143-147. doi: 10.1021/ed075p143.
Motivated by the widespread recognition that traditional teaching methods at postsecondary institutions no longer are meeting students' educational needs, 59 participants came to the first Stony Brook General Chemistry Teaching Workshop, July 20-July 25, 1997, on improving the teaching/learning process in General Chemistry. The instructors from 42 institutions across the country, including community colleges, liberal-arts colleges, and large research universities, had mutual concerns that students are having difficulty understanding and applying concepts, finding relevance, transferring knowledge within and across disciplines, and identifying and developing skills needed for success in college and a career. This situation has come about because challenges posed by students' increasing diversity in academic preparation, cultural

background, motivation, and career goals go unmet, with too many courses maintaining the conventional objective of structuring and presenting information..

Hersam, M. C., Luna, M., & Light, G. (2004). Implementation of interdisciplinary group learning and peer assessment in a nanotechnology engineering course. *Journal of Engineering Education*, 93(1), 49-57.

Nanotechnology is an inherently interdisciplinary field that has generated significant scientific and engineering interest in recent years. In an effort to convey the excitement and opportunities surrounding this discipline to senior undergraduate students and junior graduate students, a nanotechnology engineering course has been developed in the Department of Materials Science and Engineering at Northwestern University over the past two years. This is part of the University's Gateways Science Workshops program. This paper examines the unique challenges facing educators in this dynamic, emerging field and describes an approach for the design of a nanotechnology engineering course employing the non-traditional pedagogical practices of collaborative group learning, interdisciplinary learning, problem-based learning, and peer assessment. Utilizing the same nanotechnology course given the year before as a historical control, analysis of the difference between measures of student performance and student experience over the two years indicates that these practices are successful and provide an educationally informed template for other newly developed engineering courses.

Hewlet, J. A. (2005). In search of synergy. *Journal of College Science Teaching*, 33(4), 28-31. Peer-led Team Learning (PLTL) is used at Finger Lakes Community College in Canandagua, NY to improve student performance. An innovation was the merging of the Case Study Method (CSM) with PLTL which served as the learning environment in which to engage and interact with the rigorous academic content material. Participating students earned a higher percentage of C or higher grades (87%) vs. the nonparticipants (78%).

Hickman, K. (2016). *The effects of Peer-Led Team Learning on pass rates, academic performance, and retention of under-represented minority students in STEM Courses* (Ph.D. dissertation), Texas Tech University, Lubbock, TX. Available online: <https://ttu-ir.tdl.org/ttu-ir/bitstream/handle/2346/72329/HICKMAN-DISSERTATION-2016.pdf?sequence=1>

Underrepresented minority students (URM) are lagging behind White and Asian students in graduating with STEM degrees. Peer education has been used throughout higher education institutions as pedagogy and a learning strategy to improve retention and graduation rates. In addition to improving persistence rates, the use of peer education has served to prevent the loss of revenues in higher education. The involvement of peers in providing academic support outside of the classroom has proven to be beneficial to the success of URM college students. Although many studies have examined the impact of academic peer education on the participants, few have evaluated the impact peer-led team learning (PLTL) as a model with URM students in STEM. As colleges and universities seek to impact the educational experience of all students, it is important to understand the academic benefits for URM students. It is hoped that this study will inform practitioners about the persistence and academic performance of URM students in STEM to develop best practices in using institution resources to impact persistence rates. Post positivism framed this quantitative study examining the performance of underrepresented minority students in PLTL leader for science, technology, engineering, and math (STEM) courses at a research institution in Texas. Of specific interest was the course grade rates and retention rates in subsequent STEM courses. Data analyses were conducted through the use of the quantitative methods, including inferential and descriptive statistics. Findings from the study contribute to the ability of practitioners to increase student success for academic peer educators, therefore preventing the loss of tuition dollars

Hockings, S. C., DeAngelis, K. J., & Frey, R. F. (2008). Peer-led Team Learning in general chemistry: Implementation and evaluation. *Journal of Chemical Education*, 85(7), 990-996. doi: 10.1021/ed085p990.

This article describes the use of Peer-led Team Learning (PLTL) in general chemistry. This PLTL program at Washington University in St. Louis, unlike the national model, permits students to choose participation in the sessions for the academic term. However, once they declare intent, they must attend all weekly sessions. Regression analysis of the comparisons between PLTL and nonPLTL participants found statistical significance in reduction of course withdrawals (1.3% vs. 4.4%), final course grade below B- (33.6% vs. 42.8%) and final course grade (2.94, B average vs. 2.74, B- average). PLTL reported improved attitudes towards chemistry improved as a result of their experience with the weekly sessions. This study confirmed that optional participation in PLTL did not diminish its impact with students.

Hodges, L. C. (2018). Contemporary issues in group learning in undergraduate science classrooms: A perspective from student engagement. *CBE—Life Sciences Education*, 17(2). doi: 10.1187/cbe.17-11-0239.

As the use of collaborative-learning methods such as group work in science, technology, engineering, and mathematics classes has grown, so has the research into factors impacting effectiveness, the kinds of learning engendered, and demographic differences in student response. Generalizing across the range of this research is complicated by the diversity of group-learning approaches used. In this overview, I discuss theories of how group-work formats support or hinder learning based on the ICAP (interactive, constructive, active, passive) framework of student engagement. I then use this model to analyze current issues in group learning, such as the nature of student discourse during group work, the role of group learning in making our classrooms inclusive, and how classroom spaces factor into group learning. I identify key gaps for further research and propose implications from this research for teaching practice. This analysis helps identify essential, effective, and efficient features of group learning, thus providing faculty with constructive guidelines to support their work and affirm their efforts.

Hoffelder, A. M., & Hoffelder, R. L. (2003). *Evaluation of the Peer-led Learning (PLTL) approach to General Chemistry, CHM 137 for Fall Semester, 2002*. Unpublished manuscript. Miami University. Oxford, OH.

This report provides a detailed examination of the impact of Peer-led Team Learning in a chemistry course at Miami University (OH). The 65-page report carefully compares the performance of the students in the course with PLTL support and another course that did not have the support. The students enrolled in the PLTL-supported course were slightly less prepared academically than the other course. All the students were studied regarding final course grades and performance in the next course in the academic sequence. In addition, interviews and surveys were conducted with the students in the PLTL-supported course. The PLTL students slightly outperformed their counterparts but not to the degree of statistical-significance. Considering that they began slightly behind, the researchers theorize that this could be considered a minor success. The qualitative interviews with the PLTL students revealed a strong belief that the program supported their academic success in the course and reinforced their persistence in the science degree program.

Hoffelder, A. M., & Hoffelder, R. L. (2003). *A gender comparison of academic preparation and general chemistry success as seen in two approaches to instruction during Fall semester, 2002 at Miami University*. Unpublished manuscript. Miami University. Oxford, OH.

The purpose of this study was to determine if there is a gender difference in general chemistry success as a result of the Peer-Led Team Learning (PLTL) approach to instruction in general chemistry. The CHM 137 females (PLTL participants) as a group had lower preparation values

and a higher relationship between that preparation and the success variables, yet they did better (had higher scores) on both of the success variables. These students were compared with other female students enrolled in a separate section of chemistry which did not offer PLTL support. From the larger study of the PLTL program there is evidence of personal and emotional importance to the participants in the PLTL approach of CHM 137.

Hoffman, M. Z., & Crosby, A. D. (2003). *Getting general chemistry students to read, write, and speak*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA.

Peer-led Team Learning (PLTL) is part of a program to increase the competency of honors-level general chemistry students at Boston University. The sessions provide an environment for students to critically discuss and analyze chemistry concepts.

Hoffman, M. Z., & Crosby, A. D. (2004). *Assessing Peer-led Team Learning in honors-level general chemistry*. Conference Proceedings of the 228th American Chemical Society National Meeting, Philadelphia, PA. For more information, contact the authors at the Department of Chemistry, Boston University, 590 Commonwealth Avenue, Boston, MA 02215, hoffman@chem.bu.edu

Peer-led Team Learning (PLTL) was used in an honors college at Boston University. Students provided feedback about PLTL through frequent survey forms and writing assignments. Students reported that the PLTL peer facilitators were more effective than traditional graduate assistants in learning the chemistry content material. Additional reported benefits included higher self-confidence and deeper understanding of the role of a teacher.

Hogan, P., Parks, C. X., & Ciotti, A. (2004). *Early intervention with peer-led study groups for organic chemistry*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Chemistry, Suffolk University, 41 Temple Street, Boston, MA 02114

Peer-led Team Learning (PLTL) was used in an organic chemistry course at Suffolk University (MA). Surveys of students suggest improvements in understanding of difficult course material.

Holladay, S. R. H. (2004). *Analysis of PLTL leaders' reflections*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Chemistry, Indiana University Purdue University Indianapolis, 402 N. Blackford St., Indianapolis, IN 46202, holladay@chem.iupui.edu

Peer-led Team Learning (PLTL) was used in a general chemistry course at Indiana University Purdue University Indianapolis. Data was collected from the student peer PLTL leaders through journal entries. The entries included responses to open-ended questions about group dynamics and other questions that allowed the student leaders to reflect about their experience. The study revealed changes in them due to the experience.

Hong, N. K., Ford, A., Nguyen, T., & Huynh, P. (2012). *San Jose City College peer leaders share their expertise in leading and evaluating effective PLTL workshops*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ppltl.org/wp-content/uploads/2012%20Proceedings/Hong-2012.docx>

The PLTL program at San Jose City College has transformed the culture, resulting significant gains in student success and retention. Indeed, the culture has revitalized the students in the chemistry department as demonstrated by their positive and enthusiastic attitude toward chemistry and instructors. Peer leaders from San Jose City College discussed the implementation components of the PLTL program, including peer-to-peer assessment,

evaluation, as well as strategies for implementing a variety of pedagogies. We also summarized program assessment data and shared highlights of weekly leader meetings as well as our spring 2012 semester two-day orientation workshops.

Hooker, D. D. (2010). *A study of the effects of the implementation of small peer led collaborative group learning on students in developmental mathematics courses at a tribal community college*. (Ph.D. dissertation), Montana State University, Bozeman, Montana. Available online: <http://etd.lib.montana.edu/etd/2010/hooker/HookerD0510.pdf>

College students needing remediation in mathematics are a problem at nearly all colleges and universities but are immense at community colleges where large numbers of students enroll in developmental mathematics courses. This issue for Native American students at Tribal Community Colleges has an enormous effect on future opportunities in education, employment, politics and society. The overarching research question was: How does the implementation of small peer-led collaborative learning groups affect students in developmental mathematics courses at the Tribal Community College? This study focused on an application of Peer-Led Team Learning (PLTL). To answer this question five sub-questions were addressed. What impact will the treatment have on: 1) completion, 2) perseverance, 3) demonstrated procedures of mathematics, 3) personal skills for success, and 4) the leaders' perceptions of the benefits associated with acting as small peer led collaborative group leader This research study took place at a small Tribal Community College. The quasi experimental, mixed methods study involved collection and analysis of both quantitative and qualitative data. The treatment class consisted of having the students work together on a workshop activity designed to be engaging, challenging and relevant for one class period each week in small peer-led collaborative learning groups. Peer leaders were chosen according to predetermined criteria. The peer leaders were trained to help guide the group in the direction of a solution and to help the group learn how to collaborate to achieve the best results. The control class was given the same workshop activity to work on, but not encouraged to work together nor assisted by a peer leader. Results of this research study show increased completion and perseverance rates. Students participating in the small peer-led collaborative groups were more likely to attempt mathematics. The attitude toward mathematics was the most drastic change; students now look forward to attending their mathematics class and spend more time out of class doing mathematics. Group leaders gained personal, academic and leadership skills. Detailed descriptions of the results are given. In conclusion, implications of the findings and how they may be used are provided for mathematics instructors, administrators and student support personnel are offered. Recommendations for further research are also suggested.

Horwitz, S., & Rodger, S. H. (2008). *Using Peer-led Team Learning to increase participation and success of under-represented groups in introductory computer science*. Unpublished manuscript. Chattanooga, Tennessee. Available online: <http://research.cs.wisc.edu/wpis/papers/sigcse09.pdf>

This paper describes the implementation and evaluation of a program that uses active recruiting and Peer-Led Team Learning (PLTL) to increase the participation and success of women and minority students in undergraduate computer science. These strategies were applied at eight universities starting in the fall of 2004. There have been some impressive results: succeeded in attracting under-represented students who would not otherwise have taken a CS course; evaluation shows that participation in our program significantly improves retention rates and grades, especially for women; and students in the program, as well as the students who served as peer leaders, are uniformly enthusiastic about their experience.

Horwitz, S., & Rodger, S. H. (2009). *Using Peer-Led Team Learning to increase participation and success of under-represented groups in introductory computer science*. Conference Proceedings of the SIGCSE;09, Chattanooga, TN.

This paper describes the implementation and evaluation of a program that uses active recruiting and peer-led team learning to try to increase the participation and success of women and minority students in undergraduate computer science. These strategies were applied at eight universities starting in the fall of 2004. There have been some impressive results: We succeeded in attracting under-represented students who would not otherwise have taken a CS course. Evaluation shows that participation in our program significantly improves retention rates and grades, especially for women. Students in the program, as well as the students who served as peer leaders, are uniformly enthusiastic about their experience

Hudson, C., Curtis, M., & Blake, R. E. (2001). *Evaluation of the Peer-led Team Learning instructional model: Why does it work?* Conference Proceedings of the 221st American Chemical Society National Meeting, San Diego, CA. For more information, contact the authors at the Department of Chemistry, Indiana University Purdue University Indianapolis, 402 N. Blackford Street, Indianapolis, IN 46202, blake@chem.iupui.edu
Peer-led Team Learning (PLTL) is used at Indiana University Purdue University Indianapolis in chemistry courses. The critical factors associated with PLTL are explored.

Hug, S., Thiry, H., & Tedford, P. (2001). *Learning to love computer science: Peer leaders gain teaching skill, communicative ability and content knowledge in the CS classroom*. Conference Proceedings of the 42nd ACM Technical Symposium on Computer Science Education. Paper presents evidence that the PLTL student leaders gain teaching skill, communicative ability, and content knowledge in the computer science classroom

Huss-Lederman, S., Chinn, D., & Skrentny, J. (2008). *Serious fun: Peer-led Team Learning in CS*. Conference Proceedings of the 39th SIGCSE Technical Symposium on Computer Science Education, Portland, Oregon.
In the conference session, participants will learn how to use Peer-Led Team Learning (PLTL) effectively in computer science courses. This technique has been successful in reducing drop rates and increasing satisfaction among students. Therefore, it holds promise as a way to boost sagging computer science enrollments in general, and to increase participation of under-represented groups in particular. The goal of the session is to give participants practical information and hands-on experience.

Ibarra, R., & Raikar, A. (2004). *Confronting misconceptions in physics using the Peer-led Team Learning format*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Math and Science, San Jose City College, 2100 Moorpark Ave., San Jose, CA 95128, rufino.ibarra@sjcc.edu
Peer-led Team Learning (PLTL) was used in a physics course at San Jose City College. Outcomes include increases in students thinking at higher levels both qualitatively and quantitatively

Ibitoye, A., Armando, C., & Kennedy, N. (2019). *Understanding the impact of peer-led workshops on student learning*. CUNY New York City College of Technology. New York, NY. Available online: https://academicworks.cuny.edu/ny_pubs/400/
As students we often wonder why some subjects are easy to understand and requires not much effort in terms of re-reading the material, for us to grasp what it entails. One subject seems to remain elusive and uneasy for a vast majority of learners at all levels of education; that subject

is Mathematics, it is one subject that most learners find difficult even after doubling the amount of time spent on studying the material. My intention is to explore ways to make Mathematics easier for other students using feedback from students enrolled in NSF mathematics peer leading workshops, and use these data feedbacks to simplify student learning. In order to design a simplified approach to learning, I will be applying learning theories such as Polya's Problem Solving, Tuckman's Team Development Model, Vygotsky's Zone of Proximal Development (ZPD) to name a few, in the peer-led or CO group workshops. The impact of the application of the aforementioned theories shall be used in analyzing how learners respond through observation. To gather reliable data, learners shall be asked through two surveys; first of which will be conducted at the middle of the semester, because by then learners and peer-leaders will have had enough sessions to thoroughly provide assessment that can be used to form a baseline. The second survey shall be conducted at the end of the semester and the data used in comparison to the former for forming a conclusion on the impact of peer-led workshops. Questions I intend to answer are: what are the obstacles students perceive hinders them from learning mathematics; and ways in which peer-led workshops might help students overcome such obstacle(s). Thoughts and suggestions offered by students will also be considered for application with future students. Upon completion, I hope the limitations of the data sample can be overcome by being reduplicated in other colleges outside CUNY, for a more comprehensive approach that can simplify students learning in Mathematics and the influence of peers in learning any challenging skill or subject. The implications of this study are that mathematics doesn't have to be difficult and can even be as easy or easier compared to other subjects

Janke, T., & Varma-Nelson, P. (2014). *Cyber Peer-Led Team Learning (PLTL)*. Conference Proceedings of the World Conference on Educational Media and Technology, Tampere, Finland. Available online: <https://www.learntechlib.org/primary/p/147479/>

This paper describes the challenges and opportunities of adapting a high-impact face-to-face pedagogy to an online environment. At Indiana University-Purdue University Indianapolis (IUPUI), USA, Cyber Peer-led Team Learning (cPLTL) was developed by adapting Peer Led-Team Learning (PLTL) to an online environment. PLTL is a model of teaching that preserves the lecture and replaces recitation in science courses with a weekly two-hour problem solving session called a workshop. In this project, an online, synchronous, collaborative environment for conducting PLTL workshops was created by using web-conferencing software coupled with a two-camera-per-learner configuration. As in PLTL workshops, six to eight students in cPLTL workshops are guided by a peer leader through problem-solving activities for two hours. Learning gains in cPLTL were similar to those seen in PLTL. Discussed here is the development of cPLTL as well as adoption at other institutions.

Jardine, H. E., & Friedman, L. A. (2017). Using undergraduate facilitators for active learning in organic chemistry: A preparation course and outcomes of the experience. *Journal of Chemical Education*, 94(6). doi: 10.1039/C5RP00102A.

In this study, we describe a course to educate and prepare undergraduate "facilitators" for small group problem solving sessions in a large, first semester, introductory undergraduate organic chemistry course. We then explore the outcomes of the facilitator experience for one cohort of facilitators through qualitative analysis of written reflections, surveys, and field notes. Our findings suggest that the course achieved its goals of providing facilitators with effective teaching techniques and reinforcing content knowledge, and it created a forum for the facilitators to provide feedback to each other and to the course instructor. Furthermore, the course catalyzed the development of professional skills, enhanced metacognitive abilities, reinforced the benefits of active learning, and exposed facilitators to educational literature. These findings are noteworthy because they demonstrate the various potential benefits for undergraduates that facilitate active learning in large chemistry courses.

Jevtic, M. (2012). *What traits do peer leaders use to help their students?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY.

Peer leaders at New York City College of Technology, CUNY (Brooklyn, NY) are selected based on having a minimum GPA of 3.0, completion of MAT 1375 course (pre-calculus) with a grade A or B, and they are interviewed. The requirements are broad, so good peer leaders are not always only those students with the highest GPA or straight As. The crucial aspect is the interview session where interviewers become more familiar with the Peer Leader candidates. By answering questions and responding to different scenarios that the future peer leaders might find themselves in, they are observed in how they think and behave. The interview process is in part a test of emotional intelligence. Emotional intelligence can be learned (Goleman, 2004). Peer leaders are trained through weekly classes and seminars to be able to identify different types of learners and how to adapt their leading to diverse audiences. Leaders learn best through "motivation, extended practice and feedback" (Goleman, 2004, p. 4).

Johnson, E. C., & Loui, M. C. (2009). *How can students benefit as peer leader of learning teams?* Paper presented at the 39th ASEE/IEEE Frontiers in Education Conference, San Antonio, Texas.

In a course for freshmen in electrical and computer engineering, students may choose to attend optional supervised study sessions, which implement Peer-Led Team Learning (PLTL) workshops. In the sessions, students work on difficult problems from previous semesters' exams under the supervision of a team leader. The team leaders are graduate teaching assistants, undergraduate teaching assistants, and undergraduate volunteers. For two semesters, team leaders were asked to keep weekly reflective journals. The researchers qualitatively analyzed fourteen journals and found that leaders faced common challenges such as irregular student attendance and inadequate student preparation. Leaders reported that they increased their self-confidence, developed an appreciation for intellectual diversity, and gained an increased interest in teaching. Leading PLTL workshops provides an excellent opportunity for personal development. Leaders gain important insights about other students' perspectives and learn to justify and explain their own work. Leading a PLTL workshop enhances the leaders' ability to collaborate in teams and take on leadership roles in the future.

Johnson, E. C., & Loui, M. C. (2009). *Work-in-progress: How do students benefit as peer leaders of learning teams?* Conference Proceedings of the Thirty-Ninth ASEE/IEEE Frontiers in Education Conference, San Antonio, TX.

Paper describes the personal and professional development of the PLTL student leaders

Johnson, E. C., Robbins, B. A., & Loui, M. C. (2015). What do students experience as peer leaders of learning teams? *Advances in Engineering Education*, 4(4). Available online: <http://files.eric.ed.gov/fulltext/EJ1077832.pdf>.

In a course for engineering freshmen, peer leaders facilitated optional study sessions, which implemented peer-led team learning workshops. Some leaders were paid teaching assistants, but most were undergraduate volunteers. To understand the experiences of the peer leaders, we asked them to keep weekly reflective journals. By performing a basic qualitative analysis of fourteen journals from two semesters, we developed a description of the experience of leading peer-led team learning workshops over the course of the semester. At the beginning of the semester, the leaders were apprehensive about teaching and concerned with correctly answering students' questions. As the semester progressed, the leaders were often frustrated with the difficulty of teaching, and the leaders tried new ways of encouraging student participation. At the end of the semester, the leaders reported that they increased self-

confidence, developed an appreciation for intellectual diversity, and gained an increased interest in teaching.

Johnson, E. C., Robbins, B. A., & Loui, M. C. (2017). What do students experience as peer leaders of learning teams? *Advances in Engineering Education*, 6(1). Available online: <http://advances.asee.org/wp-content/uploads/vol04/issue04/Papers/AEE-16-Loui.pdf>. In a course for engineering freshmen, peer leaders facilitated optional study sessions, which implemented peer-led team learning workshops. Some leaders were paid teaching assistants, but most were undergraduate volunteers. To understand the experiences of the peer leaders, we asked them to keep weekly reflective journals. By performing a basic qualitative analysis of fourteen journals from two semesters, we developed a description of the experience of leading peer-led team learning workshops over the course of the semester. At the beginning of the semester, the leaders were apprehensive about teaching and concerned with correctly answering students' questions. As the semester progressed, the leaders were often frustrated with the difficulty of teaching, and the leaders tried new ways of encouraging student participation. At the end of the semester, the leaders reported that they increased self-confidence, developed an appreciation for intellectual diversity, and gained an increased interest in teaching.

Kalantarian, N. K., Becvar, J. E., Narayan, M., & Saupe, G. B. (2012). *Enhancement of public speaking paved through Peer-Led Team Learning*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Kalantarian-2012.docx>. The Department of Chemistry at the University of Texas at El Paso now uses an innovative constructivist approach to address the individualistic learning styles of students in general chemistry. Through funding from an NSF-STEP grant, UTEP has adopted a strong Peer-Led Team Learning (PLTL) curriculum in second semester general chemistry to emphasize team-based, student-directed learning. Students in this three-credit-hour course are required to attend only two hours of lecture each week by adding a small-section two-hour Workshop overseen by a peer leader. Previously, measures of the effectiveness of PLTL Workshop have focused on evaluating the impact on the students taking the chemistry course. However, peer leaders overseeing the Workshop show significant professional growth including enhancement in their public speaking skills. Surveying current, pre and post peer leaders from our institution prompted the creation of an instrument to assess this enhancement. The researchers reported gains of the leaders in confidence and ease in speaking in front of groups. Further evaluation suggests these gains may be directly correlated with semesters spent as a peer leader.

Kampmeier, J. A. (2000). How to get team savvy. *Chemical & Engineering News*, 78(3), 8. doi: 10.1021/cen-v078n003.p008.

The accumulated results from five years of experience are clear: Workshop students are more successful than traditional students in their chemistry courses. This increased success comes from the PLTL structure that requires them to "get team savvy."

Kampmeier, J. A. (2001). Peer-Led Team Learning. *Chemical Engineering News*, 79(41), 6.

Kampmeier, J. A. (2003). *The scholarship of teaching*. Unpublished manuscript. City University of New York. New York, NY.

This article provides an overview of the Peer-Led Team Learning (PLTL) program developed at the City University of New York. The author describes the impact of the PLTL program upon teacher preparation of the student peer group facilitators.

Kampmeier, J. A. (2004). *Using Peer-led Team Learning in organic chemistry*. Conference Proceedings of the 228th American Chemical Society National Meeting, Philadelphia, PA. For more information, contact the author at the Department of Chemistry, University of Rochester, Box 270216, University of Rochester, Rochester, NY 14627, kamp@chem.rochester.edu Peer-led Team Learning (PLTL) was used in a year-long organic chemistry course at the University of Rochester. Program outcomes included higher student performance, higher attitudes towards chemistry, and improved faculty satisfaction.

Kampmeier, J. A., & Roth, V. (2004). *Evolution and institutionalization of peer-led workshops: 1993-present*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Chemistry, University of Rochester, Box 270216, University of Rochester, Rochester, NY 14627, kamp@chem.rochester.edu Peer-led Team Learning (PLTL) was started in 1993 and since then has spread to more than 100 colleges. At the University of Rochester, nine faculty members in five departments supervise 125 trained PLTL student peer facilitators. This paper outlines critical steps for implementing and managing a PLTL program.

Kampmeier, J. A., Tien, L. T., & Roth, V. (2003). *Peer leader training: A model for preparing future faculty*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the authors at the Department of Chemistry, University of Rochester, Rochester, NY 14627, kamp@chem.rochester.edu Peer-led Team Learning (PLTL) has been used at the University of Rochester (NY) to support higher student achievement in introductory chemistry courses. A special training course was created for the PLTL student peer facilitators who are key to the program success.

Kampmeier, J. A., & Varma-Nelson, P. (2001). Peer-Led Team Learning. In N. Pienta, M. M. Cooper & T. Greenbowe (Eds.), *Chemists's guide to effective teaching, volume 2*. Upper Saddle River, NJ: Prentice Hall
This is a chapter providing an overview of the PLTL program.

Kampmeier, J. A., Varma-Nelson, P., & Wedegaertner (Eds.). (2000). *Peer-Led Team Learning, the workshop project: Organic chemistry*. Upper Saddle River, NJ: Prentice Hall
This book provides strategies for implementing the Peer-Led Team Learning (PLTL) program by other educators in an organic chemistry course.

Kampmeier, J. A., Varma-Nelson, P., & Wedegaertner, D. K. (1999). *The organic workshop project: Peer-led Team Learning*. Conference Proceedings of the 218th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the author at the Science Department, St. Xavier University, 3700 W. 103rd St., Chicago, IL 60655
Peer-led Team Learning (PLTL) was used with undergraduate organic chemistry students to improve instruction. Overview of the program and training materials for the student PLTL facilitators was shared. Preliminary evaluation studies suggest improved student learning, higher persistence rates, improved teamwork skills, and heightened communication skills..

Kampmeier, J. A., Wamser, C. C., Wedegaertner, K. D., & Varma-Nelson, P. (Eds.). (2001). *Peer-Led Team Learning: Organic Chemistry*. Upper Saddle River, NJ: Prentice Hall

Kampmeier, J. A., Wamser, C. C., Wedegaertner, K. D., & Varma-Nelson, P. (Eds.). (2006). *Peer-Led Team Learning: Organic Chemistry* (2nd ed.). Upper Saddle River, NJ: Prentice Hall

Kampmeier, J. A., & Wedegaertner, D. K. (2001). *Peer-Led Team Learning in organic chemistry*. Conference Proceedings of the 221st American Chemical Society National Meeting, San Diego, CA. For more information, contact the author at the Department of Chemistry, University of Rochester, Box 270216, University of Rochester, Rochester, NY 14627, kamp@chem.rochester.edu

Peer-led Team Learning (PLTL) is used at the University of Rochester in chemistry courses.

Kang, Y., Matsell, L., & Nakamura, M. (2012). *Implementation of PLTL in a freshman biology course at The University of Houston-Downtown*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Kang-2012.docx>

At the University of Houston-Downtown, we take pride in providing students with a faculty-intensive approach to high quality higher education in science, technology, engineering, and mathematics (STEM). As part of an UHD initiative to improve student retention and performance, we started a project to implement PLTL workshops within one freshman General Biology I course. Here, we present our initial efforts in this project and preliminary data on its effectiveness beginning in the Spring 2011 Semester. According to our data, there was an increased performance (20%) among the students who attended workshops compared to the class average and a decrease (20%) in withdrawal and failing. However, we also faced challenges in certain areas such as the lack of biology peer leaders. We will discuss these issues and the strategies we took to address them.

Kartsonaki, E., Bailey, C., & Lawrie, G. A. (2015). *iPass: Online collaborative peer-assisted study support*. Conference Proceedings of the The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference). Available online: <https://openjournals.library.sydney.edu.au/index.php/IISME/article/view/8855/9076>

Peer-assisted learning is a powerful strategy to assist students to both develop effective study skills and to apply formative feedback in self-regulated learning. In this study, existing successful face-to-face PASS learning activities have been translated into a virtual mode of delivery to enhance parallel online learning experiences. The model and template for the implementation and delivery of a cyber-peer-led team-learning (cPLTL) environment has been adopted from the initiative of Professor Pratibha Varma-Nelson [Smith et al, 2014]. Virtual iPASS sessions are hosted through the Adobe Connect tool which represents a platform that can enable a single PASS leader to synchronously guide up to 10 first-year chemistry students through collaborative study exercises. This technology enables students in the online PASS group to share their work with each other and with their leader while they are located in their preferred environment including their homes. An objective of offering a virtual PASS option was that it would enrich the on-campus experience by enabling peer support access for students who could not, or who preferred not to, engage in the face-to-face contact sessions. Translation of activities involved consideration of the format of the tasks and the training of the iPASS leaders in facilitation of the sessions to deliver an inclusive environment. Evaluation of the effectiveness of iPASS has been achieved by the comparison of a trial pilot iPASS group in parallel with a traditional face-to face PASS contact session. Consent was sought from participating students for researchers to record and characterise the nature of their interactions with their leader(s), provision of feedback and engagement with activities. Factors that must be considered for online peer support include students' technological literacy and group composition. The outcomes of this trial will be shared in this presentation.

Keiler, L. S., & Mills, P. (2010). Peer-mediated instruction in high school. Peer-Led Team Learning: Implementation in high schools. *Progressions: The Peer-Led Team Learning Project*

Newsletter, 12(1). Available online: <http://p1t1is.org/wp-content/uploads/2012/10/High-School-Implementation-Keiler-Mills-Peer-Mediated-Instruction-in-High-School.pdf>.

While educators have long been convinced of the benefits of peer-based learning experiences for all involved, its potential has remained unrealized in K-12 contexts. Logistical issues have dominated decision-making, forcing peer-mediated learning into supplemental contexts, utilized largely for remediation, and extraneous to the primary instructional experience. In contrast, the Math Science Partnership in New York City (MSPinNYC) has developed a model of mathematics and science instruction for the high school classroom that harnesses the power of peer-mediated learning on a daily basis as the primary learning modality. This model, which we call the Peer Enabled Restructured Classroom (PERC), has profoundly shifted the learning experience of students and teachers in these classrooms, produced dramatic increases in standardized test scores, and increased student motivation and skills applied across contexts. The name 'Peer Enabled Restructured Classroom' emphasizes the complete change in approach to learning and the central role of the peer-instructor, called the Teaching Assistant Scholar, in this process.

Kerr, E. F., & Samuels, M. (2019). Using Graduate and Experienced Undergraduate Students to Support Introductory Courses *From general to organic chemistry: Courses and curricula to enhance student retention* (pp. 85-103): ACS Publications

Students hoping to major in chemistry or other science fields in college often find their plans derailed by difficulties in introductory classes. Graduate students and more experienced undergraduates can be valuable resources for addressing failure rates in introductory courses. This chapter discusses the research on three types of programs using peer-instructors to support introductory courses: graduate and undergraduate teaching assistants, Supplemental Instruction, and Peer-Led Team Learning. The structure and outcome of each program are reviewed along with training strategies used to prepare peer-instructors. Both undergraduate and graduate students are able to produce positive results in student success and experience when supporting introductory courses. Successful training strategies provide peer-instructors with practical strategies for their teaching, opportunities to practice before entering the classroom, and ongoing support and feedback throughout their time teaching. This chapter discusses various structures, and how to choose the appropriate one for your course.

Kimbrell, J. B. (2012). *Major components of successful leadership training*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://p1t1is.org/wp-content/uploads/2012%20Proceedings/Kimbrell-2012.docx>

Undergraduate leadership training is an integral factor to incorporating the Peer-Led Team Learning (PLTL) Model into the department of an institution. The University of West Georgia's Chemistry Department utilizes the student-influenced leadership training, which involves two primary sections. The first section encompasses a three-day training section before the beginning of scheduled classes. The second section incorporates a "retreat" meeting, which usually occurs four weeks into the semester after the new leaders have had the opportunity to lead three or four workshops. The incorporation of weekly journal entries, leaders meetings, and midterm observations allows for the constant training and improvement of the student leaders throughout the semester. Our primary goal is to always have our leaders evolving and improving the way they lead a workshop and the overall success of the PLTL Model. Chemistry workshop new leader training at the University of West Georgia (UWG) begins with a three-day session prior to the start of class each semester. Other components include weekly journals submitted by new leaders, weekly pre-workshop leaders' meetings (for all leaders), a "retreat" after the third week of each semester, observations of new (and veteran) leaders as they conduct

workshops, and discussions based on feedback presented by mid-semester and end-of-semester surveys completed by workshop students.

Kling, T. P., & Salomone, M. (2015). Creating a peer-led cooperative learning program to improve STEM retention. *Change: The Magazine of Higher Education*, 47(6), 42-50. doi: 10.1080/00091383.2015.1089758.

Bridgewater State University has implemented PLTL as part of its strategy to retain students of color in STEM majors.

Komansky, M. (2005). More than just a review session. Peer-led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 6(4). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Komansky-More-than-a-Review-Session.pdf>.

The authors had been involved in the Peer-Led Team Learning (PLTL) project for Anatomy & Physiology (A&P) for two semesters at Middlesex County College (NJ). In spite of this relatively short time, they generated enormous interest. The PLTL model has broken barriers, helped create friendships and most significantly build confidence of every student involved.

Kudish, P., Shores, R., McClung, A., Smulyan, L., Vallen, E., & Siwicki, K. K. (2016). Active learning outside the classroom: Implementation and outcomes of Peer-Led Team-Learning workshops in introductory biology. *CBE-Life Education*, 15(3). doi: 10.1187/cbe.16-01-0051. Available from <http://www.lifescied.org/content/15/3/ar31.full.pdf+html>.

Study group meetings (SGMs) are voluntary-attendance peer-led team-learning workshops that supplement introductory biology lectures at a selective liberal arts college. While supporting all students' engagement with lecture material, specific aims are to improve the success of underrepresented minority (URM) students and those with weaker backgrounds in biology. Peer leaders with experience in biology courses and training in science pedagogy facilitate work on faculty-generated challenge problems. During the eight semesters assessed in this study, URM students and those with less preparation attended SGMs with equal or greater frequency than their counterparts. Most agreed that SGMs enhanced their comprehension of biology and ability to articulate solutions. The historical grade gap between URM and non-URM students narrowed slightly in Biology 2, but not in other biology and science, technology, engineering, and mathematics courses. Nonetheless, URM students taking introductory biology after program implementation have graduated with biology majors or minors at the same rates as non-URM students, and have enrolled in postcollege degree programs at equal or greater rates. These results suggest that improved performance as measured by science grade point average may not be necessary to improve the persistence of students from underrepresented groups as life sciences majors.

Labov, J. B., Singer, S. R., George, M. D., Schweingruber, H. A., & Hilton, M. L. (2009). Effective practices in undergraduate STEM education Part 1: Examining the evidence. *CBE-Life Education*, 8(3), 157-161. doi: 10.1187/cbe.09-06-0038. Available online: <http://www.lifescied.org/content/8/3/157.full>.

Since the publication of reports in the late 1990s by the National Science Foundation (NSF; 1996), the National Research Council (NRC; 1996, 1999), and the Boyer Commission on Educating Undergraduates in the Research University (1998) on the importance of improving undergraduate education in science, technology, engineering, and mathematics (STEM), at least 13 other federal civilian departments and agencies have spent billions of dollars on more than 200 programs to realize this goal. Most of that spending has come from the NSF and the National Institutes of Health (Government Accounting Office, 2005). Many private foundations also have invested hundreds of millions of dollars in efforts to improve undergraduate STEM

education. For example, since 1988 the Howard Hughes Medical Institute has awarded more than \$1.5 billion in grants to improve science education at the precollege and college levels.

Lansiquot, R. D., Blake, R. A., Lio-Mark, J., & Dreyfuss, A. E. (2011). Interdisciplinary problem-solving to advance STEM success for all students. *peerReview*, 13(3). Available online: <http://www.aacu.org/publications-research/periodicals/interdisciplinary-problem-solving-advance-stem-success-all>.

In 1980, Congress took decisive action on the national paucity of opportunity, access, and success of underrepresented minorities in science, technology, engineering, and mathematics (STEM) by mandating that the National Science Foundation (through the Science and Engineering Equal Opportunities Act) develop the STEM talents of the country's citizenry irrespective of gender, ethnicity, race, and economic background. Now, some thirty years later, this battle still rages on with no clear, comprehensive victory in sight. Many—if not most—of our twenty-first-century challenges will coalesce around STEM, dealing with issues ranging from such medical dilemmas as drug-resistant bacteria, to the scarcity of natural resources, to oil spills and climate change. Solutions to these challenges will require a workforce armed with a skill set that engenders technological sophistication and interdisciplinary thinking. It is, therefore, critical to train and engage a diverse workforce so as to provide foundational STEM education for the nation's citizenry with all of its inherent diversity. Both mathematics and science education must be radically improved. According to a recent National Mathematics Advisory Panel (2008) report, "American students have not been succeeding in the mathematical part of their education at anything like a level expected of an international leader."

Lazik, L., Conroy, M., Lee, A., Rocha, S., & Kirby, A. (2004). *Peer-led Team Learning: A gateway to teaching opportunities*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Math and Science, San Jose City College, 2100 Moorpark Ave., San Jose, CA 95128, Iyun.Larik@sjcc.edu

Peer-led Team Learning (PLTL) was used in a chemistry course at San Jose City College. In addition to the benefits for the participating students, the authors also cited the opportunity for growth by the PLTL student peer facilitators.

Lehr, R. E., & Royt, R. R. (2002). *Use of Peer-led Team Learning techniques to enhance undergraduate organic instruction*. Conference Proceedings of the 224th American Chemical Society National Meeting, Boston, MA. For more information, contact the authors at the Department of Chemistry and Biochemistry, University of Oklahoma, 620 Parrington Oval, Norman, OK 73019, relehr@ou.edu

Peer-led Team Learning (PLTL) has been used at the University of Oklahoma to support higher student achievement in an organic chemistry course.. PLTL was instituted in part to deal with the challenge of extremely large lecture sections that discouraged high interaction by the students.

Lestari, R. N. (2015). *The Impact of Peer Led Team Learning on students' cognitive and leadership skills in learning global warming*. Universitas Pendidikan Indonesia.

Lewis, S. E. (2011). Retention and reform: An evaluation of Peer-Led Team Learning. *Journal of Chemical Education*, 88(6), 703-707. doi: 10.1021/ed100689m. Available online: <http://dx.doi.org/10.1021/ed100689m>.

This study describes an evaluation of the Peer-Led Team Learning (PLTL) reform model in first-semester general chemistry. PLTL was implemented in place of one-third of the available lecture time, maintaining the same amount of structured class time under the reform. The

evaluation demonstrates that classes implementing the PLTL reform at the setting featured a statistically significant improvement of 15% in the pass rate for the classes, compared to conventional, lecture-only classes at the same setting. Additionally, the PLTL classes maintained a comparable score on a comprehensive American Chemical Society final exam to that of the conventional classes. Combined, these findings suggest that the improvement in pass rates occurs while maintaining the same level of rigor in the PLTL classes. Examining student groups shows that students in underrepresented minority groups demonstrated the largest improvement in pass rates with the PLTL reform.

Lewis, S. E. (2014). Starting and sustaining a Peer-Led Team Learning program *Addressing the millennial student in undergraduate chemistry* (pp. 47-57): ACS Publications
National policy documents call for the need to implement evidence-based teaching practices particularly in post-secondary science, technology, engineering and math courses. This chapter presents the author's role in employing Peer-Led Team Learning in General Chemistry in the context of implementing and sustaining the reform. In particular, there is a focus on adapting the reform to the setting and efforts to build a cultural norm that is supportive of the reform. Additionally, a discussion of parameters needed for sustaining the reform, such as faculty buy-in and generating evidence of the impact of the reform are presented. The chapter concludes with a description of future directions for Peer-Led Team Learning.

Lewis, S. E., & E, L. J. (2006). Effectiveness of a workshop to encourage action: Evaluation from a post-workshop survey. *CBE-Life Education*, 83(2), 299-304. doi: 10.1021/ed083p299.
Professional development workshops are a typical mechanism for disseminating curricular reforms. Follow-up surveys can be administered to provide information that allows the would-be reformers to consider their effectiveness, but often that information stays within the particular curriculum reform project and is not disseminated. Curricular reforms relevant for college chemistry are now relatively common. As a case in point, a set of workshops was offered by the ChemConnections systemic change initiative as part of the initiative's overall dissemination plan. The workshops were intended both to promote teaching with ChemConnections modules and to provide experience with nontraditional pedagogies supported by the modules. This report describes an evaluation of the effectiveness of this set of workshops as derived from a time-delayed post-workshop survey. The article includes a brief description of the curricular reform and the workshops, as well as the information the survey provided about the perceived effectiveness of the reform. Several factors that might be related to workshop effectiveness for this set of workshops are also discussed. With the increasing national presence of workshops to disseminate curricular reforms for college chemistry, we offer this article as a model for interpreting post-workshop survey data for a larger audience interested in reform.

Lewis, S. E., & Lewis, J. E. (2005). Departing from lectures: An evaluation of a peer-led guided inquiry alternative. *Journal of Chemical Education*, 82(1), 135-139.
Peer-led Team Learning (PLTL) was combined with a guided inquiry approach to create a modified model called Peer-led Guided Inquiry (PLGI). Use in the chemistry course favored the PLGI participants in comparison with the nonparticipants.

Lewis, S. E., & Lewis, J. E. (2008). Seeking effectiveness and equity in a large college chemistry course: an HLM investigation of Peer-Led Guided Inquiry. *Journal of Research in Science Teaching*, 45(7). doi: 10.1002/tea.20254.
This study employed hierarchical linear models (HLM) to investigate Peer-Led Guided Inquiry (PLGI), a teaching practice combining cooperative learning and inquiry and tailored for a large class. Ultimately, the study provided an example of the effective introduction of a reform pedagogical approach in a large class setting. In the narrative, the strengths of HLM as a

statistical technique are discussed in the context of pedagogical reforms, and the case is made for the use of HLM in rigorous determinations of both effectiveness and equity associated with reform practices. The implementation of PLGI in a college-level general chemistry course is also described. For the study, two general HLM models suited to investigating reform were developed and utilized to examine the effectiveness and equity of PLGI as implemented in this setting. The models showed that the reform was associated with statistically significant improvement over traditional pedagogy in terms of academic performance on multiple measures, but achieving equity remained elusive: the consequences of pre-existing achievement gaps did not lessen as a result of reform implementation. The analysis led to several implications for educational research, particularly in terms of evaluating pedagogical reforms, as well as for teaching. Choosing effective and equitable pedagogies for classroom implementation remains a critical goal for classes of any size.

Ligata, N., & Adamczeski, M. (2000). Perspectives from a female undergraduate student on successfully integrating learning and researching science with leading organic chemistry workshops. In J. Bart (Ed.), *Women Succeeding in the Sciences: Theories and Practices Across Disciplines* (pp. 139-148). Indianapolis, IN: Purdue University Press. Available online: http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1013&context=purduepress_ebooks. Although we realize that organic chemistry can be a major challenge and in some cases a stumbling block to students in achieving their career goals, 1 this subject also serves as a cornerstone to many scientific, technological, and medical advancements.2 Conveying this message and teaching the subject matter in an interesting way, one that can be understood by both male and female sophomore organic chemistry students, is and has been a formidable challenge. Further, it is becoming increasingly clear that there exists a strong need to change the way science is taught in order to appeal to both male and female students. 3 Organic chemistry workshops offer students a novel approach to hone problem solving strategies and develop effective communication skills in a nonintimidating atmosphere.4 This approach offers new pedagogical techniques for reform of traditional teaching methods for a variety of related disciplines at diverse institutions (e.g., colleges, universities, and institutes of technology),5 techniques that are potentially more “female-friendly, attracting and retaining women in chemistry, yet also retain their appeal for male students

Light, G., & Micari, M. (2013). *Making scientists: Six principles for effective college teaching*. Cambridge, MA: Harvard University Press. Northwestern University created the Gateways Science Workshop (GSW) and the Science Research Workshop (SRW) to support students enrolled in challenging courses. Based on more than a decade of the GSW and SRW serving the needs of students, learning principles have emerged that were critical to their success: (a) learning deeply, (b) engaging problems, (c) connecting peers, (d) mentoring learning, (e) creating community, and (f) doing research. The book's first chapter provides more background on the GSW and SRW and succeeding chapters examine each of these principles individually. The authors use the lessons learned from working with the students to apply them more widely as pedagogies for instructors to adopt and implement in their classes. A variety of educational theories and programs had an influence on creation of GWS and SRW. One that is often mentioned is Peer-led Team Learning.

Linton, D. L., Farmer, J. K., & Peterson, E. (2014). Is peer interaction necessary for optimal active learning? *CBE-Life Education*, 13(2), 243-252. doi: 10.1187/cbe.13-10-0201. Meta-analyses of active-learning research consistently show that active-learning techniques result in greater student performance than traditional lecture-based courses. However, some individual studies show no effect of active-learning interventions. This may be due to inexperienced implementation of active learning. To minimize the effect of inexperience, we

should try to provide more explicit implementation recommendations based on research into the key components of effective active learning. We investigated the optimal implementation of active-learning exercises within a “lecture” course. Two sections of nonmajors biology were taught by the same instructor, in the same semester, using the same instructional materials and assessments. Students in one section completed in-class active-learning exercises in cooperative groups, while students in the other section completed the same activities individually. Performance on low-level, multiple-choice assessments was not significantly different between sections. However, students who worked in cooperative groups on the in-class activities significantly outperformed students who completed the activities individually on the higher-level, extended-response questions. Our results provide additional evidence that group processing of activities should be the recommended mode of implementation for in-class active-learning exercises.

Lio-MarK, Dreyfuss, A. E., & Younge, L. (2010). Peer assisted learning workshops in precalculus: An approach to increasing student success. *Journal of Mathematics and Computer Education*, 44(3), 249-259.

Lio-Mark, J., Dreyfuss, A. E., Blake, R., Lansiquot, R. D., & Yu, K. (2013). Navigation by mentoring and leadership: Sustaining women majoring in mathematics. *Journal of Mathematics and Computer Education*, 47(2), 134-142.

The retention and persistence rates of females majoring in mathematics consistently lag behind those of their male counterparts. Indeed, the disparity in rates of females graduating in mathematics at the baccalaureate level continues to be a national challenge [1]. The Navigation by Mentoring and Leadership (NML) program at New York City College of Technology (a large, urban, minority-serving institution) was designed to address these issues. The goal of eradicating gender disparities in mathematics was supported by improving the institutional climate for women majoring in Applied Mathematics and Mathematics Education. Toward this goal, the NML program brought students together in a vibrant learning community that offered an array of activities that were designed to support them through their undergraduate years. These activities included: 1) a multi-tiered mentoring program, 2) leadership development, 3) luncheons with women mathematics faculty, 4) career preparation workshops, 5) conference participation and presentations, and 6) mathematics exposure trips. Preliminary findings from this pilot study suggest that the amalgam of these activities may increase the persistence and retention rates of women majoring in Applied Mathematics. The disparity of females graduating in mathematics has been well documented by the National Science Foundation [1]. From 1986 to 2006, the percentage of women graduating with a baccalaureate degree in mathematics and computer science has decreased by 12%, while the percentage of women graduating in the fields of biological and agricultural sciences, earth, atmospheric and ocean sciences, engineering, and physical sciences has increased (Table 1).

Liou-Mark, J. (2002). Leading Workshops at Brooklyn International High School. Peer-Led Team Learning: Implementation in high schools. *Progressions: The Peer-Led Team Learning Project Newsletter*, 3(3). Available online: <http://ptlis.org/wp-content/uploads/2012/10/High-School-Implementation-Liou-Mark-Leading-Workshops-Brooklyn-International-HS.pdf>. New York City College of Technology (NYCCT) students who took the Peer-Led Team Learning (PLTL) leader training course at the City College of New York (CCNY) via videoconferencing have had an opportunity to tutor students in mathematics at the Brooklyn International High School. Once a week during the Spring 2002 semester, these students helped prepare 9th and 10th grade students for the Mathematics Regents A* examination. This experience gave students the opportunity to apply the Workshop model at a local high school. These NYCCT students are also enrolled in the Teacher Preparation Program at CCNY (Ellen Goldstein, Co-

PI). As part of the program, they are required to take the Peer Leader Training course as an introductory course to teaching. These students are mostly associate-degree computer science majors interested in teaching mathematics. They then are encouraged to transfer to CCNY and complete their Bachelor's degree.

Liou-Mark, J., Dreyfus, A. E., Han, S., Yuen-Lau, L., & Yu, K. (2015). Aim for success: peer-led team learning supports first-year transition to college-level mathematics. *Journal of Learning Development in Higher Education*. Available online: <http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path%5B%5D=312&path%5B%5D=pdf>.

Students graduating from high school in the United States are often underprepared, unaware of, and surprised by the rigors of college courses, especially mathematics, and consequently stumble in their first year. A pilot intervention, the Academic Inventory Module (AIM) for Success in Mathematics project, at a minority-serving institution was offered to incoming freshmen students, which included a nine-hour mathematics preparation course and participation in a peer-led workshop in their first mathematics credit-bearing course. The goal of the AIM project was to establish a seamless pathway from high school to college learning of mathematics through the Peer-Led Team Learning model of instruction. The principal activities of the project were to offer a bridge program preparing students for a combined algebra and geometry course and to create a peer-led community to support freshmen enrolled in the course. Results from this study showed students participating in peer-led workshops had significantly higher grades and lower failure and withdrawal rates than those who did not participate.

Liou-Mark, J., Ghosh-Dastidar, U., Samaroo, D., & Villatore, M. (2018). The Peer-Led Team Learning leadership program for first year minority science, technology, engineering, and mathematics students. *Journal of Peer Learning*, 11(1), 65-75. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1124&context=ajpl>.

Retaining students in the Science, Technology, Engineering, and Mathematics (STEM) fields has been a challenge in the United States (U.S.). More startling is the lack of diversity across most of the STEM disciplines. Underrepresented minority groups majoring and graduating in STEM are reported to be far below the national benchmark, and it is not proportionally reflected in the overall national population. To support students in STEM, New York City College of Technology of the City University of New York has designed a Peer-Led Team Learning Leadership Program (PLTL) that recruits and trains upper freshmen majoring in STEM, particularly those who are underrepresented, to facilitate peer-led workshops in foundational STEM courses in chemistry, civil engineering, and mathematics. Results showed the PLTL Leadership Program to be highly effective for first-year underrepresented minority STEM students. First-year students self-reported the peer leading experience had strongly improved their own understanding of chemistry, engineering, and mathematics concepts, and their confidence in these subject areas was significantly increased. They also indicated gains in their confidence in public speaking and in their leadership, communication, and facilitation skills.

Liou-Mark, J., Lansiquot, R. D., Yu, K., Dreyfuss, A. E., Blake, R., Zeng, S., & Jevtic, M. (2012). *Supporting a community of women in STEM through the navigation by mentoring and peer leadership program*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Liou-Mark-2012.docx>

The retention and persistence rates of females majoring in mathematics have been consistently lower than their male peers. The disparity in the rates of minority females graduating in mathematics at the baccalaureate level continues to be a national challenge. Through the support of the Tensor Foundation and Mathematical Association of America Women and

Mathematics grant, the Navigation by Mentoring and Leadership (NML) program at the New York City College of Technology of the City University of New York was designed to address these major issues. This program is based on the Peer-Led Team Learning (PLTL) program developed initially at the City University of New York. The goal of eradicating gender disparities in Mathematics and other Science, Technology, Engineering, and Mathematics (STEM) areas can be assisted by creating a matrix of academic and social support structures for women. These structures include a multi-tiered mentoring program in which role-modeling and leadership skills are enhanced through the Peer-Led Team Learning instructional model.

Liu, Y., Raker, J. R., & Lewis, J. E. (2018). Evaluating student motivation in organic chemistry courses: Moving from a lecture-based to a flipped approach with peer-led team learning *Chemistry Education Research and Practice* 19(1), 251-264. doi: 10.1039/C7RP00153C Available online: <https://pubs.rsc.org/en/content/articlehtml/2018/rp/c7rp00153c>. Academic Motivation Scale-Chemistry (AMS-Chemistry), an instrument based on the self-determination theory, was used to evaluate students' motivation in two organic chemistry courses, where one course was primarily lecture-based and the other implemented flipped classroom and peer-led team learning (Flip-PLTL) pedagogies. Descriptive statistics showed that students in both courses were more extrinsically motivated and their motivation moved in negative directions across the semester. Factorial multivariate analysis of covariance revealed a main effect of pedagogical approach. Students in the Flip-PLTL environment were significantly more motivated toward chemistry at the end of the semester while controlling for the motivation pre-test scores; however, there was no evidence for a sex main effect or an interaction effect between sex and pedagogical approach. Correlation results revealed variable relationships between motivation subscales and academic achievement at different time points. In general, intrinsic motivation subscales were significantly and positively correlated with student academic achievement; motivation was negatively correlated with academic achievement. The findings in this study showed the importance of Flip-PLTL pedagogies in improving student motivation toward chemistry.

Lloyd, P. M., & Echhardt, R. A. (2010). Strategies for improving retention of community college students in the sciences. *Science Educator*, 19(1), 33-41. Almost one half of U.S. students receiving B.S. and M.S. science degrees attend community colleges during their academic careers, yet for the large majority of community college students in the sciences, a four-year degree in a STEM discipline remains an unrealized goal. The authors describe methods intended to improve student learning, retention, and graduation rates of community college students in the sciences.

Loui, M. C. (2008). *Assessment of student teams in a freshman engineering course*. Department of Electrical and Computer Engineering. University of Illinois at Urbana-Champaign. Urbana, Illinois. The document is a plan to seek funding from the GATE program to redesign and to assess the Supervised Study Sessions in ECE 110, a freshman engineering course in the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign. They will use Peer-led Team Learning. As part of the pilot plan, they will construct the assessment to answer the following questions: How do students and team leaders benefit from participating in the Supervised Study Sessions? Does student attendance at Supervised Study Sessions improve exam scores? Does student attendance at Supervised Study Sessions promote the retention of women and minority students? These questions are crucially important for engineering education. Born et al. (2002) suggested that workshop-style groups promote the retention of women and underrepresented minorities in the sciences. We hope to gain the same retention benefit in engineering.

Loui, M. C., & Robbins, B. A. (2008). *Work-in-progress: Assessment of peer-led team learning in an engineering course for freshmen*. Conference Proceedings of the Thirty-Eighth ASEE/IEEE Frontiers in Education Conference, Saratoga Springs, N.Y.
Evaluation of the PLTL program to increase academic achievement in an engineering course for first-year students

Loui, M. C., Robbins, B. A., Johnson, E. C., & Venkatesan, N. (2013). Assessment of peer-led team learning in an engineering course for freshmen. *International Journal of Engineering Education*, 29(5), 1440-1455.
An evaluation study of PLTL with a first-year engineering course.

Lu, C. (2012). *How can the peer leader support students' learning in workshop?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Lu-2012.docx>

Peer-led workshops usually consist of 6-8 students who come together to discuss and solve problems on modules given to them each week. Workshop students often lack confidence in their ability to solve problems in mathematics. Comparison is a big factor in lack of confidence, especially in group-based work. Students usually compare themselves with others based on how fast they could learn new material or complete assignments. Students also compare their own abilities to contribute to teamwork to their teammates, resulting in hesitating to ask for help. Grades and the amount of material students master is also a big factor to compare. Gender roles are another factor in lack of confidence. Men usually conclude they are superior to their peers and women usually conclude they are inferior. When facing challenges, women tend to dwell on their failures and men only rarely. In situations where students find themselves inferior to others, they lose confidence. Faculty play a big part in increasing confidence in students; they could also explain to students that how long it takes to solve a problem is less important than understanding and solving it.

Lunkmark, J., Paradis, J., Kapp, M., Lowe, E., & Tashiro, O. (2017). Development and impact of a training program for undergraduate facilitators of peer-assisted learning *Journal of College Science Teaching*, 46(6), 50-54.

In late 2011, we created a Peer-Assisted Learning (PAL) program focused on improving student performance in high-risk STEM courses. Our PALs are modeled after the Peer-Led Team Learning (PLTL) program, which has been shown to provide long- and short-term benefits to both students (Chan & Bauer, 2015; Gosser, Kampeier, & Pratibha, 2010; Lewis, 2011) and peer leaders (Gafney & Pratibha, 2007). The PLTL model often describes key qualities for student leaders, including excellence with content, independence, and an outgoing personality (Tien, Roth, & Kampmeier, 2004). However, after hiring our first team of PAL leaders, it became apparent that occasionally “independent” and “outgoing” translated into leaders who were the center of attention and resisted operating on the sidelines. As a result, we shifted our emphasis to training “facilitators” rather than “leaders.” Students must still earn at least a B in the course they facilitate, but we now emphasize empathy, creativity, and approachability during recruitment, hiring, and training. Our program has resulted in an average 20% increase in pass rates for students taking a PAL course versus similar populations of non-PAL students.

Lyle, K. S., & Robinson, W. R. (2003). A statistical evaluation: Peer-Led Team Learning in an organic chemistry course. *Journal of Chemical Education*, 80(2), 132-134. doi: 10.1021/ed080p132.

This report documents the impact of Peer-Led Team Learning (PLTL) in an organic chemistry course taken by sophomore students at a small research college in the eastern United States. Participating students outscored their counterparts by a statistically significant level. The effect size was 0.64 which is large. This was consistent for all student subpopulations regardless of gender or ethnicity.

Lyon, D. C., & Lagowski, J. J. (2008). Effectiveness of facilitating small-group learning in large lecture classes: A general chemistry case study. *Chemical Education Research*, 85(11), 1571-1576.

This article reports on the use of Peer-led Team Learning (PLTL) in a large, 400 student general chemistry course that is usually taught in a traditional lecture format. The administrative structure, the training of the PLTL facilitators, and the achievement of the students is compared with a control group.

Malik, D. J. (2002). *Improving the transition from secondary to higher education in a large urban public university: Recognizing the role of PLTL*. Conference Proceedings of the 224th American Chemical Society National Meeting, Boston, MA. For more information, contact the author at the Department of Chemistry, Indiana University Purdue University Indianapolis, Indianapolis, IN 46202, malik@chem.iupui.edu

Peer-led Team Learning (PLTL) has been used at Indiana University Purdue University Indianapolis to support higher student achievement in introductory science courses. PLTL is viewed as a critical program for helping high school students quickly make the adjustment to the academic rigor of challenging college courses.

Malik, D. J. (2004). *Creating a culture for PLTL: Selling the faculty and administration*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Chemistry, Indiana University Purdue University Indianapolis, 402 N. Blackford Street, Indianapolis, IN 46202, malik@chem.iupui.edu

Peer-led Team Learning (PLTL) was used in a chemistry course at Indiana University Purdue University Indianapolis. A number of recommendations are presented for marketing of the PLTL to fellow faculty members and administrators that align the program with institutional mission and priorities.

Marcano, Y., Velez, A., & Fraiman, A. (2003). *Implementation of PLTL in sophomore organic chemistry at Northeastern Illinois University*. Conference Proceedings of the 25th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the author at the Department of Chemistry, Northeastern Illinois University, 5500 North St. Louis, Chicago, IL 60625, y-marcano@neiu.edu

The Peer-Led Team Learning (PLTL) program is used with the general chemistry courses at Northeastern Illinois University since Fall 2002. The authors share program outcomes and challenges with implementation of the model.

Mauser, K., Sours, J., Banks, J., Newbrough, J., Janke, T., Shuck, L., . . . Varma-Nelson, P. (2011). Cyber Peer-Led Team Learning (cPLTL): Development and implementation. *EducauseReview*. Available online: <http://er.educause.edu/articles/2011/12/cyber-peerled-team-learning-cpltl-development-and-implementation>.

Given the proven success of peer-led team learning, an experiment explored whether cyber PLTL could achieve similar success, especially in STEM fields. Results indicated that cPLTL students achieve at the same level as PLTL students in General Chemistry courses. cPLTL workshops eliminate the ongoing need for physical classroom spaces. Students can be effective

partners with faculty in improving educational practice. The type and amount of student interaction with major socializing agents on campus—faculty and their peers—determine the impact of college on students. Much of the research on postsecondary education links the quality of peer interactions directly to student learning outcomes and satisfaction with the college experience, and Alexander Astin went so far as to suggest that "peers are the single most potent source of influence" affecting virtually

McCreary, C. L., Golde, M. F., & Koeske, R. (2006). Peer instruction in the general chemistry laboratory: Assessment of student learning. *Journal of Chemical Education*, 82(5), 804. doi: 10.1021/ed083p804.

The Peer-Led Teaching and Learning (Workshop) model has been applied since 1998 to a subset of all General Chemistry laboratory sections at the University of Pittsburgh. In the workshop model, the graduate TA instructor is replaced by a team of 3–4 qualified advanced undergraduates. Each undergraduate acts as the teacher, mentor, and facilitator for a small group of students during lab sessions. In implementing the model, several changes to the labs' structure were made in an effort to increase students' active involvement and reflective thinking. We report the first systematic comparison of conventional and workshop labs. A natural experiment proved possible because students sign up for labs without knowing the type of instruction they will receive. A reliable grading system was developed to characterize students' written responses to the final lab exam, and an independent rater used it to assess student learning. Assessments of learning were made without knowledge of students' instructional condition. Compared to students in conventional sections, students in workshop sections showed superior learning and critical thinking skills, and gave answers that were longer and of greater clarity. Possible reasons for these improvements are discussed.

Merkel, J. C. (2015). Assessment of Peer-led Team Learning in calculus I: A five-year study. *Innovative Higher Education*, 40(5), 415-428. doi: 10.1007/s10755-015-9322-y.

This five-year study of the peer-led team learning (PLTL) paradigm examined its implementation in a Calculus I course at an all-male HBCU institution. For this study we set up a strong control group and measured the effect of PLTL in the teaching and learning of Calculus I through two points of measure: retention and success rates and learning gains. Our analysis reveals those aspects that can make the implementation of PLTL in calculus and perhaps in mathematics in general challenging and also shows hopeful aspects that promote better learning of the subject.

Merkle, J. C., & Brania, A. (2015). Assessment of Peer-Led Team Learning in Calculus I: A five-year study. *Innovative Higher Education*, 40(5), 415-428. doi: 1007/s10755-015-9322-y.

This five-year study of the peer-led team learning (PLTL) paradigm examined its implementation in a Calculus I course at an all-male HBCU institution. For this study we set up a strong control group and measured the effect of PLTL in the teaching and learning of Calculus I through two points of measure: retention and success rates and learning gains. Our analysis reveals those aspects that can make the implementation of PLTL in calculus and perhaps in mathematics in general challenging and also shows hopeful aspects that promote better learning of the subject.

Micari, M. (2014). *Mentoring learning in the STEM disciplines*. Unpublished manuscript. Northwestern University.

SESP 291 is a one-credit course taken over three academic quarters. It is designed to provide facilitators in the Gateway Science Workshop (GSW) program [based upon Peer-led Team Learning] an opportunity to develop as leaders and as learning mentors. In particular, the course aims to enhance your knowledge, understanding, and practical skills in facilitating groups, coaching peers, and promoting meaningful learning in the STEM (science, technology, engineering, and math) disciplines. The course integrates three essential components of

learning – academic knowledge, “on-the-job” training, and engagement with a learning community – to create a unique undergraduate learning experience at Northwestern. The goals for the course are for the GSW mentors to (a) gain practical facilitation skills; (b) become familiar with, and critically engage with, learning theory and research, and bring this knowledge into your GSW mentoring; (c) gain knowledge of the dynamics of small groups, and bring this knowledge into your GSW mentoring; (d) become familiar with the process of conducting educational research, and begin to critically evaluate classroom practices through a research lens; and (e) reflect on facilitation practice and develop self-evaluation skills.

Micari, M., & Drane, D. (2011). Intimidation in small learning groups: The roles of social-comparison concern, comfort, and individual characteristics in student academic outcomes. *Active Learning in Higher Education, 12*(3).

This study examines the relationship of social-comparison concern, comfort, and self-efficacy to course performance and program persistence in a small-group learning environment. As part of the study, 205 undergraduates in a peer-led, small-group science learning program were surveyed at the beginning and end of the academic term; surveys addressed self-efficacy for the course, comfort participating in the small groups, and concern about comparison with others in the groups. Results indicated that while social-comparison concern and comfort were unrelated to prior academic preparation (as measured by grade point average and SAT mathematics score), they were related to self-efficacy, ethnic minority status, and gender, as well as to persistence in the program and final grade.

Micari, M., Gould, A. K., & Lainez, L. (2010). Becoming a leader along the way: Embedding leadership training into a large-scale peer-learning program in the STEM disciplines. *Journal of College Student Development, 51*(2), 218-230.

Although many college students enter leadership programs with the express goal of developing leadership skills, some specialized leadership programs draw students who seek to gain expertise in a disciplinary area, with leadership development as a secondary goal. The Gateway Program is based on Peer-led Team Learning. In the latter case, program developers face the challenge of generating enthusiasm among student participants for thinking and talking about leadership. This paper addresses the question of whether undergraduates can develop as leaders when that is not their explicit goal, chronicling the evolution of a program designed to do just that. Data collected through survey and interview research suggest that participating students do indeed develop as leaders in meaningful ways.

Micari, M., Gould, A. K., & Lainez, L. (2010). Becoming a leader along the way: Embedding leadership training into a large-scale peer-learning program in the STEM disciplines. *Journal of College Student Development, 51*(2), 218-230. doi: 10.1353/csd.0.0125.

Although many college students enter leadership programs with the express goal of developing leadership skills, some specialized leadership programs draw students who seek to gain expertise in a disciplinary area, with leadership development as a secondary goal. In the latter case, program developers face the challenge of generating enthusiasm among student participants for thinking and talking about leadership. This paper addresses the question of whether undergraduates can develop as leaders when that is not their explicit goal, chronicling the evolution of a program designed to do just that. Data collected through survey and interview research suggest that participating students do indeed develop as leaders in meaningful ways.

Micari, M., & Light, G. (2009). Reliance to independence: Approaches to learning in peer-led undergraduate science, technology, engineering, and mathematics workshops. *International Journal of Science Education, 31*(13), 1713-1741. doi: 10.1080/09500690802162911.

The phenomenographic 'approach to learning' literature holds that students' approaches to learning can change depending on the learning context. This implies that, by modifying the learning context, teachers can change the way students approach learning, and this can ultimately lead to a change in learning outcomes. The study presented here examines one effort to modify a science, technology, engineering, and mathematics (STEM) learning context and the approaches to learning taken by students experiencing this environment. Using a qualitative, phenomenographic approach, we interviewed 45 students in a STEM peer-led workshop programme at Northwestern University, a research-intensive university. Similar to previous approach-to-learning research, the study identified three approaches students took to learning in the peer-led programme, in which they focused on simply making it through the course, engaging more meaningfully with the material, and gaining better control over their own learning. The Gateway Science Workshops program was developed at Northwestern.

Micari, M., Pazos, P., Streitwieser, & Light, G. (2010). Small-group learning in undergraduate STEM disciplines: effect of group type on student achievement. *Educational Research and Evaluation*, 16(3), 269-286. doi: 10.1080/13803611.2010.520860.

Small-group learning in the science, technology, engineering, and mathematics (STEM) disciplines has been widely studied, and it is clear that this method offers many benefits to students. Less attention has been paid to the ways in which small learning groups differ from one another, and how these differences may affect student learning and experiential outcomes. This study uses a previously validated instrument to categorize, or type, small peer-led STEM learning groups, and then to investigate the impact of group characteristics on student outcomes. Six hundred and forty-six students were observed over 2 academic quarters. During the fall quarter, no relationship was found between group type and student course grade. During the winter quarter, statistically significant differences in student grade were found among group types. We posit that group type may not make a difference in grade early in the year because the groups are not yet functioning optimally, so that group "noise", such as facilitator inexperience or student discomfort, may drown out the effects of group type on student performance.

Micari, M., Streitwieser, B., & Light, G. (2006). Undergraduates leading undergraduates: Peer facilitation in a science workshop program. *Innovative Higher Education*, 30(4), 269-288. doi: 10.1007/s10755-005-8348-y.

This article presents the results of a study at Northwestern University concerning experiences of undergraduate students serving as facilitators of Peer led Team Learning (PLTL) sessions for introductory undergraduate sciences and engineering course. The PLTL facilitators reported growth in a variety of areas: cognitive growth (consolidating knowledge in the discipline, enhancing conceptual understanding, and developing problem-solving skills); personal growth (communication skills in confidence, audience understanding, and self-expression; pedagogical skills; improved ability to explain concepts; and skill at learning to allow students to work out their ideas on their own without interrupting to offer guidance; understanding the role of the teacher); and instrumental growth (career development and striving to achieve professional goals).

Micari, M., Winkle, Z. V., & Pazos, P. (2016). Among friends: The role of academic-preparedness diversity in individual performance within a small-group STEM learning environment. *International Journal of Science Education*, 38(12), 1904-1922. doi: 10.1080/09500693.2016.1218091.

In this study, we investigate the relationship between academic-preparedness diversity within small learning groups and individual academic performance in science, technology, engineering, and mathematics (STEM) university courses. We further examine whether academic-

preparedness diversity impacts academically more- and less-prepared students differently. We use data from 5367 university students nested within 1141 science, engineering, and mathematics learning groups and use a regression analysis to estimate the effect of group diversity, measured in two ways, on course performance. Our results indicate that academic-preparedness diversity is generally associated with positive learning outcomes, that academically less-prepared students derive greater benefit, and that less-prepared students fare best when they are not alone in a group of highly prepared students. Implications for teaching and small-group facilitation are addressed.

Miller, I., & Sadler-McKnight, N. (2012). *Implementation and institutionalization of PLTL in a Caribbean university: Successes, challenges, and implications*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/McKnight-PLTLIS-2012.pptx> Peer-Led Team Learning (PLTL) workshops significantly improved performance in introductory chemistry as well as increased student self-confidence and attitude towards chemistry. Participation in both semesters results in better performance than in one semester only. The PLTL model provides an atmosphere in which students freely express themselves, show less fear of failure, and develop the self-confidence and problem solving skills that are necessary for independent learning. Results point to the need for institutionalization of the PLTL model to include all Year 1 students as well as other subjects e.g. Math, Physics, etc. Need for a PLTL programme director who can focus on coordinating the programme and need to revisit our mode of instruction.

Miller, I. R. (2015). *Assessing the relationship between students' science background knowledge and their performance in an introductory level chemistry course and the impact of Peer-Led Team Learning on academic and transferable skills of undergraduate chemistry students*. (Ph.D. dissertation), University of West Indies, Jamaica, West Indies. Research study assessing the relationship between students' science background knowledge and their performance in an introductory level chemistry course and the impact of Peer-Led Team Learning on academic and transferable skills of undergraduate chemistry students

Miller, J. E., Groccia, J. E., & Miller, M. S. (2007). *Student-assisted teaching: A guide to faculty-student teamwork*. Upper Saddle River, NJ: Prentice Hall.

Mitchell, Y. D., Ippolito, J., & Lewis, S. E. (2012). Evaluating Peer-Led Team Learning across the two semester General Chemistry sequence. *Chemistry Education Research and Practice*, 13, 378-383.

Peer-Led Team Learning (PLTL) is a widely disseminated pedagogical reform that employs previously successful undergraduate students, peer leaders, to lead sessions of structured group work in the target class. Numerous studies have evaluated the impact of this reform in various post-secondary chemistry classes. Results from these studies suggest that PLTL may be effective at improving student success in these classes, either through improved performance on common exams or reduced student attrition in the classes. This study seeks to take a broader picture at measuring the impact, by examining the role PLTL plays across a two semester General Chemistry sequence. This includes an analysis of PLTL on students' decision to progress through the two semester sequence, and on PLTL impact on the algorithm-heavy second-semester General Chemistry. The findings suggest that the PLTL implementation is robust in improving student success directly in terms of the target class. However, PLTL had little to no effect on students' decision to continue in the General Chemistry sequence. Additionally, PLTL had little effect on student performance in subsequent courses where the

pedagogy returned to lecture-only instruction. The results suggest that PLTL implementation on one course within a sequence would have limited impact, and in order to improve student progress toward graduation, PLTL implementation may have to be curricular wide.

Molloy, J. (2017). Reinforcing medication administration through student-directed simulation. *Teaching and Learning in Nursing*.

Medication errors are a threat to patient safety, and the distress experienced by nurses affects their confidence and practice. Nursing students have reported a decrease in medication administration in the clinical setting. This article documents the creation of a pilot study to explore the potential for a teaching approach that utilizes senior students as mentors in a simulation laboratory to practice medication administration. Results revealed that all students reported an increased competence and confidence to administer medication autonomously in the future.

More, T., & Hill, G. (2002). *Integrating calculus and general physics using a workshop and peer-leader approach*. Conference Proceedings of the International Conference on Transforming Math and Science Education in the K16 Continuum, Arlington VA. Available online: <http://k12s.phast.umass.edu/stemtec/pathways/Proceedings/Papers/More-p.pdf>

Peer-led Team Learning (PLTL) is being used in an integrated introductory physics and calculus course at the University of Portland to address several persistent problems in student learning: poor conceptualization and retention of material, under-developed problem-solving skills, and difficulty actively applying knowledge across disciplines. The course and dedicated laboratory will also improve training of both pre-service and in-service K-12 teachers. The course will be integrated in terms of content, pedagogy and classroom design. Going beyond a “just in time” approach in which mathematics is often subordinate to physics, the professors take advantage of the integration, organizing the course around ‘threads’ in which the subjects reinforce and motivate each other. Working in small groups on investigative activities with supervising peer-leaders and a faculty member overseeing the entire class, students will make connections across disciplines in one classroom environment using a common set of tools. Lecture, hands-on learning, and computer usage will be integrated with group activities such as experimentation and joint problem-solving. Using the PLTL model, the conference workshop will follow one or more ‘threads’ through a semester. Participants will also have the opportunity to suggest, discuss, and develop additional activities supporting these threads.

Mottley, J. G., & Roth, V. (2013). *Peer-Led Team Learning: Adjunct to lectures in an electrical engineering course for non-majors*. Conference Proceedings of the Frontiers in Education Conference, 2013 IEEE, Oklahoma City, OK.

Peer-Led Team Learning (PLTL) is a recognized model for teaching and learning in which select students in a course return in later semesters to serve as peer leaders who facilitate small learning groups. At our institution (a small, private, research-intensive university), this technique is adopted in Workshops; our peer leaders meet weekly with small groups of students to guide them through sets of exercises designed by the instructor(s) of the course. Peer leaders receive instruction and support in pedagogy and group dynamics in a course jointly taught by a learning specialist from the Center for Excellence in Teaching and Learning (CETL) and the instructor of the course. Workshops have been adopted in many courses, ranging from Chemistry, Biology, Earth Sciences, Physics, and Optics, to Economics and Business. This paper describes the use of Workshops for several years in an Electrical and Computer Engineering (ECE) course intended for non-ECE majors. We discuss the processes and pitfalls for initiating the use of Workshops in this and other courses, present an example of Workshop problems and questions currently in use, and discuss the value of the Workshops to students, peer leaders, and faculty as told to us in surveys, course journals, and reflective sessions held after the course.

Muller, O., Scacham, M., & Herscovitz, O. (2017). Peer-led Team Learning in a college of engineering: First-year students' achievements and peer leaders' gains. *Innovations in Education & Teaching International*. doi: 10.1080/14703297.2017.1285714. Available online: <http://srhe.tandfonline.com/doi/full/10.1080/14703297.2017.1285714?scroll=top&needAccess=true>.

Due to high dropout rates (30%) among first-year students, our college of engineering operates programmes for promoting students' retention and learning. The peer-led team learning (PLTL) programme accompanies Science, Technology, Engineering and Mathematics introductory courses with a high rate of failures, and incorporates workshops of small groups of students for developing active-learning and problem-solving skills. The workshops are led by outstanding students from advanced years; the peer leaders (PL). This study focused on the effects of the PLTL programme (40 workshops, 26 PLs) on the achievements of students who participated in the workshops compared with those who did not, and on its impact on the PLs. Findings reveal that workshops advance students of all levels and improve their achievements in several courses, while contributing more to students with higher academic capabilities. PLs felt satisfaction and believe they have gained self-confidence, and mentoring and communication skills for their future careers.

Muller, O., Shacham, M., & Herscovitz, O. (2018). Peer-led team learning in a college of engineering: First-year students' achievements and peer leaders' gains. *Innovations in Education and Teaching International*, 55(6), 660-671. doi: 10.1080/14703297.2017.1285714. Due to high dropout rates (30%) among first-year students, our college of engineering operates programmes for promoting students' retention and learning. The peer-led team learning (PLTL) programme accompanies Science, Technology, Engineering and Mathematics introductory courses with a high rate of failures, and incorporates workshops of small groups of students for developing active-learning and problem-solving skills. The workshops are led by outstanding students from advanced years; the peer leaders (PL). This study focused on the effects of the PLTL programme (40 workshops, 26 PLs) on the achievements of students who participated in the workshops compared with those who did not, and on its impact on the PLs. Findings reveal that workshops advance students of all levels and improve their achievements in several courses, while contributing more to students with higher academic capabilities. PLs felt satisfaction and believe they have gained self-confidence, and mentoring and communication skills for their future careers.

Mullins, J. J. (2003). *The effectiveness of Peer-led Team Learning workshops in organic chemistry instruction at Le Moyne College*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the authors at the Department of Chemistry, Le Moyne College, 1419 Salt Springs Road, Syracuse, NY 13214, mullinjj@lemoyne.edu

The Peer-Led Team Learning (PLTL) program is used with the general chemistry courses at Le Moyne College (NY) beginning in 2002. Participating students earn higher grades than nonparticipants. Surveys suggest that students are highly satisfied with PLTL.

Muniz, J., Saupe, G., Becvar, J. E., & Narayan, M. (2012). *A speed of one molar per second presents some blocks in the road*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Muniz-2012.docx>

It is challenging for students in general chemistry to recognize that every chemical reaction is associated with a rate (speed). Peer Leaders in second semester general chemistry have found a 'solution': provide students in Workshop with oversized Lego®-like blocks in a large clear bag.

These blocks can be used to represent molecules composed of atoms with appropriate combining properties. The blocks permit visualization of amounts of reactants and products in a chemical reaction like 1) H₂ and O₂ to produce H₂O (burning of hydrogen) or 2) CH₄ and O₂ to produce CO₂, and H₂O (combustion of methane). Concentrations of reacting species can be followed as the reaction progresses by having student teams pay close attention to the rearranging block combinations over time. Reacting a certain amount (e.g. one molar) of the combustible reactant per unit time can be easily represented to reconcile and visualize the abstract concept of “rate of a chemical reaction”. Moreover, altering the starting ‘concentrations’ of reactants (differing initial numbers of block combinations) permits students to understand two difficult concepts: limiting reagent and final concentrations at completion or at equilibrium. The ‘blocks’ transform an obstacle into a vehicle for students to ‘get’ the speed of reaction.

Munkeby, A., Drane, D., & Light, G. (2005). *Supporting innovative freshman study: The Engineering Workshop Program at Northwestern University*. Conference Proceedings of the 2005 American Society for Engineering Education Annual Conference, Portland, OR. A research study concerning the utility of the PLTL approach for increased grades in engineering

Murphy, C., Powell, R. M., Parton, K., & Cannon, A. (2011). *Lessons learned from a PLTL-CS program*. Conference Proceedings of the 42nd ACM technical symposium on Computer science education, Dallas, TX.

The Peer-Led Team Learning (PLTL) approach has previously been shown to be effective in recruiting and retaining students, particularly under-represented students, in undergraduate introductory CS courses. In PLTL, small groups of students are led by an undergraduate peer and work together to solve problems related to CS. At Columbia University, the Columbia Emerging Scholars Program has used PLTL in an effort to increase enrollment in CS courses beyond the introductory level, and to increase the number of students who select Computer Science as their major, by demonstrating that CS is necessarily a collaborative activity that focuses more on problem solving and algorithmic thinking than on programming. Over the past six semesters, over 80 students have completed the program, and preliminary results indicate that this program has had a positive effect on increasing participation in the major. This paper discusses our experiences of building and expanding the Columbia Emerging Scholars program, and addresses such topics as recruiting, training, scheduling, student behavior, and evaluation. We expect that this paper will provide a valuable set of lessons learned to other educators who seek to launch or grow a PLTL program at their institution as well.

Mutanyatta-Comar, J., & Mooring, S. R. (2019). Evaluation of a Peer-Led Team Learning-flipped classroom reform in large enrollment organic chemistry courses *From general to organic chemistry: Courses and curricula to engage student retention* (pp. 145-157): ACS Organic Chemistry is an essential course for students in STEM disciplines and for those interested in pursuing professional degrees such as medicine and dentistry. It also has the reputation of being a “gate-keeper” course that has high DWF rates. At Georgia State University, the enrolled students have been split into one small honors class (of about 70 students) and two large sections of 212 students, in each section. The course presents conceptual challenges for many students in these large sections resulting in a high DWF rate (approximately a 30% DWF rate). There are an increasing number of studies in the literature that show the benefits of active learning strategies, including lowering of failure rates and higher performance on examinations. In order to reduce the DWF rates and increase student motivation, persistence, and completion of their degrees, we implemented a flipped classroom in conjunction with Peer-led Team Learning (PLTL) in Organic Chemistry. Herein, we present the details of this implementation, the assessment of student outcomes and lessons learned.

Nakamura, M., & Wilder, S. (2012). *Peer leaders' training - workshop style*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Nakamura-2012.docx>

Typically workshop leaders are trained in a general classroom setting, one faculty member explaining the requirements and objectives of the workshop style to a classroom full of prospective leaders. The University of Houston-Downtown (UHD) has adapted the Peer-Led Team Learning (PLTL) training model to better suit the needs of both the students and the university by incorporating the workshop ideal into the training itself. UHD leaders experience first-hand the benefits of the workshop style and are given the chance to become familiar with the student's perspective before they begin running workshops themselves. The number of prospective leaders to be trained every semester has been reduced in accordance to the workshop style. Approximately 8 students undergo training per semester, with 11 sessions in total. The group meets for 1 hour each week under the guidance of a peer-coordinator to discuss topics from the Handbook for Team Leaders (Roth, Goldstein and Marcus, 2001). Peer-coordinators are previously trained leaders chosen due to their interest in education; their objective is to guide the leaders through their training in a manner that workshops should be conducted. Leaders are required to read through the section of the handbook to be discussed that week, reflect over, and then answer 3-6 questions as assignment so that they can be prepared to collaborate in the workshop. The materials used in the training workshops are created by the faculty supervisor, then given to the peer-coordinator to modify according to the group's particular needs. The coordinator offers all modifications up for approval to the supervisor as well as reviews after every workshop session is completed to ensure a constant flow of communication throughout the semester.

Narode, R. (2001). PLTL and the future of science teacher education. Peer-Led Team Learning: Implementation in high schools. *Progressions: The Peer-Led Team Learning Project Newsletter*, 2(2). Available online: <http://pltlis.org/wp-content/uploads/2012/10/High-School-Implementation-Narode-PLTL-Future-of-Science-Teacher-Education.pdf>.

The current shortage of math and science teachers (especially physical science teachers) is exacerbated by two important factors: 1) a strong economy offering excellent employment opportunities with higher starting salaries, faster financial growth, and greater status than teaching, and 2) a culture among scientists that encourages students to become scientists far more frequently than to become teachers of science. While PLTL cannot directly change the first of these factors it can directly and indirectly address the second factor. By supporting Peer-Led Team Learning (PLTL) faculty with initial funding, professional development, inquiry-based curriculum for student-led workshops, guides for workshop development, and continuing education of workshop leaders, the PLTL Model educates college science faculty about the potential of students as teachers / learning-facilitators. The student workshop leaders themselves awaken faculty to the understanding that their talents ought to be directed toward the profession of teaching. Furthermore, the presence and support of learning specialists in collaboration with PLTL science faculty and workshop leaders complete the connection to teacher education.

Okoro, J. (2012). *How can the peer leader help students' learning through questioning?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Okoro-2012.docx>

The most common question peer leaders often ask themselves is how can they improve on maintaining the students engaged and interested in learning a certain topic. One way of improving on this is to observe how students learn and process information taught in class.

Parente, A. D. (2010). The scholarship of Peer-Led Team Learning: My progression from student leader to faculty. Peer-Led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 12(1). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Parente-The-Scholarship-of-Peer-Led-Team-Learning.pdf>.

This is a first-hand account to a student facilitator involved with the Peer-led Team Learning (PLTL) program. Twenty years ago, I was an undergraduate majoring in Biology and Chemistry, struggling with the desire to integrate the details I had learned in my Chemistry courses with the 'big picture' philosophy stressed in my Biology curriculum. These early educational experiences fostered my passion for curricula geared towards interdisciplinary learning and in programs designed to increase awareness of alternative learning styles and pedagogies for instruction. My Workshop journey began five years later, shortly after the program's inception in Organic Chemistry at the University of Rochester under the direction of Jack Kampmeier. To this day, I can't remember how I became involved with this program, but know it was a life-changing opportunity with incredible people that played a central role in shaping my academic career.

Parker Siburt, C. J., Bissell, A. N., & Macphail, R. A. (2011). Developing metaconitive and problem-solving skills through problem manipulation. *Journal of Chemical Education*, 90(8), 961-967. doi: 10.1021/ed100891s. Available online:

https://www.academia.edu/933778/Developing_Metacognitive_and_Problem-Solving_Skills_through_Problem_Manipulation.

In a collaborative effort between the our university's department of chemistry and the academic resource center, we designed a model for general chemistry recitation based on a problem manipulation method in which students actively assess the skills and knowledge used to answer a chemical problem and then manipulate the problem to create a new one. This reflective process aims to facilitate student engagement with the chemistry problem-solving process and to enhance student metacognition by helping students identify their knowledge gaps. The recitation format provides an opportunity for students to work collaboratively on this process and to present and discuss their work. Student response to this new style of recitation was overwhelmingly positive. In addition, students easily assimilated the vocabulary of the methodology into everyday conversation and were better able to articulate their learning needs.

Pazos, P., Drane, D., Light, G., & Munkeby, A. (2007). *A peer-led team learning program for freshman engineering students: Impact on retention*. Conference Proceedings of the 2007 American Society for Engineering Education Annual Conference, Honolulu, HI. Evaluation study of PLTL as supporting higher student persistence.

Pazos, P., Micari, M., & Light, G. (2009). Developing an instrument to characterise peer-led groups in collaborative learning environments: Assessing problem-solving approach and group interaction. *Assessment & Evaluation in Higher Education*, 35(2), 191-208. doi: 10.1080/02602930802691572.

Collaborative learning is being used extensively by educators at all levels. Peer-led team learning in a version of collaborative learning that has shown consistent success in science, technology, engineering and mathematics disciplines. Using a multi-phase research study we describe the development of an observation instrument that can be used to assess peer-led group learning. This paper illustrates the development of a classification system for peer-led learning groups and an instrument based on this classification system. The instrument

evaluates small learning groups on two important aspects of group learning: problem solving approach and group interaction style. We provide evidence of the factor structure of the two dimensions using both exploratory and confirmatory factor analysis. We also provide information about the reliability of the two scales as measured by the Cronbach's alpha coefficient. Data from a large peer-led learning programme was used to conduct the factor analysis. Results from the factor analysis confirmed that the instrument is actually measuring two key characteristics of small learning groups: problem solving approach and group interaction style, characteristics that have been linked to effective functioning of the group and to the student learning outcomes. This instrument may be particularly appealing to practitioners (faculty members, those running small-group learning programmes, etc.) because it is easy to use and it does not require extensive time for analysis.

Pazos, P., Micari, M., & Light, G. (2010). Developing an instrument to characterize peer-led groups in collaborative learning environments: assessing problem-solving approach and group interaction. *Assessment & Evaluation in Higher Education*, 35(2), 191-208.

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Peace, G. E., Lewis, E. L., & Burke, K. A. (2002). The multi-initiative dissemination project: Active-learning strategies for college chemistry. *Journal of Chemical Education*, 79(6), 699. Aspects of the NSF-funded Multi-Initiative Dissemination Project (MID) are discussed in order to inform potential participants of the benefits of attending a MID workshop. The workshops are for two- and four-year college instructors who want to improve their students' understanding of science. Four of the NSF-funded chemistry systemic reform projects (ChemConnections, Molecular Science, New Traditions, and Peer-Led Team Learning) disseminate information and conduct hands-on activities with their session participants during the MID workshops. The MID workshops are funded from 2001 through 2003.

Peteroy-Kelley, M. A. (2007). A discussion group program enhances the conceptual reasoning skills of students enrolled in a large lecture-format introductory biology course. *Journal of Microbiology & Biology Education*, 8(1), 13-21. Available online:

<http://www.physics.emory.edu/faculty/weeks/journal/jmbe07.pdf#14>.

It has been well-established that discussion groups enhance student learning in large lecture courses. The goal of this study was to determine the impact of a discussion group program on the development of conceptual reasoning skills of students enrolled in a large lecture-format introductory biology course. In the discussion group, students worked on problems based on

topics discussed in lecture. The program was evaluated using three assessment tools. First, student responses to pre- and posttests were analyzed. The test question asked the students to demonstrate the relationships between 10 different but related terms. Use of a concept map to link the terms indicated an advanced level of conceptual reasoning skills. There was a 13.8% increase in the use of concept maps from pre- to posttest. Second, the students took a Likert-type survey to determine the perceived impact of the program on their conceptual reasoning skills. Many of the students felt that the program helped them understand and use the main course concepts to logically solve problems. Finally, average exam grades increased as the semester progressed. The average final grade in the course was 75%. Students enrolled in the course the previous year (where the lecture component of the course did not assess or reflect student learning in the discussion group) had an average final grade of 69%. The results of this study demonstrate that the discussion group program improves the conceptual reasoning skills of students enrolled in a large lecture-format introductory biology course.

Piaku, A. (2012). *How can the peer leader help students in workshop trust their partner's knowledge?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/PIaku-2012.docx>

I became interested in assisting the students in workshop to be more cooperative as a team by using the pair problem-solving method. This method helped the students communicate openly with each other by breaking the barriers of not being afraid or intimidated. Working in small groups students were able to discuss the workshop tasks and as a result, they built trust by performing better in Math 1175 (Fundamentals of Mathematics).

Pilgrim, M. E., & Dick, T. P. (2019). *Actively engaging in calculus to support all students*. San Diego State University. Available online: [https://directorymathsed.net/public/Ireland/IrelandPapersPDF&Docx/Pilgrim%20&%20Dick%20\(5\)W.pdf](https://directorymathsed.net/public/Ireland/IrelandPapersPDF&Docx/Pilgrim%20&%20Dick%20(5)W.pdf)

Research findings support the use of active engagement in the mathematics classroom. Active learning not only has the potential to positively impact student learning, it also helps to address equity issues in the mathematics classroom. However, with limited experiences in student-centered instruction and little to no pedagogical training, mathematics faculty are often underprepared to meet the needs to today's STEM majors. In addition, content-specific professional development is typically not readily available to faculty on their campuses. With a focus on calculus, this workshop aims to fill this professional development gap by providing participants with the opportunity to engage in student-centered activities as well as reflect and discuss the implications for their own mathematics classrooms.

Pittenger, A., & LimBybliw, A. L. (2013). Peer-Led Team Learning in an online course on controversial medication issues and the US healthcare system *American Journal of Pharmaceutical Education*, 77(7), Article 150. doi: 10.5688/ajpe777150. Available online: <http://www.ajpe.org/doi/abs/10.5688/ajpe777150>.

Objective. To implement peer-led team learning in an online course on controversial issues surrounding medications and the US healthcare system. Design. The course was delivered completely online using a learning management system. Students participated in weekly small-group discussions in online forums, completed 3 reflective writing assignments, and collaborated on a peer-reviewed grant proposal project. Assessment. In a post-course survey, students reported that the course was challenging but meaningful. Final projects and peer-reviewed assignments demonstrated that primary learning goals for the course were achieved and students were empowered to engage in the healthcare debate. Conclusions. A peer-led team-learning is an effective strategy for an online course offered to a wide variety of student

learners. By shifting some of the learning and grading responsibility to students, the instructor workload for the course was rendered more manageable.

Platt, T. (2006). *Peer-Led workshops: Leader training and cooperative examinations*. Unpublished manuscript. Paper presented at Annual Conference on Case Study Teaching in Science, October 6-7, 2006. Buffalo, NY.

This paper presents the results of the use of cooperative examinations in the classes that were supported by the Peer-led Team Learning (PLTL) program. Students were given a large number of potential exam questions ahead of time with only a small subset actually presented on the unit exam. Individually and during PLTL sessions the students worked on these questions. Six important advantages to the "cooperative examination" model emerged from their study (supporting recent similar findings from others): (1) the anxiety level was much lower (there were no surprises, and students who diligently prepared aU10 answers were guaranteed to do well), (2) cram all nighters were eliminated (students realized it would be impossible, so began working on their answers as soon as the questions became available), (3) competition between students was diminished and much active learning occurred (as students worked together to formulate their best answers), (4) cheating was reduced (more tempting when rote answers are needed), (5) students worked harder and studied substantially longer, both alone and with others, in preparing for the exam, and (6) they engaged with a greater number and variety of resources, in seeking understanding rather than rote answers.

Platt, T., Barber, E., Yoshinaka, A., & Roth, V. (2003). An innovative selection and training program for Problem-based Learning (PBL) workshop leaders in biochemistry. *Biochemistry and Molecular Biology Education*, 31(2), 132-136.

A version of Peer-led Team Learning (PLTL) was implemented at the University of Rochester in New York. Traditional recitation sections were replaced in a large upper level biochemistry course with PLTL. A key factor in the program's success was extensive training of the PLTL student facilitators..

Platt, T., Barber, E., Yoshinaka, A., & Roth, V. (2003). Problem-based learning: An innovative selection and training program for problem-based learning (PBL) workshop leaders in biochemistry. *Biochemistry and Molecular Biology Education*, 31, 132-136.

Platt, T., Roth, V., & Kampmeier, J. A. (2008). Sustaining change in upper-level courses: Peer-led workshops in organic chemistry and biochemistry. *Chemistry Education Research Practices*, 9, 144-148.

Our peer-led collaborative learning groups, called Workshops, have now had extended success in two upper-level courses in chemistry and biochemistry. These Workshops are in turn supported by a third upper-level course for training peer-leaders. Our data confirm that the initial positive results from the introduction of Workshops in organic chemistry and in biochemistry have been maintained over time and over changes in course instructor. In addition, training upper-level Workshop leaders has contributed substantially to the self-sustaining character of our program. These longitudinal results have been accompanied by the lateral spread of Workshops into other courses and departments. The concurrent development of mutually reinforcing partnerships among faculty, staff and students has supported these changes. Complementary adjustments in institutional practice, and the recent establishment here of a Center for Workshop Education now provide a formal framework to foster the continuing promise of our Workshop program.

Powell, R. M., Murphy, C., Cannon, A., Gordon, J., & Ramachandran, A. (2013). *Evaluation of the Emerging Scholars Program at Columbia University*. Conference Proceedings of the 44th ACM technical symposium on Computer science education, Denver, CO.

The Columbia Emerging Scholars Program (CESP) in Computer Science is a Peer Led Team Learning (PLTL) approach to bringing undergraduates new to the discipline together with peer mentors to work on computational problems, and to expose them to the broad array of disciplines within computer science. CESP demonstrates that computer science is necessarily a collaborative activity that focuses more on problem solving and algorithmic thinking than on programming. In spring 2012 the computer science department at Columbia University completed the 9th iteration of CESP, with 104 women and 36 men having completed the program to date. Female enrollment at Columbia during the past four years has increased from 9% to 23%, but did CESP play a part in this increase? This poster presents our evaluation data, which indicates that CESP increased enrollment in the computer science major, especially for women. Students who took CESP along with the introduction to computer programming course in 2009-10 were three times more likely to major in computer science the following year than the students who took introduction to programming without CESP. 47% of CESP students subsequently chose the computer science major. In addition, survey results indicated that a large majority of students intended to take another computer science course, were enthusiastic about the program, and found the workshop topics exciting and engaging. Participants reported that they learned more about computer science in CESP, and would recommend CESP to others.

Pratt, D. E. (2017). *A narrative case study examining the influences of Peer-led Team Learning on student critical thinking skill acquisition and deeper process content knowledge in a midsize Texas university humanities and social science program*. (Ph.D. dissertation), The University of New Orleans, New Orleans, LA. Available online: <https://scholarworks.uno.edu/td/2429/>
This dissertation will examine the efficacy of peer-led team learning (PLTL) in a humanities and social sciences program, at a midsize Texas university. It will be conducted exclusively within the College of Humanities and Social Sciences (CHSS), and the academic subjects to be evaluated include English, history, and philosophy. Its primary function is to disclose whether or not PLTL facilitates in student participants improvement in critical thinking skill acquisition and deeper process content knowledge. Of primary interest in this qualitative, narrative case study is deducing how breakout sessions – supplementary meetings led by student participants, in the absence of instructors, designed to enhance classroom instruction – aid in concept synthesis and retention. Of equal importance is evaluating how the implementation of a PLTL instructional framework cultivates in its participants the acuity necessary to demonstrate that positive learning outcomes are occurring, or have the potential to occur; thereafter, collected data, in the form of participant and instructor narratives derived from questionnaires, interviews, researcher observations, writing samples, and essay-based examinations will support or refute whether improvement in critical thinking skill acquisition and deeper process content knowledge is evident in student participants.

Preszler, R. W. (2009). Replacing lecture with Peer-led workshops improves student learning. *CBE-Life Education*, 8(3), 182-192. Available online:

<http://www.lifescied.org/content/8/3/182.full.pdf+html>.

Peer-facilitated workshops enhanced interactivity in an introductory biology course, which led to increased student engagement and learning. This approach was based on the Peer-Led Team Learning (PLTL) model. A majority of students preferred attending two lectures and a workshop each week over attending three weekly lectures. In the workshops, students worked in small cooperative groups as they solved challenging problems, evaluated case studies, and participated in activities designed to improve their general learning skills. Students in the

workshop version of the course scored higher on exam questions recycled from preworkshop semesters. Grades were higher over three workshop semesters in comparison with the seven preworkshop semesters. Although males and females benefited from workshops, there was a larger improvement of grades and increased retention by female students; although underrepresented minority (URM) and non-URM students benefited from workshops, there was a larger improvement of grades by URM students. As well as improving student performance and retention, the addition of interactive workshops also improved the quality of student learning: Student scores on exam questions that required higher-level thinking increased from preworkshop to workshop semesters.

Pyatt, R. E., Rosser, T., & Powell, K. (2009). Undergraduates as science museum docents: Training students to be the teachers using Peer led Team Learning. *The American Biology Teacher*, 71(1), 16-19.

This article describes how the Fernbank Museum of Natural History trained undergraduate students as docents for The Genomic Revolution exhibit. Methodology from Peer led Team Learning (PLTL). The best elements of PLTL were important for the docents to acquire: good communication abilities, demonstrate knowledge of the content material, and strong leadership skills. Rather than focusing on a class of students who were preparing for exams, this application of PLTL was focused on helping groups of visitors to the museum exhibit to interact with the learning content and with one another to increase their learning outcomes. The student docents reported that as a result of their experience they learned more about the content material of the exhibits.

Quitadamo, I. J., Brahler, C. J., & Crouch, G. J. (2009). Peer-led Team Learning: A prospective method for increasing critical thinking in undergraduate science courses. *Science Educator*, 18(1), 29-39. Available online:

<http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=EJ851877>. Peer-Led Team Learning (PLTL) is a specific form of small group learning recognized by Project Kaleidoscope as best practice pedagogy (Varma-Nelson, 2004). PLTL was first developed by Woodward, Gosser, and Weiner (1993) as an integrated method that promoted discourse and creative problem solving in chemistry at the City College of New York. It is characterized by a cohort-based social learning structure whereby trained undergraduates, or "peer leaders", guide 4-8 less experienced peers toward conceptual understanding through group-focused science and math problem solving. This study examines the impact of PLTL on critical thinking gains in science and math courses at a research university in the Pacific Northwest. Results of this study show that PLTL has a small but positive impact on critical thinking gains in some science courses, and that it improves grade performance and retention in science and math courses, particularly for females. While math students did not show significant critical thinking gains, it is premature to conclude that PLTL does not promote critical thinking in math. Many factors affect the development of critical thinking skills, and more study is necessary to discover their influence. These results indicate PLTL has potential to improve undergraduate critical thinking. (Contains 2 figures and 3 tables.)

Raab, M. M., & Jodis, Stephen M. (2012). *Training student facilitators to lead peer-led group discussions in computing and the sciences*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: http://pltlis.org/wp-content/uploads/2012%20Proceedings/cilitators_CollaborativeLearningProgram_MRaab_pptversion.ppt

Saint Vincent College offers the opportunity for Peer-Led Team Learning through the Collaborative Learning Program (CLP). Upper-class student facilitators, who were hand-

selected by their departmental faculty, lead freshmen and sophomore discussion and problem solving groups in the science and computing disciplines. Each year the CLP provides a summer training workshop for 8-10 new student facilitators. The workshop is divided into 3 phases. The Initiation Phase helps the students get to know each other through engaging in Ice Breaker Games and Activities. The workshop then proceeds to the Methodology Phase where students learn the pedagogy of the CLP Program. Facilitators also learn how to integrate various study skills and strategies into their CLP sessions including Time Management, Note-Taking Styles, and Learning Styles. The final stage of the workshop is the Hands-On Phase. Student facilitators practice mock sessions to feel more prepared and confident in leading a solo session during the upcoming academic year.

Randloff, J. D., Maybee, C., Slebodnik, M., & Pelaez, N. (2014). *Why are we doing this? The role of personal relevance in developing biological information literacy using cyber Peer-led Team Learning*. Paper presented at the Impact Purdue, West Lafayette, IN. Available online: <http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1010&context=impsymposium>. Student-centered learning necessitates that students engage with an array of materials to develop their own understandings, often requiring students to find and critically engage with biological information. This project describes a course (BIOL 131; Biology II: Development, Structure and Function of Organisms) that utilizes cyber Peer-led Team Learning (cPLTL) as a student-centered approach to enhance students' biological information literacy. Emphasizing the social aspects of learning, students work together in small groups led by a peer mentor using online meeting software. Scaffolded across the first half of the semester, students were given information literacy focused questions as part of a weekly problem set, beginning with finding images or videos on the Internet to eventually examining experiments to understand what kind of evidence biologists use to solve problems. In the cPLTL environment, students teach one another to be critical and consider ethical guidelines in using biological information. In the second half of the semester, the students applied what they had learned to create academic posters. The first iteration of the redesigned course was successful in making Biol 131 more student-centered and did enhance students' biological information literacy. However, a review of the small group sessions revealed some students did not make the connection between the weekly information literacy questions and developing a greater understanding of how biological information holds personal relevance. In the next iteration of the course, efforts will be made to reframe the information literacy component to emphasis students' engagement with biological information in personally relevant ways.

Read, D. (2016). It's good to talk. *Education in Chemistry*. Available online: <http://www.rsc.org/eic/2016/05/good-talk-facilitating-peer-group-learning>.

"Researchers are increasingly investigating the factors that influence students' discussions during group work to better understand the learning that occurs during such activities. In this study, a team of researchers led by Regina Frey analyzed students' conversations during peer-led team learning (PLTL) sessions to shed light on the features of their discourse that contributed to the most effective learning. The study took place at a medium-sized selective university in the US Midwest. The researchers collected data from 15 out of a total of 40 PLTL groups involving students on a general chemistry course. During PLTL sessions, students work in groups of 6–8, facilitated by a peer leader who has previously achieved a high grade in the class and works under the supervision of the instructor. PLTL develops problem-solving skills and provides an active-learning environment, with peer leaders responsible for ensuring that collaborative learning takes place with equal participation across the group. The data collection involved recording 60 hours of video footage of PLTL groups working in three different sessions over the course of a term. Conversations were transcribed and coded, allowing the analysis of the language used by students during the sessions. It was found that approximately half of the

conversation involved instructive talk, ie directly related to science/chemistry, with the rest being regulative talk, ie supporting the group dynamic and collaborative processes. Analysis of instructional communication showed students often engaged in joint decision making involving questioning and explaining, and building on each other's ideas. Interestingly, it was found that conversations infrequently featured open questioning, deeper conceptual discussions and self-monitoring, which are all considered to be benefits of peer learning. As such, the authors suggest that collaborative-learning activities be designed that prompt students to become aware of their learning and to engage them in questioning and explaining phenomena at a deeper conceptual level. They suggest research is needed into the ways peer leaders can be trained to facilitate groups more effectively, to emphasise the importance of open questions and metacognitive awareness during PLTL sessions. The social and communicative skills that students develop through these kinds of activities are clearly beneficial in preparing students for collaborative working in professional settings, which is interesting to those designing degree programmes for the future." -- Direct quote from blog posting

Reisel, J. R., Jablonski, M., & Munson, E. (2013). *A study of the impact of Peer-Led Team Learning on the first-year math course performance of engineering students*. Conference Proceedings of the American Society for Engineering Education Conference. Available online: https://scholar.google.com/scholar?start=50&q=%22Peer-Led+Team+Learning%22&hl=en&as_sdt=0,24&as_ylo=2013

As part of an NSF-sponsored STEP grant, formal peer-led team learning (PLTL) groups were created for first-year engineering and computer science students. The groups were organized around the math course taken by the students so that all students in a particular group were taking the same math course. In both the 2010-11 and 2011-12 academic years, these groups were offered as a formal class, with students receiving a grade based upon participation. This was done to stress the importance of the groups to the students, and increase the level of participation by the students. Work with the groups in previous years showed that increased levels of participation led to greater impacts on student grades. Approximately 73% of the first-year students in engineering and computer science participated in these PLTL groups in 2010-11, with most students attending most of the weekly sessions. This participation rate increased to 82% in 2011-12. The impact of the PLTL groups on students in Calculus-level classes (Calculus I and II) was strong. When compared to all students in the Calculus courses who did not participate in the PLTL groups, the grades of the students who participated in the PLTL groups were generally 0.4-0.7 points (on a 4-point scale) higher. However, the results at the Pre-Calculus level (College Algebra and Trigonometry) were not as impressive. Students in the PLTL groups in College Algebra only had average grades 0.2 points higher than nonparticipants, while the Trigonometry students demonstrated little impact from the PLTL groups. This difference may be a result of the students' self-perceived need for the PLTL groups, with Calculus-level students seeing a greater need for the groups. In this paper, the format of the PLTL groups is described in detail, and a detailed analysis of the impact of the PLTL groups on the student grades is presented.

Repice, M. D., Sawyer, R. K., Mogrebe, M. C., Brown, P. L., Luesse, S. B., Gealy, D. J., & Frey, R. F. (2016). Talking through the problems: Study of discourse in Peer-Led Team Learning small groups. *Chemistry Education Research and Practice*, 2.

Increasingly, studies are investigating the factors that influence student discourse in science courses, and specifically the mechanisms and discourse processes within small groups, to better understand the learning that takes place as students work together. This paper contributes to a growing body of research by analyzing how students engage in conversation and work together to solve problems in a peer-led small-group setting. This qualitative study evaluates video of Peer-Led Team Learning (PLTL) sessions in general chemistry, with

attention to both the activity structures and the function of discourse as students undertook different types of problems across one semester. Our findings suggest that students talk their way through the problems; practicing a combination of regulative and instructional language to manage the group dynamics of their community of peer learners while developing and using specific disciplinary vocabulary. Additionally, student discourse patterns revealed a focus on the process of complex problem-solving, where students engage in joint decision-making by taking turns, questioning and explaining, and building on one another's ideas. While students in our study engaged in less of the deeper, meaning-making discourse than expected, these observations about the function of language in small-group learning deepens an understanding of how PLTL and other types of small-group learning based on the tenets of social constructivism may lead to improvements in science education, with implications for the structure of small-group learning environments, problem design, and training of peer group leaders to encourage students to engage in more of the most effective discourse in these learning contexts.

Robert, J., Lewis, S. E., Oueini, R., & Mapugay, A. (2016). Coordinated implementation and evaluation of flipped classes and Peer-Led Team Learning in General Chemistry. *Journal of Chemical Education*. doi: 10.1021/acs.jchemed.6b00395. Available online: <http://pubs.acs.org/doi/abs/10.1021/acs.jchemed.6b00395>.

The research-based pedagogical strategy of flipped classes has been shown to be effective for increasing student achievement and retention in postsecondary chemistry classes. The purpose of flipped classes is to move content delivery (e.g., lecture) outside of the classroom, freeing more face-to-face time for active learning strategies. The opportunity to engage in active learning with students can be a challenge for instructors of large classes (more than 100 students). Furthermore, there has been little discussion in the chemical education literature to provide instructors with detailed descriptions of successful implementations of flipped classes combined with active learning in large classes. To this end, this report provides a comprehensive description and evaluation of a coordinated implementation of flipped classes with peer-led team learning (PLTL) for second-semester general chemistry with class sizes greater than 200 students. This approach is described as "Flipped PLTL". This report includes details about creation of videos for flipped instruction, class structure, and the recruiting and training of peer leaders. The purpose of this paper is to provide an example of flipped classes with PLTL that can guide other instructors who wish to implement these pedagogies in large classes.

Robert, J., Lewis, S. E., Queini, R., & Mapugay, A. (2016). Coordinated implementation and evaluation of flipped classes and Peer-Led Team Learning in general chemistry. *Journal of Chemical Education*, 93(12), 1993-1998. doi: 10.1021/acs.jchemed.6b00395.

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with PLTL that can guide other instructors who wish to implement these pedagogies in large classes.

Rodriguez, N., Cruz, A., Sardinias, S., & Ramon, A. (2016). *Peer leaders' perceptions of learning experiences*. Paper presented at the 2016 Conference for Undergraduate Research at Florida International University, FL. Available online:

<http://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1057&context=fiu-undergraduate-research-conference>.

Peer-Led Team Learning (PLTL) at Florida International University maintains a large volume of student and Peer Leader (PL) participation. Students, who participate in PLTL, on average, perform a letter grade better than their peers who do not participate in PLTL. To analyze PL perspectives on learning, a survey was conducted. The survey had a series of Likert scale statements and free response questions on learning. The nature of the questions are regarding barriers in education, individual learning strengths and weaknesses, and the perception that PLTL improved the learner's capabilities to overcome these obstacles. Based on the survey responses, PLs perceive an improvement in the way they learn during and/or after becoming a PL. Students participating in PLTL exhibited an increase in course content retention and perceived improvement in study skills. Students in PLTL also perceived the PLTL workshop environment to be comfortable enough to address questions and misconceptions.

Roth, V., Goldstein, E., & Marcus, G. (Eds.). (2001). *Peer-Led Team Learning: A handbook for team leaders*. Upper Saddle River, NJ: Prentice Hall

This book provides strategies for implementing the Peer-Led Team Learning (PLTL) program by other educators. This book offers suggestions for successful implementation including how to write effective group problems and how to train peer leaders.

Rovner, S. L. (2005). Tips for teachers. *Chemical & Engineering News*, 83(30), 55-57. Available online: <http://pubs.acs.org/cen/education/83/8330education.html>.

Rovner, S. L. (2009). High jinks boost chemical learning. *Chemical Engineering News*, 87(16), 46-47. doi: 10.1021/cen-v087n016.p046.

Instructors need to impart plenty of heavy concepts to their chemistry students, but there's no reason they can't have a little light fun in the process. Even better, there's evidence that a playful approach can pay dividends in terms of student comprehension, according to several posters presented before the Division of Chemical Education during last month's American Chemical Society national meeting in Salt Lake City. The approaches described in these posters are enough to elicit a giggle, or at least an appreciative groan: Classroom activities include games dubbed "Al-mole-st Dead," "Krispy Khem Donut Races," and "Chemistry Battleship"; a competition called "Cake or Death"; and an exercise called "Body Geometry." All of these activities were developed by undergraduate students mentored by James E. Becvar, a chemistry professor at the University of Texas, El Paso (UTEP). Becvar is a devotee of peer-led team learning (PLTL),

Russell, C. B., & Weaver, G. C. (2011). A comparative study of traditional, inquiry-based, and research-based laboratory curricula: impacts on understanding of the nature of science.

Chemistry Education Research and Practice, 12, 57-67. doi: 10.1039/C1RP90008K. Available online: <http://pubs.rsc.org/en/content/articlepdf/2011/RP/C1RP90008K>.

We explored the impact of laboratory curriculum on students' understanding of the nature of science at five US universities. The specific curricula studied were traditional (verification), inquiry-based, and research-based. The inquiry curriculum was *Inquiries into Chemistry*, and the research-based curriculum was developed by the Center for Authentic Science Practice in

Education (CASPiE). Our findings suggest that laboratory curriculum is a strong factor in the development of students' discussions of theories and their conceptions of creativity in science. Students in the research-based laboratory curriculum demonstrated the most gains as a result of their laboratory when compared to their counterparts in the traditional and inquiry-based laboratories.

Samaroo, D. (2012). *Peer-Led Team Learning: A general chemistry approach*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Samaroo-2012.docx>

Peer-led team learning (PLTL) has been implemented in General Chemistry at New York City College of Technology. The approach used in chemistry involves workshops consisting of problem sets developed by the Chemistry course instructor. These problem sets include textbook problems as well as practice examination questions. The effectiveness of peer-led team learning at New York City College of Technology entails that attendance is required, as opposed to encouraged at workshops. Comparative data prior to and after implementation of PLTL will demonstrate improvement in grades as well as understanding chemical concepts.

Sandler, C. R., & Salvatore, J. A. (2013). Peer-led study groups as learning communities in the natural sciences. In R. E. Yager (Ed.), *Exemplary college science teaching* (pp. 47-60): NSTA Press

At the University of Michigan in Ann Arbor (UM) created the Peer-Led Study Group (PLSG) program to support student academic achievement through its sponsorship by the Science Learning Center. The PLSG employs over 250 high-achieving undergraduates each term to facilitate nearly 300 groups meeting weekly. While participation is voluntary, missing two weekly sessions precludes further attendance for the academic term. This program provides a smaller learning space than the large lecture halls that are prevalent for the introductory sciences courses. Three full-time staff members lead the program. Twenty different science courses are supported. PLSG shares common practices with Supplemental Instruction, Peer-led Team Learning, and Northwestern University's Gateway Science Program, to name a few. Satisfaction surveys of participants rated effectiveness of the program with over 92% of the students. Studies also identified personal and professional growth by the study group leaders.

Sarquis, J. L., & Detchon, J. C. (2006). *The PLTL experience at Miami University*. Miami University. Oxford, OH.

In comparison with other sections of general chemistry, the population of the Peer-led Team Learning (PLTL) class has a statistically significant difference in Math SAT scores (588, PLTL; 625 and 620 non-PLTL; $p = .005$). Students in three sections were given the ACS First-Semester General Chemistry Exam, and it was found that the PLTL section did score lower, but the difference was not statistically significant (44.1, PLTL; 45.1 and 47.0, non-PLTL; $F(2, 400) = 2.276$, $p = .05$). Therefore the conclusion of the researchers is that the PLTL model is boosting the performance of the PLTL student to a level almost comparable to their counterparts in the traditional course even though the PLTL students are "at risk" based on their math preparation that has been known to be a predictor for success in general chemistry.

Sarquis, J. L., Dixon, L. J., Gosser, D. K., Kampmeier, J. A., Roth, V., Strosak, V. S., & Varman-Nelson, P. (2001). The workshop project: Peer-Led Team Learning in chemistry. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student assisted teaching: A guide to faculty-student teamwork* (pp. 150-155). Bolton, MA: Anker Publishing Company

This book chapter describes the Peer-Led Team Learning (PLTL) program as it is used with a chemistry course.

Sawyer, K., Frey, R., & Brown, P. (2013). Peer-led Team Learning in general chemistry. In D. D. Suthers (Ed.), *Productive multivocality by the analysis of group interactions, computer-supported collaborative learning series 16* (pp. 183-190). New York, NY: Springer Science+Business Media. doi:10.1007/978-1-4614-8960-3_9.

This chapter describes the setting and context of the discourse that occurs during Peer-led Team Learning in first-year General Chemistry at Washington university in St. Louis. PLTL is designed to facilitate chemistry literacy and success for all students, not only for chemistry majors by supplementing the lecture with formalized study groups that provide opportunities for active and collaborative learning.

Sawyer, K., Frey, R., & Brown, P. (2013). Knowledge building discourse in Peer-led Team Learning Groups in first-year general chemistry. In D. D. Suthers (Ed.), *Productive multivocality by the analysis of group interactions, computer-supported collaborative learning series 16* (pp. Chapter 10). New York, NY: Springer Science+Business Media. doi:10.1007/978-1-4614-8960-3_9.

To better understand the interactional mechanisms that make PLTL effective, we closely examined videotapes of two PLTL groups as they both solved the same chemistry problem. In one group, students engaged in group knowledge building: intellectual conversations where they asked each other questions, provided procedural and conceptual explanations, and closely monitored each others' understanding of the problem. This led to an increasingly accurate understanding of the problem. In the contrasting group, their conversations focused on rote application of formulas as they worked to calculate a "correct" solution. Our analyses help us to understand what effective collaborative discourse looks like, and have practical implications for how peer leaders are trained and for how peer groups are organized.

Sawyer, K., Frey, R., & Brown, P. (2013). Knowledge building discourse in Peer-Led Team Learning (PLTL) groups in first-year general chemistry. In D. D. S. e. a. (*eds). (Ed.), *Productive multivocality in the analysis of group interactions. Computer-supported collaborative learning series 16* (pp. 191-204). New York, NY: Springer Science+Business Media

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Schaber, P. M., Dinan, F. J., St. Phillips, M., & Larson, R. (2011). Juicing the juice: A laboratory-based case study for an instrumental analytical chemistry course. *Journal of Chemical Education*, 88(4), 496-498. doi: 10.1021/ed100863d. Available online:

https://www.researchgate.net/publication/231268961_Juicing_the_Juice_A_Laboratory-Based_Case_Study_for_an_Instrumental_Analytical_Chemistry_Course.

A young, inexperienced Food and Drug Administration (FDA) chemist is asked to distinguish between authentic fresh orange juice and suspected reconstituted orange juice falsely labeled as fresh. In an advanced instrumental analytical chemistry application of this case, inductively coupled plasma (ICP) spectroscopy is used to distinguish between the fresh and reconstituted samples based on their calcium and magnesium concentrations. Students working in teams are given the challenge posed in the case to the FDA chemist. They are charged with designing an

experimental procedure, obtaining and analyzing the needed data, and writing a formal report. This case study requires students to conduct themselves in the same manner chemists would in the “real world” when faced with a new and challenging problem. Experimental procedures developed by student teams lead to the correct identification of unknowns a majority of the time. Assessment data indicate this case study elicited positive interest and interactions.

Schray, K., Russo, M. J., Egolf, R., Lademan, W., & Gelormo, D. (2009). Are in-class peer leaders effective in the Peer-led Team Learning approach? *Journal of College Science Teaching*, 38(4), 62-67.

Peer-led team learning (PLTL) has been widely adopted for enhanced learning in a variety of disciplines, mostly in introductory chemistry, but also in organic chemistry, as in this study (Tien, Roth, and Kampmeier 2002). This pedagogical approach forms student groups led by students who have previously done well in the course (standard peer leaders). This study shows that in-class peer leaders (students currently taking the class) can perform as effectively as standard peer leaders, enabling easier implementation of this pedagogy. (Contains 4 tables and 1 figure.)

Shapiro, C., Ayon, C., Moberg-Parker, J., Levis-Fitzgerald, M., & Sanders, E. R. (2013). Strategies for using peer-assisted learning effectively in an undergraduate bioinformatics course. *Biochemistry and Molecular Biology Education*, 41(1), 24-33. doi: 10.1002/bmb.20665. Available online: <http://onlinelibrary.wiley.com/doi/10.1002/bmb.20665/epdf>.

This study used a mixed methods approach to evaluate hybrid peer-assisted learning approaches incorporated into a bioinformatics tutorial for a genome annotation research project. Quantitative and qualitative data were collected from undergraduates who enrolled in a research-based laboratory course during two different academic terms at UCLA. Findings indicate that a critical feature of the peer-assisted learning approach is to have near-peer leaders with genome annotation experience, allowing them to communicate technical and conceptual aspects of the process in the context of a research project (a.k.a., the “big picture”). These characteristics are important for creating connections between the wet lab experiments and the computer lab activities, engendering excitement about the research project and fostering engagement in bioinformatics as a discipline. Likewise, it is essential to couple tutorial training in genome annotation with appropriate instructional materials, providing detailed, step-by-step instructions for database navigation. Finally, the assessment results support this hybrid peer-assisted learning approach as a model for undergraduates to successfully learn bioinformatics in a course setting.

Shields, S. P., Hoglebe, M. C., Spees, W. M., Handlin, L. B., Noelken, G. P., Riley, J. M., & Frey, R. F. (2012). A transition program for underprepared students in general chemistry: Diagnosis, implementation, and evaluation. *Journal of Chemical Education*, 89(8), 995-1000. doi: 10.1021/ed100410.

We developed an online exam to diagnose students who are underprepared for college-level general chemistry and implemented a program to support them during the general chemistry sequence. This transition program consists of extended-length recitations, peer-led team-learning (PLTL) study groups, and peer-mentoring groups. We evaluated this program's impact on student performance in general chemistry using data from the fall semesters 2007, 2008, and 2009. We found that our transition program helped the underprepared students make significant gains in their course performance relative to other students when controlling for prior content knowledge and experience. PLTL did improve the performance of the underprepared students relative to other students in the lower 40% of the class. Inclusion of peer mentoring resulted in additional gains over the use of PLTL. Via surveys to students in the transition program, students agreed or strongly agreed that extended-length recitations and peer-

mentoring groups improved their performance in general chemistry. This is important given the voluntary nature of our program.

Sibert, J., Goeckner, M., Galley, D., & Goldammer, K. (2013). *Lowering barriers to enhance 2 + 2 transfer student success, persistence, and retention: The Dallas STEM Gateways Collaborative*. Conference Proceedings of the 2013 ASEE Gulf Southwest Annual Conference, Arlington, TX. Available online:

http://aseegsw.com/past%20Proceedings/2013%20Proceedings/Abst_galley.pdf

The University of Texas at Dallas, Collin College, and Richland College of the Dallas County Community College District have established a joint effort, the NSF-sponsored Dallas STEM Gateways Collaborative, to significantly increase the number of undergraduate students completing degrees in Science, Technology, Engineering, and Mathematics (STEM) in the North Texas region. Building upon previous cooperation among these three institutions and the remarkable concentration of high-tech businesses in the Dallas-Fort Worth Metroplex, the Collaborative has implemented best-practice methods to bring about a cultural change that will lead to a sustained increase in the production of STEM-trained graduates. First, the Collaborative has strengthened recruitment into introductory STEM courses and expanded the use of student mentoring within those courses to encourage student selection of STEM majors and classroom success. Second, it has increased opportunities for internships and undergraduate research experiences for students early in their college career to encourage students to remain committed to the pursuit of STEM majors. Finally, a concerted effort of curriculum alignment across all STEM fields at the three participating institutions combined with a formal professional development program aimed at spreading effective pedagogical techniques across all three institutions has been designed to enhance teaching effectiveness at the critical introductory level. The Dallas STEM Gateways Collaborative program is built to enhance the number, quality, and diversity of undergraduates successfully earning STEM degrees.

Sidoine, G. (2009). Running a good workshop takes more than training the Peer Leader. *Peer-Led Team Learning: Leader training. Progressions: The Peer-Led Team Learning Project Newsletter, 10(4)*. Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Sidoine-Running-a-Workshop.pdf>.

The Peer-led Team Learning (PLTL) research project was based on observations of the author while leading a Mathematics Workshop over a 15-week period during the Spring 2009 semester, as well as readings based on materials presented in an independent study course required for first-time Peer Leaders. The objective of the independent study course is to equip workshop leaders with the necessary skills and competence to facilitate peer-assisted learning apart from the classroom settings. The workshop leader is provided with the flexibility to implement techniques and ideas about learning. This helps to discover the hidden ability in the students and to allow them to discover different ways of learning the course material.

Sisman, E. N. E., Cigdemoglu, C., & Geban, O. (2019). Investigation of the effect of Peer-Led Team Learning Model on university students' exam achievement in general chemistry. *Bartın University Journal of Faculty of Education, 7(2)*, 636-664. Available online: <https://dergipark.org.tr/tr/download/article-file/494963>.

The purpose of this study was to compare freshmen engineering students' exam achievement in general chemistry course using peer-led team learning model and traditional instruction and to investigate the effect of this model on different achieving level students. A total of 128 students who were instructed by the same professor participated in the study. Throughout the semester, Peer-Led Team Learning (PLTL) model was implemented in the experimental group while traditional instruction was used in the control group. 14 peer leaders who have successfully

completed general chemistry course in previous semester have been trained on basic communication and pedagogy issues and they have supported their teams in problem solving. Both experimental and control group students took the same mid-terms and final exam. The data were analyzed by two-way analysis of variance (ANOVA). Consequently, although there was no statistically significant main effect of teaching methods, due to statistically significant interaction effect, it was found that low and medium achievers' general chemistry exam grades were statistically higher in PLTL group than those of traditional group; however, there was no statistically significant mean difference in high achievers' grades between PLTL and traditional instruction groups.

Sloane, J. D. (2016). *The influence Of Peer-Led Team Learning on underrepresented minority student achievement in introductory biology and recruitment and retention in science, technology, engineering, and mathematics majors*. (Doctoral dissertation), Syracuse University, Syracuse, NY. Available online:

<http://surface.syr.edu/cgi/viewcontent.cgi?article=1607&context=etd>

Increasing underrepresented minority (URM) participation in science, technology, engineering, and mathematics (STEM) is of increasing national importance as the United States continues to fall behind other nations in global economic competitiveness. These students constitute a large pool of potential STEM majors at the college level, but they have been recruited to and retained in STEM programs at significantly lower rates than students from other populations. As such, President Barack Obama's President's Council of Advisors on Science and Technology (PCAST) has called on undergraduate science instructors to diversify their teaching methods and employ active learning strategies to improve students' success in introductory or "gatekeeper" courses as well as improving students' attitudes toward STEM. As a strategy that fosters active learning, Peer-Led Team Learning (PLTL) holds the potential to provide much of what PCAST deems necessary to improve URM student performance in introductory courses and retention in STEM majors. In the first of two studies presented herein, we found the PLTL model to be effective in improving scores for both URM and non-URM students in an introductory college science course. In the second study, we found PLTL to be associated with higher levels of retention among URM students. We conclude that participation in PLTL can help URM students who may struggle to identify with STEM to develop stronger STEM identities, which, along with higher achievement, may lead to enhanced retention.

Smith, A. C., Stewart, R., Shields, P., Hayes-Klosteridis, J., Robinson, P., & Yuan, R. (2005). Introductory biology courses: A framework to support active learning in large enrollment introductory science courses. *CBE-Life Education*, 4(2), 143-156. doi: 10.1187/cbe.04-08-0048. Available online: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1103716/>.

Active learning and research-oriented activities have been increasingly used in smaller, specialized science courses. Application of this type of scientific teaching to large enrollment introductory courses has been, however, a major challenge. The general microbiology lecture/laboratory course described has been designed to incorporate published active-learning methods. Three major case studies are used as platforms for active learning. Themes from case studies are integrated into lectures and laboratory experiments, and in class and online discussions and assignments. Students are stimulated to apply facts to problem-solving and to learn research skills such as data analysis, writing, and working in teams. This course is feasible only because of its organizational framework that makes use of teaching teams (made up of faculty, graduate assistants, and undergraduate assistants) and Web-based technology. Technology is a mode of communication, but also a system of course management. The relevance of this model to other biology courses led to assessment and evaluation, including an analysis of student responses to the new course, class performance, a university course evaluation, and retention of course learning. The results are indicative of an increase in student

engagement in research-oriented activities and an appreciation of real-world context by students.

Smith, J., Wilson, S. B., Banks, J., Zhu, L., & Varma-Nelson, P. (2014). Replicating Peer-Led Team Learning in cyberspace: Research, opportunities, and challenges. *Journal of Research in Science Teaching*, 51(6), 714-740. doi: 10.1002/tea.21163. Available online: <http://onlinelibrary.wiley.com/doi/10.1002/tea.21163/full>.

This quasi-experimental, mixed methods study examined the transfer of a well-established pedagogical strategy, Peer-Led Team Learning (PLTL), to an online workshop environment (cPLTL) in a general chemistry course at a research university in the Midwest. The null hypothesis guiding the study was that no substantive differences would emerge between the two workshop settings. Students in the PLTL (n = 220) condition were more satisfied with their workshop and earned statistically significantly higher course grades, yet earned comparable standardized final exam scores. They also had lower incidence of students' earning D or F course grades or withdrawing from the course (DFW rates) than students in the cPLTL setting (n = 175). Interviews with 10 peer leaders and 2 faculty members, as well as discourse analysis of workshop sessions, revealed more similarities than differences in the two conditions. The final exam scores and discourse analysis support the null hypothesis and use of both face-to-face and synchronous online peer-led workshops in early science courses

Snyder, J. J. (2012). *Peer Led Team Learning in introductory biology: Effects on critical thinking skills*. (Ph.D. dissertation), Syracuse University, Syracuse, NY. Available online: http://surface.syr.edu/scied_etd/22/

This study evaluated the potential effects of the Peer-Led Team Learning (PLTL) instructional model on undergraduate, biology peer leaders' critical thinking skills. This investigation also explored peer leaders' perceptions of their critical thinking skills. A quasi-experimental pre-test/post-test with control group design was used to determine critical thinking gains in PLTL/non-PLTL groups. Critical thinking was assessed using the California Critical Thinking Skills Test (CCTST) among participants who had previously completed and been successful in the second semester of a two-semester introductory biology course sequence. Qualitative data from open-ended questionnaires confirmed that factors thought to improve critical thinking skills such as interaction with peers, problem solving, and discussion were perceived by participants to have an impact on critical thinking gains. However, no significant quantitative differences in peer leaders' critical thinking skills were found between pre- and post-treatment CCTST measurements nor between experimental and control groups. Additionally, students led by peer leaders attained significantly higher exam and final course grades in introductory biology than similar students not participating in PLTL. Finally, among introductory biology students who opted not to enroll in the associated lab course, those who participated in PLTL averaged more than a letter grade higher than those who did not, and this difference was statistically significant.

Snyder, J. J., Carter, B. E., & Wiles, J. R. (2015). Implementation of the Peer-Led Team Learning instructional model as a stopgap measure improves student achievement for students opting out of laboratory. *CBE-Life Education*, 14(1). doi: 10.1187/cbe.13-08-0168. Available online: <http://www.lifescied.org/content/14/1/ar2.full.pdf+html>.

In entry-level university courses in science, technology, engineering, and mathematics fields, students participating in associated laboratory sessions generally do better than those who have no related lab classes. This is a problem when, for various reasons, not enough lab sections can be offered for students and/or when students opt out of optional available lab courses. Faced with such a situation, this study evaluated the efficacy of the peer-led team-learning (PLTL) instructional model as a potential method for narrowing the achievement gap among undergraduate students electing not to enroll in an optional laboratory component of an

introductory biology course. In peer-led workshops, small groups of students participated in solving problems and other activities that encouraged active learning. Students led by peer leaders attained significantly higher exam and final course grades in introductory biology than comparable students not participating in PLTL. Among the introductory biology students who opted not to enroll in the optional lab course, those who participated in PLTL averaged more than a letter grade higher than those who did not. This difference was statistically significant, and the PLTL workshops almost entirely closed the achievement gap in lecture exam and final grades for students who did not take the lab.

Snyder, J. J., Sloane, J. D., Dunk, R. D. P., & Wiles, J. R. (2016). Peer-Led Team Learning helps minority students succeed. *PLOS Biology*, *14*(3). doi: 10.1371/journal.pbio.1002398. Available online: <http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002398>. Active learning methods have been shown to be superior to traditional lecture in terms of student achievement, and our findings on the use of Peer-Led Team Learning (PLTL) concur. Students in our introductory biology course performed significantly better if they engaged in PLTL. There was also a drastic reduction in the failure rate for underrepresented minority (URM) students with PLTL, which further resulted in closing the achievement gap between URM and non-URM students. With such compelling findings, we strongly encourage the adoption of Peer-Led Team Learning in undergraduate Science, Technology, Engineering, and Mathematics (STEM) courses.

Snyder, J. J., & Wiles, J. R. (2015). Peer Led Team Learning in introductory biology: Effects on peer leader critical thinking skills. *PLOS One*. doi: 10.1371/journal.pone.0115084. Available online: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0115084>. This study evaluated hypothesized effects of the Peer-Led Team Learning (PLTL) instructional model on undergraduate peer leaders' critical thinking skills. This investigation also explored peer leaders' perceptions of their critical thinking skills. A quasi-experimental pre-test/post-test with control group design was used to determine critical thinking gains in PLTL/non-PLTL groups. Critical thinking was assessed using the California Critical Thinking Skills Test (CCTST) among participants who had previously completed and been successful in a mixed-majors introductory biology course at a large, private research university in the American Northeast. Qualitative data from open-ended questionnaires confirmed that factors thought to improve critical thinking skills such as interaction with peers, problem solving, and discussion were perceived by participants to have an impact on critical thinking gains. However, no significant quantitative differences in peer leaders' critical thinking skills were found between pre- and post-experience CCTST measurements or between experimental and control groups.

Sperry, R. A., & Tedford, P. (2008). Implementing peer-led team learning in introductory computer science courses. *Journal of Computing Sciences in Colleges*, *23*(6), 30-35. This paper describes the implementation of Peer-Led Team Learning (PLTL) in the first two introductory programming courses at Texas A&M University - Corpus Christi in an attempt to attract and retain competent computer science majors through cooperative and active learning sessions. Preliminary results suggest that the students participating in the PLTL program are directly benefiting from the learning experiences facilitated by the peer leaders.

Staff. (2005). Peer-led Team Learning, fewer lectures: More learning. *The Teaching Professor*, *16*(3), 5.

This short article describes Peer-led Team Learning (PLTL). Results from a general chemistry class indicate that participants earned higher final course grades.

Stanich, C. A., Pelch, M. A., Theobald, E. J., & Freeman, S. (2018). A new approach to Supplementary Instruction narrows achievement and affect gaps for underrepresented minorities, first-generation students, and women. *Chemistry Education Research and Practice*, 19(3), 846-866. doi: 10.1039/C8RP00044A. Available online <https://kopernio.com/viewer?doi=10.1039/C8RP00044A&route=5>.

To help students who traditionally underperform in general chemistry, we created a Supplementary Instruction (SI) course and called it the STEM-Dawgs Workshops. These workshops are an extension of the Peer-led Team Learning (PLTL) SI. In addition to peer-facilitated problem-solving, we incorporated two components inspired by learning sciences: (1) training in research-based study skills, and (2) evidence-based interventions targeting psychological and emotional support. Here we use an explanatory mixed methods approach to measure the impact of the STEM-Dawgs Workshops, with a focus on four sub-populations that are historically underrepresented in Chemistry: underrepresented minorities, females, low-income students, and first-generation students. Specifically, we compared three groups of students in the same General Chemistry course: students in general chemistry and not the workshops ("Gen Chem students"), students in the workshops ("STEM-Dawgs"), and students who volunteered for the workshops but did not get in ("Volunteers"). We tested hypotheses with regression models and conducted a series of focus group interviews with STEM-Dawgs. Compared to the Gen Chem population, the STEM-Dawg and Volunteer populations were enriched with students in all four under-represented sub-populations. Compared to Volunteers, STEM-Dawgs had increased exam scores, sense of belonging, perception of relevance, self-efficacy, and emotional satisfaction about chemistry. URM STEM-Dawgs had lower failure rates, and exam score achievement gaps that impacted first-generation and female Gen Chem students were eliminated in the STEM-Dawg population. Finally, female STEM-Dawgs had an increased sense of belonging and higher emotional satisfaction about chemistry than women Volunteers. Focus groups suggested that successes came in part from the supportive peer-learning environment and the relationships with peer facilitators. Together, our results indicate that this supplementary instruction model can raise achievement and improve affect for students who are underrepresented in chemistry.

Stanlec, A. C., & Doerr, H. M. (2012). *Flexible and sustainable interventions for mathematics support of first-year students*. Conference Proceedings of the American Society for Engineering Education 2012 Annual Conference. Available online: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CGUQFjAA&url=http%3A%2F%2Fwww.asee.org%2Ffile_server%2Fpapers%2Fattachment%2Ffile%2F0002%2F2920%2FASEE_Final_Draft.pdf&ei=5k0WUKnyPlaa9gTknoGYBA&usq=AFQjCNG-87XAz4jYI9F93arWeWB7dw5YqA

According to the researchers, initial results from Syracuse University were surprising, promising, and provide directions for future work. They adapted the Peer-led Team Learning (PLTL) model for use at their institution. They named their program Peer-Led Study Groups (PLSG). One of the most surprising results of our pilot was the overall low participation in the pre-Calculus PLSGs but satisfactory participation in the Calculus I PLSGs. The researchers anticipated that students would take advantage of the flexible nature of the PLSGs and move in and out of different sessions based on their needs throughout the semester. However, the students who participated in the PLSGs were largely those who came at the beginning of the semester and continued to attend for the entire semester. The Calculus I students were engaged from the beginning and continued to utilize the PLSGs throughout the semester while the pre-Calculus PLSGs never seemed to gain momentum and saw only sporadic attendance. Another surprise was that the Facebook pages and the virtual office hours did not see a lot of use by the students. The researchers expected that students would want to communicate in real-time with their peer facilitator and would utilize social media for that purpose. One of the most promising

results is the overwhelming feedback from both the students and the peer facilitators regarding the timeliness of the PLSG worksheets. The learning specialists worked closely with the pre-Calculus and Calculus I professors to coordinate the worksheets and help prepare the facilitators in the material. Another promising result is that the PLSGs were able to be responsive to the needs of the students. Even though worksheets were available in the PLSGs, they often were only used as supplementary work after the students worked on actual homework problems. In addition, the PLSGs met multiple times per week in different formats, which allowed the peer facilitators to be available to the students at times when they needed it most. In contrast, the AEWs meet only once per week and students are required to complete the worksheets. This often leaves little to no time, or desire, to work on homework problems.

Steitwieser, B., & Light, G. (2010). When undergraduates teach undergraduates: Conceptions of and approaches in a peer led team learning intervention in the STEM disciplines: Results of a two year study. *Journal of Teaching & Learning in Higher Education*, 22(2), 346-356.
Use of PLTL to enhance learning for undergraduates in STEM disciplines

Stephenson, N. S., Miller, I., & Sadler-McKnight, N. (2019). Impact of Peer-Led Team Learning and the Science Writing and Workshop Template on the critical thinking skills of first-year chemistry students. *Journal of Chemical Education*, 96(5), 841-849. doi: 10.1021/acs.jchemed.8b00836.

The Peer-Led Team Learning (PLTL) and the Science Writing and Workshop Template (SWWT) are two active learning instructional approaches which combine writing, inquiry, collaboration, and reflection, elements which have been associated with critical thinking development. In this study, we used a quasi-experimental pretest–post-test design to investigate the impact of the implementation of these two approaches on the critical thinking skills of first-year chemistry students, measured using the California Critical Thinking Skills Test (CCTST). The results indicate that implementation of the PLTL and the SWWT instructional strategies led to significantly higher gains in critical thinking.

Stephenson, N. S., & Sadler-McKnight, N. (2016). Developing critical thinking skills using the Science Writing Heuristic in the chemistry laboratory. *Chemistry Education Research and Practice*, 17, 72-79. doi: 10.1039/C5RP00102A.

The Science Writing Heuristic (SWH) laboratory approach is a teaching and learning tool which combines writing, inquiry, collaboration and reflection, and provides scaffolding for the development of critical thinking skills. In this study, the California Critical Thinking Skills Test (CCTST) was used to measure the critical thinking skills of first year general chemistry students who were instructed using the SWH approach and first year general chemistry students who received traditional (TRAD) laboratory instruction. A quasi experimental pretest–posttest design involving the use of matched groups was used to assess differences in critical thinking between the two groups. Students in the SWH group had significantly higher total critical thinking scores over their traditional counterparts. The results indicate that the SWH approach shows efficacy in improving students' critical thinking skills over the traditional approach.

Stewart, B. (2005). Using InterChemNet to promote active learning curriculum development cycles. *Dissertation Abstracts International*, 65(12), 6384.

This dissertation, completed at the University of Maine (Orono, ME) in 2004 explored a number of topics including how InterChemNet had been used to manage and evaluate the Peer-led Team Learning (PLTL) program in the general chemistry lecture course at the university. ICN was used to deliver PLTL workshops, record attendance, and evaluate student understanding of workshop content as well as monitor student attitudes. Results shows significant increases in student grades and retention rates. The analysis considered factors such as previous GPS, high

school rank, and SAT scores. Student and leader attitudes towards PLTL were also documented.

Stewart, B., Kirk, R., LaBrecque, D., & Bruce, M. (2006). InterChem Net: An integrated instrumentation a course management system for general chemistry. *Journal of Chemical Education*, 83(3), 494-. Available online: https://www.researchgate.net/publication/242484186_InterChemNet_An_Integrated_Instrumentation_and_Web-based_Course_Management_System_for_the_General_Chemistry_Laboratory. InterChemNet system ws designed to overcome barriers for providing an active learning environment in a large chemistry class.

Stewart, B. N., Amar, F. C., & Bruce, M. R. (2007). Challenges and rewards of offering peer-led team learning (PLTL) in a large general chemistry course. *Australian Journal of Education in Chemistry*, 67, 31-36.

Stewart, B. N., Amar, F. G., & Bruce, M. R. M. (2004). *Measuring the effect of PLTL in a large general chemistry course*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Chemistry, University of Maine, Orono, ME 04469, mbruce@maine.edu
Peer-led Team Learning (PLTL) was used in a general chemistry course at the University of Maine. PLTL was first implemented in 2000. Research studies suggest increased student grades and retention rates. The analysis included variables of previous GPA, high school rank, and SAT scores.

Stewart, D. W., Brown, S. D., Clavier, C. W., & Wyatt, J. (2011). Active-learning processes used in US pharmacy education. *American Journal of Pharmaceutical Education*, 75(4), Article 68. doi: 10.5688/ajpe75468. Available online: <http://www.ajpe.org/doi/abs/10.5688/ajpe75468>.
Objective. To document the type and extent of active-learning techniques used in US colleges and schools of pharmacy as well as factors associated with use of these techniques. Methods. A survey instrument was developed to assess whether and to what extent active learning was used by faculty members of US colleges and schools of pharmacy. This survey instrument was distributed via the American Association of Colleges of Pharmacy (AACP) mailing list. Results. Ninety-five percent (114) of all US colleges and schools of pharmacy were represented with at least 1 survey among the 1179 responses received. Eighty-seven percent of respondents used active-learning techniques in their classroom activities. The heavier the teaching workload the more active-learning strategies were used. Other factors correlated with higher use of active-learning strategies included younger faculty member age (inverse relationship), lower faculty member rank (inverse relationship), and departments that focused on practice, clinical and social, behavioral, and/or administrative sciences. Conclusions. Active learning has been embraced by pharmacy educators and is used to some extent by the majority of US colleges and schools of pharmacy. Future research should focus on how active-learning methods can be used most effectively within pharmacy education, how it can gain even broader acceptance throughout the academy, and how the effect of active learning on programmatic outcomes can be better documented.

Stewart-Gardiner. (2010). Using peer led team learning to assist in retention in computer science classes. *Journal of Computing Sciences in Colleges*, 25(3), 164-171.
Recent work in Peer Led Team Learning (PLTL) has resulted in development of strategies and exercises for implementation of PLTL in the first course in Computer Science as well as two higher-level undergraduate courses at a public university with a largely commuter student

population. Initial results identify many reasons why students are unable to take full benefit from offered PLTL Workshops, while demonstrating the significant advantages that junior and senior Computer Science majors feel they received from the PLTL experience. Suggestions for future success with PLTL are included.

Stigmar, M. (2016). Peer-to-peer teaching in higher education: A critical literature review. *Mentoring & Tutoring: Partnership in Learning*, 24(2), 124-136. doi: 10.1080/13611267.2016.1178963.

The aim of my critical literature review is to identify studies where students are engaged as partners in teaching in higher education and to analyze how tutors and tutees benefit from peer teaching. Thirty studies were included for review. Thirteen countries are represented and two thirds of the studies conducted in the United States of America or the United Kingdom. There is a significant representation of studies from natural- and physical science. The dominating pedagogical belief and theory is social constructivism. The most frequent study design is the use of quasi-experimental pre- and post-testing. University teachers do not comprise the view of peer teaching necessarily resulting in greater academic achievement gains or deep learning. University teachers identify and esteem other pedagogical benefits such as improving students': critical thinking, learning autonomy, motivation, collaborative and communicative skills. The main finding of this review is the clarification that the training of generic skills benefits from peer teaching.

Stockwell, B. R., Stockwell, M. S., & Kiang, E. (2017). Group problem solving in class improves undergraduate learning. *ACS Central Science*, 3(6), 614-620. Available online: <https://pubs.acs.org/doi/full/10.1021/acscentsci.7b00133>.

Developing methods for improving student learning is a long-standing goal in undergraduate science education. However, the extent to which students working on problems in small groups versus individually results in improved learning among undergraduate science students has not been evaluated in a randomized controlled trial. We have performed such a trial with 80 students in an undergraduate biochemistry class, in which students were randomized to either learning in groups or learning individually. All students participated in the same class, which consisted of a lecture with periodic breaks for students to solve problems using an audience response system. Students in the individual learning condition answered these questions on their own, but students in the group-based learning condition answered these questions in an assigned group of four students. At the end of the class, all students then took the same exam as individuals. The exam had two types of questions—recall questions, in which students had to simply recall information provided to them, and predict questions, in which students had to apply their new knowledge to a new context. Students in the individual and group-based learning conditions performed similarly well on recall questions. However, students who had been in the group-based learning condition performed significantly better as individuals on the predict questions. This suggests that learning in groups may be more effective than individual learning for undergraduate science students, particularly for applying their knowledge to new contexts; this highlights the potential need for pedagogical approaches in undergraduate science courses that incorporate learning in groups.

Strozak, V. S. (2001). *Bringing Peer-led Team Learning to the community college: Starting a new initiative*. Conference Proceedings of the 222nd American Chemical Society National Meeting, Chicago, IL. For more information, contact the authors at the Center for Advanced Study in Education, The Graduate Center of the City University of New York, 365 Fifth Avenue, New York, NY 10016, vstrozak@gc.cuny.edu

Peer-led Team Learning (PLTL) has been used at institutions to support higher student achievement in chemistry courses. The model has been adapted for implementation at

community and technical colleges. Special issues regarding implementation at two-year institutions are discussed.

Strozak, V. S. (2003). *Peer-Led Team Learning: Research and evaluation*. Unpublished manuscript. City University of New York. New York, NY.

This article provides suggestions for evaluation of the Peer-Led Team Learning (PLTL) program. PLTL has established a separate web site that focuses on evaluation and research issues at <http://pltlresearch.org>

Strozak, V. S. (2003). *Peer-led Team Learning: A cooperative learning strategy that works*. Conference Proceedings of the 226th American Chemical Society National Meeting, New York, NY. For more information, contact the author at the Center for Advanced Study in Education, The Graduate Center of the City University of New York, 365 Fifth Avenue, New York, NY 10016, vstrozak@gc.buny.edu

Peer-Led Team Learning (PLTL) was used with introductory chemistry courses of the City University of New York. Research studies suggest that PLTL participants earn higher quality grades (A, B, or C), reducing withdrawal rates, and effectiveness with students with low and moderate ability.

Strozak, V. S. (2004). *Peer-led Team Learning evaluation and research: Past and present*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Center for Advanced Study in Education, The Graduate Center of the City University of New York, 365 Fifth Avenue, New York, NY 10016, vstrozak@gc.cuny.edu

Peer-led Team Learning (PLTL) was used in chemistry at the City University of New York. Analysis of a decade of data suggests the following: substantially more quality grades (A, B, C) and student attitudes.

Stry, M. V., Gaber, F., Sklensky, D., & Ude, M. (2019). Peer-Led Team Learning and course-based undergraduate research experiences in general biology and general chemistry. *FASEB Journal*, 33(1).

Lane College is a historically black college with a commitment to educating underserved minority students. Our overall goal for this project is to improve student learning of foundational concepts and retention in Biology and Chemistry through student-centered activities within our first-year courses. These approaches include implementation of peer-led team learning strategies and course-based undergraduate research experiences (CUREs) within the General Biology and General Chemistry courses. Our peer-mentors, who serve as supplemental instructors for our General Biology and Chemistry courses are an essential element for the success of the program. They receive leadership training, through a collaboration with the Office of the First Year Experience as well as mentored undergraduate research experiences before working with our first-year students. We have redesigned our laboratory courses to implement CUREs. Biology projects include comparative genomics in collaboration with the Genomics Education Partnership, environmental surveys of antibiotic resistant bacteria or sequence analysis of GAPC from plants growing on campus. Chemistry projects include development of novel analytical methods to measure chemical components of household products, such as using the iodine-clock reaction to determine the amount of starch in various foods. We are assessing student learning outcomes related to understanding the scientific method using the Experimental Design Ability Test and the CURE survey developed by the GEP. In addition, we are evaluating student learning outcomes of the process of science, such as development and testing of hypotheses, recording observations within a laboratory notebook, and communication of results through oral presentations and written reports.

Swarat, S., Drane, D., David, S. H., Light, G., & Pinto, L. (2004). Opening the gateway: Increasing minority student retention in introductory science courses. *Journal of College Science Teaching*, 34(1), 18-23.

The Gateway Science Workshop is a peer-facilitated, problem-focused program designed to improve student retention in the sciences. This article discusses its development, implementation, and efficacy, which is demonstrated by higher retention of workshop students in the course sequences. Evidence suggests that the program has particular benefits for minority students.

Tanner, K. D. (2009). Talking to learn: Why biology students should be talking in classrooms and how to make it happen. *CBE-Life Education*, 8(2), 89-94. doi: 10.1187/cbe.09-03-0021. Available online: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2689152/>.

Many 50-min biology lectures occur every day all around our country, with the majority of students listening but never uttering a word. Why do the majority of undergraduate biology students primarily experience biology teaching, particularly in introductory courses, by listening, listening, and listening some more? I've had numerous discussions with earnest colleagues about how to improve biology teaching and increase student learning in undergraduate courses, especially big lecture courses. Often, I inquire about whether students are talking in their classrooms, and the answer is generally no. Most instructors aren't resistant to promoting Student Talk, as I'll refer to it, but they aren't sure about how to make it happen. Encouraging Student Talk in classrooms is a good place to begin working on your own teaching for two reasons. First, most instructors seem to agree that Student Talk is an important part of learning. Resistance to this idea is rarely encountered, in contrast to the skepticism encountered in response to suggestions of more complex teaching approaches. Getting students talking seems, for the most part, uncontroversial among instructors, and it is widely recognized as an important way for students to process new information. Second, and more importantly, teaching strategies that can encourage and structure Student Talk are some of the simplest teaching techniques that we encounter. Sure, these techniques can be made quite complex, usually by embedding them in a larger, more elaborate approach to teaching. But almost any "named" pedagogy or teaching strategy currently in use—cooperative learning, case-based learning, clicker questioning, process-oriented guided inquiry learning, just in time teaching, and peer-led team learning, to name just a few—has Student Talk as a core requirement. Student Talk can be thought of as the common denominator of many innovative, active, inquiry-based approaches to teaching. And importantly, the most common strategies for getting students to talk are those with which most undergraduate biology instructors can have quick success.

Tavera, G. (2012). *How can female students in a math workshop increase their problem-solving capabilities?* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Tavera-2012.docx>

The way women perceive their surroundings plays an important role in how they behave, think, and express themselves (Belenky et al., 1986). During workshop sessions I observed different attitudes among female and male students. That is why this topic of females in mathematics caught my attention. Also, as a female, I have been through similar situations as other females in a classroom setting.

Taylor, K., & Kelly, T. *Comparison of effectiveness of several peer learning programs to support 1st year chemistry.* Conference Proceedings of the Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference), Australia.

Available online:

<https://openjournals.library.sydney.edu.au/index.php/IISME/article/view/7664/8023>

Many higher education institutions use peer learning programs for supplemental instruction, particularly in subjects such as chemistry (e.g. Gosser & Roth, 1998). Online peer learning programs have also been trialled, with mixed success (e.g. Beaumont et al., 2012). At this institution, there is an established peer mentoring program consisting of weekly study sessions. In 2013 and 2014, several additional peer mentoring programs for chemistry were investigated, including interactive revision lectures, a helpdesk, rovers, and a trial of a synchronous online chemistry session. The relative effectiveness of each of these programs was compared, with a focus on the two programs that had the greatest student attendance. This report provides a comparison of several peer learning programs designed to support first-year chemistry, in regards to both program attendance and to improvement in retention and success in the unit. This comparison could be useful for other institutions considering similar peer-learning approaches. In 2012 and 2013 (2014 data analysis awaiting final unit results), a consistent improvement in retention and success has been observed in student groups who attended chemistry peer mentoring sessions compared with groups who did not attend. Additional peer learning approaches were trialled in 2013 and 2014 to determine if further improvements could be made. The interactive revision lectures ran most weeks of semester and were staffed by one chemistry tutor and several roving peer mentors. The chemistry helpdesk, rovers and study sessions ran multiple times each week and were staffed by peer mentors. The online study session trial utilised Blackboard Collaborate. Attendance in the face-to-face peer mentoring programs was recorded using Opticon OPN-2001 portable barcode scanners. Unit enrolment and result lists were obtained from university records. The total cohort for the unit was grouped into attendees and non-attendees in the various peer learning programs. These groups were analysed against unit enrolment and results, in regards to student retention (proportion of withdrawn grades), success (proportion of P or higher grades in the retained students) and average final mark. Across the two chemistry units in 2013, the majority of student attendances were in the interactive revision lectures (n=1492 attendances) and in the weekly study sessions (n=717 attendances). Most students who attended weekly study sessions also attended the interactive lectures. Three student groups were compared: those who did not attend peer learning programs, those who only attended interactive lectures, and those who attended both the weekly study sessions and interactive lectures (Table 1 - not included in the metadata but included in the word doc). The greatest improvement in retention and success was seen in groups who attended the weekly peer-led study sessions as well as the interactive lectures. The online chemistry peer learning trial had positive results; however there were limitations in the types of materials that could be used with the Blackboard Collaborate program, and a greater requirement for preparation and training. Of the programs analysed so far, the weekly face-to-face sessions have had the greatest impact on student success. Several of the other peer learning approaches have potential additional benefits, e.g. in catering for off-campus students in the case of online peer sessions, or in attaining greater attendance, albeit with smaller improvement in success, in the interactive lectures.

Tenney, A. (2001). *Peer-led Team Learning in general chemistry*. Conference Proceedings of the 221st American Chemical Society National Meeting, San Diego, CA. For more information, contact the authors at the Department of Chemistry, University of Portland, 5000 N. Willamette Blvd., Portland, OR 97203, tenney@up.edu

Peer-led Team Learning (PLTL) was used in entry-level courses in general, organic, and biological chemistry courses at the University of Portland.

Tenney, A., & Houck, B. (2004). Learning about leadership: Team learning's effect on peer leaders. *Journal of College Science Teaching*, 33(6), 25-29.

This article describes the use of Peer-Led Team Learning (PLTL) to improve student learning in a chemistry course at the University of Portland, a private, comprehensive, regional university of about 3,000 students in Oregon. The focus of this article was on research concerning the leadership development of the student peer facilitators. The student leaders reported increases in their scientific knowledge, interpersonal communication skills, teaching skills, and leadership skills.

Tenney, A. D. (2002). *What works in institutionalizing student centered teaching methods: Peer-led Team Learning*. Conference Proceedings of the 224th American Chemical Society National Meeting, Boston, MA. For more information, contact the author at the Department of Chemistry, University of Portland, 5000 N. Willamette Blvd., Portland, OR 97203, tenney@up.edu
Peer-led Team Learning (PLTL) has been used at the University of Portland (OR) to support higher student achievement in introductory science courses since Fall 1999. PLTL has now been expanded to nine faculty members in three academic disciplines. This paper discusses the critical factors needed to implement and support the PLTL program. Preliminary studies suggest that the academic culture has been positively impacted by PLTL, especially regarding female students.

Thadeane, B. W. (2013). *Peer-Led Team Learning as an instructional strategy for secondary school science*. (Ph.D. dissertation), Brock University. Available online: <http://hdl.handle.net/10464/4309>

This study investigated the impact of an instructional learning strategy, peer-led team learning (PLTL), on secondary school students' conceptual understanding of biology concepts related to the topic of evolution. Using a mixed methods approach, data were gathered quantitatively through pre/posttesting using a repeated measures design and qualitatively through observations, questionnaires, and interviews. A repeated measures design was implemented to explore the impact of PLTL on students' understanding of concepts related to evolution and students' attitudes towards PLTL implementation. Results from quantitative data comparing pre/posttesting were not able to be compared through inferential statistics as a result of inconsistencies in the data due to a small sample size and design limitations; however, qualitative data identified positive attitudes towards the implementation of PLTL, with students reporting gains in conceptual understanding, academic achievement, and interdependent work ethic. Implications of these findings for learning, teaching, and the educational literature include understanding of student attitudes towards PLTL and insight into the role PLTL plays in improving conceptual understanding of biology concepts. Strategies are suggested to continue further research in the area of PLTL.

Thiry, H., Hug, S., & Barker, L. (2008). *CAHSI Year 2 annual evaluation report: Recruiting, retaining, and advancing Hispanics in computing*. University of Colorado. Boulder, Colorado. Available online: www.colorado.edu/eer/downloads/CAHSIyear2Report2008.pdf
CAHSI institutions have focused their efforts on the recruitment, retention, and advancement of Hispanic computer science students. In 2007, the seven CAHSI computer science departments graduated 149 Hispanic computer science majors. Excluding the University of Puerto Rico, Mayaguez, which is 100% Hispanic, 45% of computer science majors at CAHSI institutions were Hispanic. In addition, two CAHSI institutions graduated an above-average proportion of women in computer science. Three institutions serve other underrepresented minorities as well, specifically African-American computer science students. When compared to other Hispanic serving institutions, the enrollment of Hispanic computer science students at CAHSI institutions is closer to parity with the overall enrollment of Hispanic students at their schools. However, most CAHSI schools have opportunities for growth in this area. The Alliance has implemented multiple interventions to enhance the recruitment, retention, and advancement of Hispanic

computer science students at participating institutions. The CS-0 course is intended to help CAHSI institutions recruit and retain more Hispanics into the computer science major. At every institution, the percentage of Hispanics enrolled in CS-0 is higher than the percentage of Hispanics enrolled in the CS major, suggesting that CS-0 is an effective method for recruiting more Hispanics into the department. Although the recruitment, retention, and advancement of women into computing are not explicit goals of CAHSI, CS-0 has also been successful in enrolling women in CS-0. At every institution except one, the percentage of women undergraduates enrolled in CS-0 is higher than the percentage of women enrolled in the CS major. Though the CS-0 course has attracted more Hispanics and women than are presently enrolled in CAHSI computer science departments, it is too early to tell whether these students will continue in computer science. To determine the retention rate of CS-0 students, the evaluation team will track whether these students enroll in CS1 in subsequent semesters. In addition, the enrollment of Hispanics in many CAHSI computer science departments is lower than the enrollment of Hispanics in the institution, suggesting that there is room for growth in the recruitment of Hispanics into the computer science major. The CS-0 course was successful in boosting students' confidence in their programming abilities. Students who had not programmed a computer made the greatest gains in confidence. Women gained greater confidence in computer programming than men. All racial/ethnic groups, including Hispanics, exhibited strong increases in confidence in computer programming. Indeed, the gains in computer programming confidence across all demographic variables, such as gender and ethnicity, suggest that the CS-0 course served to boost the confidence of most students. Peer-Led Team Learning in "gatekeeper" courses aims to increase student retention in the major by providing near-peer role models to boost their confidence and knowledge. Sessions were informal and involved group work to develop relationships among students in the course, said to influence student persistence in the major. Overall, students found the PLTL sessions to be fun, interesting, and helpful. Students, particularly Hispanic students, gained confidence in their computing abilities through PLTL sessions, and leaders reported confidence gains as well. Being a peer leader increased students' communication, teaching, leadership, and interpersonal skills. Hispanics had slightly better gains in skills than other peer leaders. Students were generally confident in their skills as a peer leader, particularly in their ability to help students understand concepts, to motivate students, and to effectively communicate. Students' experiences as peer leaders also increased their aspirations to have a computing career and, to a lesser extent, their aspirations to attend graduate school in computing. Peer leading had a more positive influence on the aspirations of women and Hispanics. Being a peer leader also enhanced students' disciplinary and conceptual knowledge. In part, this increase in knowledge and confidence contributed to some students' motivation to pursue graduate studies.

Thomas, A. S., Bonner, S. M., Everson, H. T., & Somers, J. (2015). Leveraging the power of peer-led learning: Investigating effects on STEM performance in urban high schools. *Educational Research and Evaluation, 21*(7-8), 537-557. doi: 10.1080/13803611.2016.1158657. The Peer Enabled Restructured Classroom (PERC) is an instructional innovation developed to address gaps in science, technology, engineering, and math (STEM) in urban high schools. The PERC model changes instruction from teacher led to peer led by bringing peer students into the classroom to lead small-group work. Our study sought to provide empirical evidence in support of the peer-led model as a means of improving STEM learning for tutored students in urban schools. We used propensity score matching to evaluate the innovation's impact on students' achievement on standardized end-of-course tests in two 9th-grade courses – Integrated Algebra and Biology. Results suggest that by the 2nd year of implementation, enrolment in PERC Biology increased the likelihood of passing. Similar effects were not observed for PERC Integrated Algebra, but when comparing cohorts, we found that the 2nd year was twice as likely to pass as the 1st year. We discuss implications for programme improvement.

Tien, L. T., Roth, V., & Kampmeier, J. A. (2002). Implementation of a Peer-Led Team Learning instructional approach in an undergraduate organic chemistry course. *Journal of Research in Science Teaching*, 39(7), 601-632. doi: 10.1002/tea.10038.

This study focused on the use of Peer-Led Team Learning (PLTL) program for all students enrolled in an undergraduate organic chemistry course and an evaluation of student outcomes. Quantitative and qualitative data were collected. PLTL students (treatment) were compared with students who participated in recitation sessions (control). PLTL students earned higher final course grades and had higher persistence rates. Analysis of interviews with PLTL students suggested that the program helped them to learn more course material, were more socially engaged, intellectually stimulated, and found the experience to be a productive use of time.

Tien, L. T., Roth, V., & Kampmeier, J. A. (2004). A course to prepare peer leaders to implement a student-assisted learning method. *Journal of Chemical Education*, 81(9), 1313-1321. doi: 10.1021/ed081p1313.

This article describes a two-credit training program for peer student facilitators to assist other students in mastering difficult academic content material. An outline of the training curriculum is provided. Peer-led Team Learning (PLTL) utilizes the skills of trained student paraprofessionals to help a small team of students to work through difficult problems posed by the classroom instructor. The student facilitators are cited as key in the success of PLTL with increasing student academic achievement. Comments from student peer leaders are provided to illustrate the impact of the training program on their professional development and preparation for the program. The leader training course is a collaborative effort of faculty and educational specialists to join pedagogy and chemistry. The syllabus is grounded in the research literature and situated in the context of the specific course in which the peer leaders will work, leading a weekly Workshop. Since the peer leaders take the training course while they are working as leaders, the pedagogical ideas find immediate application. The authors had taught the course since 1995 to more than 250 undergraduate and graduate students. In practice, the training course is the central mechanism to transform students from Workshop participants to skilled Workshop leaders. In turn, these carefully prepared peer leaders are essential forces for curricular change. In addition to the immediate practical benefits, the training course leads to new working relationships among students, faculty, and educational specialists. As a result, the training course becomes a mechanism to introduce current faculty to a new research literature and to encourage the development of future faculty.

Utschig, T. t., & Sweat, M. (2008). *Implementing Peer Led Team Learning in first-year programming courses*. Conference Proceedings of the Frontiers in Education Conference, 2008. FIE 2008. 38th Annual, Saratoga Springs, NY.

In the Peer Led Team Learning model (PLTL) many of the skills developed by students correlate well with desired learning outcomes in CSET programs. The authors report the results of a project to implement PLTL in introductory programming courses. An overview of the implementation model is provided, lessons learned are reported, and the assessment process and results are described. The research questions explored are: (1) What is the impact of the PLTL model on student skills and confidence regarding teamwork, leadership and communication? (2) How effective is PLTL in terms of building problem-solving skills in introductory programming? This project involved a pilot implementation followed by full implementation in the following year. Student peer leader surveys, along with a peer leader focus group, were used to analyze project impact and to plan for improvement in achieving the learning outcomes described above. Results indicate that students are satisfied with the peer led team learning model and that significant skill enhancement is occurring. In particular, a

significant fraction of peer leaders in the second year of implementation came from those participating in the pilot.

Vandal, B. (2019). Recognition, reform, and convergence in developmental education. In T. U. O'Banion (Ed.), *13 ideas that are transforming the community college world*

Various. (2001-2010). Implementation - Starting a PLTL Program. *Progressions: The Peer-Led Team Learning Project Newsletter*. Available online:

<http://ppltlis.org/resources/implementation/implementation-starting-a-pltl-program/>.

A collection of short case studies for implementation of PLTL at colleges across the U.S. The articles explore the administrative issues required for starting a PLTL program.

Various. (2001-2010). Implementation - Training the student leaders in the PLTL Program. *Progressions: The Peer-Led Team Learning Project Newsletter*. Available online:

<http://ppltlis.org/resources/leader-training/>.

A collection of training materials for the new student PLTL leaders.

Various. (2001-2010). Sustaining a PLTL program. *Progressions: The Peer-Led Team Learning Project Newsletter*. Available online: <http://ppltlis.org/resources/sustaining-a-pltl-program-2/>.

A collection of training materials for sustaining the PLTL over the long term.

Varma-Nelson, P. (1997). *Workshop chemistry: Peer-led Team Learning*. Conference Proceedings of the 214th American Chemical Society National Meeting, Las Vegas, NV. For more information, contact the author at the Science Department, St. Xavier University, 3700 W. 103rd St., Chicago, IL 60655

Peer-led Team Learning (PLTL) was used with undergraduate chemistry students to improve instruction. Preliminary evaluation studies suggest improved student learning, teamwork skills, and communication skills..

Varma-Nelson, P. (2005). The Peer-Led Team Learning workshop model *Project Kaleidoscope Volume IV: What works, what matters, what lasts*. Washington, D.C.: Project Kaleidoscope

This short narrative provides an overview of the Peer-Led Team Learning (PLTL) model.

Varma-Nelson, P. (2014). IUPUI faculty and undergrad researchers evaluate Peer-led Team Learning in cyberspace. *Psys.org*, Available online: <http://phys.org/news/2014-01-iupui-faculty-undergrad-peer-led-team.html>

This online article provides an overview of an adapted use of PLTL at Indianapolis University-Purdue University Indianapolis.

Varma-Nelson, P. (n.d.). *What is PLTL?* Unpublished manuscript. Northeastern Illinois University. Chicago, IL.

This paper provides a narrative overview of the Peer-Led Team Learning (PLTL) program.

Varma-Nelson, P., & Banks, J. (2013). PLTL: Tracking the trajectory from face-to-face to online environments. In t. Holme, M. Cooper & P. Varma-Nelson (Eds.), *Trajectories of chemistry education innovation and reform*: American Chemical Society

Over the past three years, an interdisciplinary team of investigators, led by Varma-Nelson, has worked to adapt the Peer-Led Team Learning (PLTL) instructional model to a cyber-environment (aka cPLTL). PLTL is a pedagogy that preserves the lecture and replaces the course recitation with a weekly two-hour workshop in which six to eight students work collaboratively to solve challenging problems under the guidance of a peer leader. cPLTL is the

“cyber” evolution of PLTL to an online format. The team’s work represents a new direction for educational research and expands the knowledgebase on teaching science, technology, engineering and mathematics (STEM) concepts, while using technology as an educational tool. With funding from the National Science Foundation (NSF) and the Next Generation Learning Challenges (NGLC) initiative, the team is examining cPLTL’s impact on student performance. Analysis of course grades and standardized exam scores has shown cPLTL’s positive impact on educational outcomes. This chapter traces the evolution of a pedagogy developed for the face-to-face classroom environment to an online platform. Specifically, it outlines the rationale that led to the development of cPLTL; describes how technology was integrated into the PLTL model; summarizes its effectiveness, outcomes, and lessons learned; and speculates on the future use of cPLTL.

Varma-Nelson, P., & Coppola, B. P. (2005). Team learning. In M. M. Cooper, T. Greenbowe & N. Pienta (Eds.), *The chemists' guide to effective teaching*. Upper Saddle River, NJ: Prentice Hall

Varma-Nelson, P., & Cracolice, M. S. (1998). *Workshop chemistry: Peer-led Team Learning*. Conference Proceedings of the 216th American Chemical Society National Meeting, Boston, MA. For more information, contact the author at the Science Department, St. Xavier University, 3700 W. 103rd St., Chicago, IL 60655

Peer-led Team Learning (PLTL) was used with undergraduate chemistry students to improve instruction. Preliminary evaluation studies suggest improved student learning, higher persistence rates, improved teamwork skills, and heightened communication skills..

Varma-Nelson, P., & Cracolice, M. S. (Eds.). (2001). *Peer-Led Team Learning: General organic and biological chemistry*. Upper Saddle River, NJ: Prentice Hall

This book provides strategies for implementing the Peer-Led Team Learning (PLTL) program by other educators in a general organic and biological chemistry course.

Varma-Nelson, P., Cracolice, M. S., & Gosser, D. K. (2003). Peer-Led Team Learning: A student-faculty partnership for transforming the learning environment *Invention and impact: Building excellence in undergraduate science, technology, engineering, and mathematics (STEM) education* (pp. 43-48). Washington, D.C.: American Association for the Advancement of Science

This chapter describes the use of the Peer-Led Team Learning (PLTL) program in science courses to increase their academic success. After providing an overview of the PLTL program, effects on the peer leaders are presented along with a report of the national dissemination of the model.

Varma-Nelson, P., & Gosser, D. (2005). Dissemination of Peer-led Team Learning (PLTL) and formation of a national network: Embracing a common pedagogy. In M. Ouellet (Ed.), *Teaching inclusively: Diversity and faculty development* (pp. 503-518). Stillwater, OK: New Forums Press

Varma-Nelson, P., & Gosser, D. K. (2000). *National dissemination of the workshop project: Peer-led Team Learning*. Conference Proceedings of the 219st American Chemical Society National Meeting, San Francisco, CA. For more information, contact the authors at the Science Department, St. Xavier University, 3700 West 103rd Street, Chicago, IL 60653, varmanelson@sxu.edu

Peer-led Team Learning (PLTL) is used at the St. Xavier University in chemistry courses. The national PLTL dissemination efforts are reviewed.

Varma-Nelson, P., & Gosser, D. K. (2001). *National dissemination of Peer-led Team Learning: Its design, implementation, documentation, and evaluation*. Conference Proceedings of the 222nd American Chemical Society National Meeting, Chicago, IL. For more information, contact the authors at the Science Department, St. Xavier University, 3700 West 103rd Street, Chicago, IL 60655, varmanelson@sxu.edu

Peer-led Team Learning (PLTL) has been used at more than 100 institutions to support higher student achievement in an organic chemistry course. National data studies as well as recommendations for successful implementation are shared.

Varol, H., & Carol, C. (2014). Improving female student retention in computer science during the first programming course. *International Journal of Information and Educaiton Technology*, 4(5), 394-398.

This paper is an evaluation study to improve female student retention in Computer Science during the first programming course. Although, colleges are using variety of ways to attract female students to continue their studies in Computer Science, the number of female students is decreasing in the major. Therefore, we have employed two survey studies to learn more about the lack of supported items in the major and tried to address most of those issues in the classroom to see the change in student's feeling about Computer Science. Moreover, we support some of our suggestions not only by the survey results, but also students' performance from the course. We observed that lack of communication among students and with faculty, primitive programming editors, and not well prepared course materials are some of the reasons for the decrease in female student retention.

Vaughan, J. (2009). My experience as a Peer Leader: Insight hindsight.. Peer-Led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 10(2). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Vaughn-My-Experience-as-a-Peer-Leader.pdf>.

This report is based on first-hand account by a student facilitator involved with the Peer-led Team Learning (PLTL) program. Some of my favorite memories over the last four years at The City College of New York of the City University of New York were not of me at a desk, listening intently about the mysteries of the known universe. Rather, my finest memories involved me in a workshop, at a chalkboard, using wit and comedic humor to clarify a topic that was introduced by a 'boring' professor not more than an hour prior.

Veale, C. G. L., Krause, R. W. M., & Sewry, J. D. (2018). Blending problem-based learning and Peer-Led Team Learning, in an open ended "home-grown" pharmaceutical chemistry case study. *Chemistry Education Research and Practice*, 19(1), 68-79. doi: 10.1039/c7rp00180k. Pharmaceutical chemistry, medicinal chemistry and the drug discovery process require experienced practitioners to employ reasoned speculation in generating creative ideas, which can be used to evolve promising molecules into drugs. The ever-evolving world of pharmaceutical chemistry requires university curricula that prepare graduates for their role as designers with the capability of applying complex concepts in pharmaceutical chemistry, thereby improving the decision-making process. Common methods of teaching drug discovery, including the linear nature of the traditional case study model, do not provide a realistic picture of the underlying complexity of the process, nor do they equip students with the appropriate tools for personal sense making and abstraction. In this work, we discuss the creation of an open-ended, nonlinear case study for 3rd year pharmaceutical chemistry students, developed from drug discovery research conducted at Rhodes University. Furthermore, we discuss blending problem based learning (PBL) with peer-led team learning (PLTL) in the context of curriculum transformation, underpinned by the theory of semantic waves, to assist students in the early

attainment of abstract concepts and answer questions of contextualisation, personal sense making, relatability, relevance and ultimately the skills for lifelong learning.

Villatoro, M. L., Moreira, M., & Liang, Y. (2012). *Successful implementation of PLTL for the Department of Construction Management and Civil Engineering Technology (CMCE) of New York City College of Technology* Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Villatoro-2012.docx>

Peer Led Team Learning (PLTL) involves students working in small groups under the guidance of a Peer leader. Peer Leaders are current students who have successfully completed the course. The goal of PLTL is to enable students to gain confidence and critical problem solving skills that will help them master the course content thereby improving their ability to succeed in successive design courses. PLTL is currently in its first semester of implementation and data indicates that the students in the PLTL inclusive Statics classes are performing better than those in sections without PLTL.

Villatoro, M. L., Pena, K. K., & Liou-Mark, J. (2018). *The effects of peer-led workshops in a statics course*. Conference Proceedings of the ASEE Mid-Atlantic Section Spring Conference, Washington, District of Columbia.

According to the Bureau of Labor Statistics, an 8% increase in employment for civil engineers is expected in the next decade.¹ To assist in attracting more undergraduates to pursue a degree in Civil Engineering Technology, New York City College of Technology has implemented an instructional strategy in one of the main gatekeeper courses. Statics has been identified as a course where undergraduates either decide to retain in their Civil Engineering Technology major or transfer out to another one. To provide more support for undergraduates taking this course, the Peer-Led Team Learning (PLTL) strategy was adopted. This study compared the final grade distribution of the Statics course in three categories: no PLTL, non-mandatory PLTL, and mandatory PLTL. These categories reflect the time periods of the Statics course where PLTL was not offered at all, when it was an optional support program, and when it officially became part of the curriculum. After analyzing the final grade distribution, results showed that the ABC pass rates of the mandatory PLTL sections were approximately 20% higher when compared to both the no PLTL and non-mandatory PLTL sections. Moreover, the withdrawal rates were approximately 10% lower for the mandatory PLTL sections when compared to the rates of the other two sections.

Wade, P. (2016). Student tutors: An analysis of the creation of peer-led tutoring initiative utilizing the implementation staircase model. *Journal of Teaching English for Specific and Academic Purposes*, 4(2). Available online: <http://espeap.junis.ni.ac.rs/index.php/espeap/article/view/382/244>.

This article describes the creation of a Peer-led Team Learning tutoring initiative in the English department of a French university. It utilizes the implementation staircase model of group steps to provide greater understanding of the progression of the initiative from policy to tutoring sessions down and up the staircase. The feedback findings highlight the success of the initiative and the subsequent recommendations will be of use to teachers considering adopting peer tutor programmes on university courses. The tutoring initiative policy was developed into a 20-hour, 10 week PLTP programme run by 2 students. Despite the recruitment issues, the final outcomes were deemed successful by the teachers, the tutors and the student attendees. The implementation staircase enables us to appreciate the work involved in the progressive „step-by-step“ development of the tutoring initiative and the input of the groups involved. Perhaps more significantly, it highlights the nonlinear progression of policy implementation not just down but also back up the stairs. In this case, it could be argued that the course had not been formed

enough or explained well to the student tutors at step 4 which resulted in them quitting. When it reverted from step 5 to the teachers at step 4 for further development it then succeeded where before it failed. The staircase thus draws our attention to the importance of the people in the process. On account of the limited instructions at the beginning of the initiative, it is difficult to identify any implementation gap or loose coupling between it and the final version. The format of the tutoring programme, the topics and the number were mainly developed by the middle managers and teachers and then influenced by the students. In this respect, we could argue for an „implementation lift“ where the policy moves straight from step 1 to 3 or 4. In actuality, if this initiative had not included contract and employment issues and purely been an academic matter, it could have easily moved from step 1 to 4.

Walker, J. P., Sampson, V., & Zimmerman, C. O. (2011). Argument-driven inquiry: An introduction to a new instructional model for use in undergraduate chemistry labs. *Journal of Chemical Education*, 88(8), 1048-1056. doi: 10.1021/ed100622h.

This article presents a new instructional model called Argument-Driven Inquiry (ADI) that can be used in undergraduate college chemistry laboratory courses. ADI is designed to provide students with an opportunity to develop their own method to generate data, to carry out investigations, use data to answer research questions, write, and be more reflective as they work. In addition, the ADI instructional model integrates opportunities for students to engage in scientific argumentation and peer review. This article describes the ADI instructional model, provides the empirical and theoretical foundation for it, and presents a detailed semester pacing schedule for general chemistry I laboratories, peer-review guides, and instructor scoring rubrics.

Wamser, C. C. (2004). *PLTL and student success in organic chemistry*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the author at the Department of Chemistry, Portland State University, Portland, OR 97207, wamserc@pdx.edu

Peer-led Team Learning (PLTL) was used in chemistry at Portland State University (OR). PLTL is an optional one-credit, two-hour weekly course that attracts about 30% of the students to enroll. Student outcomes for the participants include: slightly higher GPA based on all courses taken, higher persistence rates, and improved attitudes. Positive differences were greater than can be attributed to differences in entry GPA.

Wamser, C. C. (2006). Peer-Led Team Learning (PLTL) in organic chemistry: Effects on student performance, success, and persistence in the course. *Journal of Chemical Education*, 83(10), 1562-1566. doi: 10.1021/ed083p1562.

This paper describes the results of instituting Peer-led Team Learning (PLTL) for the first two years of chemistry (general chemistry and organic chemistry). Data was collected for the past five years. Students who elected to take the workshops had a somewhat higher overall grade point average based on all courses taken (3.26 vs 3.14). However, the gains of the PLTL students in each category: success rate (85% vs. 69%), three-term persistence (57% vs. 28%), and course performance (71% vs. 65%), course GPAS (2.90 vs. 2.51), and ACS exam scores (77th vs. 69th percentile) were all significantly higher than can be attributed solely to differences in student GPA.

Wang, B. (2010). From Peer-Led Team Learning to professional work experiences. Peer-Led Team Learning: The experience of leading. *Progressions: The Peer-Led Team Learning Project Newsletter*, 12(1). Available online: <http://pltlis.org/wp-content/uploads/2012/10/Experience-of-Leading-Wang-PLTL-to-Professional-Experience.pdf>.

The author relates their personal story of how serving as a student facilitator of the Peer-led Team Learning (PLTL) program had benefits for himself as well as for the participating students.

Some of those new skills were: improved problem-solving skills, increased interpersonal communication skills, and deeper understanding of the course material that benefited degrees in Computer Science (CS) and obtained employment as a Tech Analyst at JPMorgan Chase.

Wang, F., Toce, A., & Zaritsky, J. (2012). *Academic Peer Instruction (API) Program for remedial algebra at LaGuardia Community College*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://ptlis.org/wp-content/uploads/2012%20Proceedings/Wang-2012.docx>

In 2011 and 2012, LaGuardia Community College, City University of New York, conducted a large-scale study by deploying highly selective Academic Peer Instruction (API) tutors in about 20 remedial algebra sections to promote collaborative learning and effective use of technology. The research hypothesis was that API tutors would motivate students to spend more time on studying, utilizing the online learning system called "EDUCO," which in turn would improve their academic performance. The researchers present evidence that the students in the API group consistently show better outcomes in course pass rates and mean exam scores with lower standard deviations, compared to the students in the control group. They also share results of faculty and student surveys, demonstrating the promise and challenge of peer instruction.

Weaver, G. C., Russell, C., & Wink, D. (2008). Inquiry-based and research-based laboratory pedagogies in undergraduate science. *Nature Chemical Biology*, 4, 577-580. doi: 10.1038/nchembio1008-577.

Undergraduate research experiences help retain students in science majors and prepare our workforce for increasingly competitive jobs. Course-based approaches to research and inquiry allow educators to reach larger numbers of students and provide an entry into further research experiences. Much has been said and written about the benefits of active learning pedagogies for revitalizing traditional lecture-based courses. For example, collaborative learning approaches in the classroom can be used to engage students in discussion and problem solving to greater effect

Weaver, G. C., Wink, D., Varma-Nelson, P., Morris, R., Formes, W., Russell, C., & Boone, W. J. (2006). Developing a new model to provide first and second-year undergraduates with chemistry research experience: Early findings of the Center for Authentic Science Practice in Education (CADPiE). *The Chemical Educator*, 11(2), 125-129.

Research experiences can often be inspiring and life changing for young college students. It is possible that research experiences are pivotal in making decisions about college majors and careers. We are beginning to implement research as part of the regular curriculum for first- and second-year students in chemistry as part of the Center for Authentic Science Practice in Education (CASPiE) project. The center utilizes authentic research projects, a remote-access network of chemical instruments, and the peer-led team learning (PLTL) model. Our early evaluation results indicate that students are finding this to be a rewarding experience.

White, P., Rowland, A. B., & Pesis-Katz, I. (2012). Peer-led Team Learning model in a graduate-level nursing course. *Journal of Nursing Education*, 51(8), 471-476. doi: 10.3928/01484834-20120706-03.

The peer-led team learning (PLTL) model was introduced into a graduate-level course in health economics at our school of nursing. We believed this collaborative learning program, emphasizing peer-to-peer interaction to solve complex problems, would increase student engagement and mastery of course content. The course was redesigned to accommodate a weekly 1-hour workshop conducted by peer leaders. To gain better understanding of the effect of the PLTL model, focus groups were conducted at the end of the course. Evaluation of the focus group discussions showed that peer-led workshops helped students understand the

subject matter. The opportunity to discuss concepts taught during lecture with their peers helped deepen students' understanding of the material and apply this knowledge in the classroom. These findings support continuation of the PLTL model in future health economics classes and suggest that this approach may be beneficial in other graduate level-nursing courses.

Williams, J. L., Miller, M. E., Avitabile, B. C., Burrow, D. L., Schmittou, A. N., Mann, M. K., & Hiatt, L. A. (2017). Teaching students to be instrumental in analysis: Peer-Led Team Learning in the instrumental laboratory. *Journal of Chemical Education*, 94(12), 1889-1895. doi: 10.1021/acs.jchemed.7b00285.

Many instrumental analysis students develop limited skills as the course rushes through different instruments to ensure familiarity with as many methodologies as possible. This broad coverage comes at the expense of superficiality of learning and a lack of student confidence and engagement. To mitigate these issues, a peer-led team learning model was developed to give each student in-depth experiences operating and troubleshooting six common instruments. Electronic cigarette solutions were chosen for all work because of their current relevance. Small groups became "class experts" on their assigned instrument. Students were responsible for teaching their peers how to utilize their instrument for experimentation. Each student rotated through their peer's instruments, learned to apply the knowledge they gained from one instrument to others, while they answered questions from peers. The students developed troubleshooting and communication skills—foundational tools for chemists. This model proved successful in promoting cognitive flexibility and critical thinking about experimental design, as reflected by oral quizzes and peer teaching. This adaptation of peer-led team learning helped engage students, promote confidence, and facilitate a deeper understanding of instrumentation.

Willoughby, L. J. (2004). *The effect of an enriched learning community on success and retention in chemistry courses*. (Ph.D. dissertation), Florida International University, Miami, FL.

This dissertation study examined a variety of factors including Peer-led Team Learning (PLTL) and their impact on success within a chemistry course. The students studied were an existing learning community of science, mathematics, and engineering majors. During the two years the learning community project has existed, success, retention, and next-course continuation rates were higher than in traditional courses. Faculty and student interviews indicated there were many affective accomplishments as well. Substantial differences were found in comparing the learning community and the traditional course students in the following areas: perceptions about the lecture, lab, and other supported used for the course; contact with other students, helping them reach their potential; and student recommendations about the course that they give to others. Because of the limitation of small sample size, these differences were reported in descriptive terms. Success and retention rates for the two student groups were collected and analyzed. No statistically significant differences were found between the two groups.

Wilson, S. B. (2015). *A comparison of first-semester organic chemistry students' experiences and mastery of curved-arrow formalism in face-to-face and cyber Peer-Led Team Learning*. (Ph.D. dissertation), Indiana University-Purdue University Indianapolis, Indianapolis, IN. Available online: <http://hdl.handle.net/1805/10082>

The cyber Peer-Led Team Learning (cPLTL) workshops are a synchronous online adaptation of the educational intervention PLTL, in which students, under the guidance of undergraduate peer facilitators, collaboratively solve problems in small groups. The purpose of this parallel convergent mixed methods study was to assess the impact of implementing cPLTL in an organic chemistry course on students' workshop experiences, performance, and development of curved-arrow formalism skills. Statistical analyses revealed comparable attendance rates, distribution of course grades, and achievement on American Chemical Society First-semester Organic Chemistry Exams. However, plotting workshop grades by AB, C, and DFW grade

groupings revealed that PLTL students earned more successful grades than their cPLTL counterparts (91% vs 77% ABC grades). Utilization of a new curved-arrow formalism analytic framework for coding student interview artifacts revealed that cPLTL students were statistically less likely to successfully draw the product suggested by the curved-arrows than their PLTL classmates. Both PLTL and cPLTL students exhibited a comparable incidence of relational to instrumental learning approaches. Similarly, both PLTL and cPLTL students were more likely to exhibit a common Scheme for Problem-Solving in Organic Chemistry (SPOC) than having dialogue that could be characterized by Toulmin's Argumentation scheme. Lastly, implications for faculty are suggested, including: developing more explicit connections concept, mode, and reasoning components of understanding curved-arrow formalism for organic chemistry students; optimizing graphical collaborative learning activities for online learners; and developing online students' sense of community.

Wilson, S. B., & Varma-Nelson, P. (2016). Small groups, significant impact: A review of Peer-Led Team Learning research with implications for STEM education researchers and faculty. *Journal of Chemical Education*, 93(10), 1686-1702. doi: 10.1021/acs.jchemed.5b00862. Peer-led team learning (PLTL) research has expanded from its roots in program evaluation of student success measures in Workshop Chemistry to a spectrum of research questions and qualitative, quantitative, and mixed methods study approaches. In order to develop recommendations for PLTL research and propose best practices for faculty who will integrate PLTL in their classrooms, the theoretical frameworks, study designs, results, and limitations of sixty-seven peer-reviewed studies, spanning a variety of STEM disciplines and institution types, were examined. Five program evaluation themes emerged from this synthesis of the literature: student success measures; student perceptions; reasoning and critical thinking skills; research on peer leaders; and variants of the PLTL model. For each of the themes, areas for future study and implications for practice are suggested to STEM discipline-based education researchers and faculty.

Wilson, S. B., & Varma-Nelson, P. (2019). Characterization of first-semester organic chemistry Peer-Led Team Learning and Cyber Peer-Led Team Learning students' use and explanation of electron-pushing formalism. *Journal of Chemical Education*, 96(1), 25-34. doi: 10.1021/acs.jchemed.8b00387.

The purpose of this parallel convergent mixed methods study was to characterize organic chemistry students' expression of electron-pushing formalism skills who had participated in peer-led team learning (PLTL) and cyber peer-led team learning (cPLTL), a synchronous online version of peer-led team learning (PLTL) workshops. A new electron-pushing formalism analytic framework was developed from a review of the literature in addition to analysis of students' interview artifacts, using a constant-comparison process. Utilization of this new electron-pushing formalism analytic framework for coding student interview artifacts revealed that cPLTL students were significantly less likely to successfully draw the product suggested by the curved arrows than their PLTL classmates. Implications for instructors are suggested, including encouraging students to verbally explain their rationale while drawing mechanisms as well as optimizing graphical collaborative learning activities for online learners.

Winterton, C. (2018). *Peer-led Team Learning: The effects of peer leader and student interactions on student learning gains and course achievement in introductory biology*. (Ph.D. dissertation, unpublished manuscript), Syracuse, NY, Syracuse, NY. Available online: <https://surface.syr.edu/etd/901/>

This study sought to connect the literature on Peer-Led Team Learning (PLTL) to the work on student-teacher interactions as well as STEM role models. Student and peer leader interactions were explored to determine the effect of these interactions on student learning outcomes.

Students and their peer leaders were both asked to determine the student's learning gains from the PLTL course. Perceived learning gains were measured using a modified version of the Student Assessment of their Learning Gains (SALG) instrument. Peer leader responses were paired with their student's responses to determine differences in peer leader ability to discern learning gains, learning gains from students in different groups, and to identify the pairings that were most closely aligned. Qualitative data from open-ended questionnaires collected from the peer leaders were used to establish contributing factors of these findings. The ability to relate to the student was found to be an important factor in peer leader's ability to assess learning gains and establishing a positive relationship between student and peer leader. Relatability was further shown to positively and significantly influence student's final grade in the course, as well as increase student perceived learning gains. When students considered their peer leaders to be a role model, perceived learning gains significantly increased but there was no measurable effect on final course grade. Positive interactions with the peer leader were shown to benefit all students, regardless of their chosen major. Qualitative responses from peer leaders and students were analyzed to identify the factors contributing to role model status.

Woods, D. R. (2014). Problem-oriented learning, problem-based learning, problem-based synthesis, process oriented guided inquiry learning, Peer-Led Team Learning, model-eliciting activities, and project-based learning: What is best for you? *Industrial & Engineering Chemistry Research*, 53(13), 5337-5354. doi: 10.1021/ie401202k.

The educational contributions of David Himmelblau and Gary Powers are extended by describing a broad spectrum of learning environments that start with a problem. Many of these are characterized in the literature as being simply problem-based learning (PBL) or claiming to be similar to PBL (for example, process oriented guided inquiry learning, model-eliciting activities, project-based synthesis). In this paper, the different outcomes from the learning environment and the degree to which students are empowered with the learning process are criteria used to help identify the subtle differences of the options in 33 learning environments. Elaborations and examples are given for 23 of these. Options for assessment are cited. Brief suggestions are given about how to select an effective learning environment with which you are comfortable.

Woodward, A., Gosser, D., & Weiner, M. (1993). Problem-solving Workshops in General Chemistry. *Journal of Chemical Education*, 70(8), 651. doi: 10.1021/ed070p651.1.

A pilot program to restructure the conventional two semester general chemistry lecture course for science and engineering majors with two main goals: 1) improve student performance in the course and 2) increase student interest in chemistry. The performance on examinations is directly related to workshop attendance and the passing rate has been increased substantially. Student surveys show increased interest in chemistry as a possible major.

Xu, C., Kwon, O., But, J., Mendoza, B., Lio-Mark, J., & Ostrom, R. (2018). *Peer-led Team Learning bridges the learning gap in a first-year engineering technology course*. Conference Proceedings of the ASEE Mid-Atlantic Section Spring Conference, Washington, District of Columbia.

Electrical Circuits (EMT 1150) is a first-year engineering gateway course for Electromechanical Engineering Technology (EMT) associate degree students. It is a five-credit course with a combined lecture and laboratory components. EMT 1150 has always been identified as one of the most challenging courses in the major with high failing rate. From the instructors' perspective, the reason for the high failure rates is due to first-year students having to learn the language of engineering in a very short time; simultaneously, they need to develop good critical thinking and problem-solving skills. In this paper, the preliminary results of a new pedagogical approach that incorporates Peer-Led Team Learning (PLTL) and discipline-specific literacy

strategies to improve student learning will be presented. The proposed approach consists in a restructure of the course material and the introduction of recitation workshop integrated with the PLTL strategies. The new course design was piloted in a semester and the results were compared with a controlled section using a uniform final exam at the end of the semester. On average, the piloted PLTL section performed approximately 15% higher than the non-PLTL sections.

Yanez, D., Saupe, G., & Becvar, J. E. (2012). *Let my people go*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Yanez-2012.docx>
Motivating students to study and learn chemistry is difficult especially as the semester progresses and more and more abstract concepts are introduced. Peer-Led Workshops have many types of students: some students are independent learners that don't need extra help; many students, however, benefit significantly from closer to one-on-one attention. This latter category of student often has a tendency simply to become overwhelmed without extra assistance and then to give up. Peer-Led Team Learning at UTEP offers strategies to reach those students in need of significant help. One of them is the "Let my People Go" incentive that offers all students in Workshop the opportunity to leave early (e.g. 20 minutes early from the two-hour workshop) if they demonstrate understanding of the concepts for the week. After the independent or successful learners have departed, the peer leader can focus on and personally assist the "Lost Sheep": those students in greater need of the one-on-one problem-solving attention.

Yarnel, A. (2002). Focusing on reform. *Chemical & Engineering News*, 80(43), 1562. Available online: http://pubs.acs.org/subscribe/journals/cen/80/i43/toc/toc_i43.html.
Brief overview of the PLTL approach to curricular reform.

Zaki, N. (2016). PageRank algorithm to improve the Peer-Led Team Learning pedagogical approach. *Smart Education and e-Learning*, 59, 226-234.
Peer-Led Team Learning model has been introduced into several undergraduate courses and it showed improvement in students' learning performance. Despite its success, little attention has been given to further enhance the model for academic benefits particularly in terms of suitable peer leaders selection, homogenous groups forming and the process of disseminating the educational knowledge. In this paper, we utilized PageRank Algorithm to improve the PLTL pedagogical approach. Unlike the traditional way, we introduced social interaction analysis as a way to create natural groups of students, and select the best peer leaders in classrooms who can disseminate the educational knowledge in an efficient and smooth fashion. The new proposed approach was tested on a dataset of 16 students in an Operating System course offered at the College of Information Technology (CIT), United Arab Emirates University. The improvement in students' performance achieved is encouraging evidence in favor of the proposed method.

Zha, S., Estes, M. D., & Xu, L. (2019). A meta-analysis on the effect of duration, task, and training in peer-led learning. *Journal of Peer Learning*, 12(1), 5-28. Available online <https://ro.uow.edu.au/ajpl/vol12/iss1/2>.

This meta-analytic study compared the effect of peer-led learning versus non peer-led learning on students' cognitive achievement in post-secondary education. Twenty-eight studies published in English from six countries between 1993 and 2017 were identified and used in the analysis. Some of these studies included ones of Peer-led Team Learning, Supplemental Instruction (SI), or variations of SI as used in other countries under different names. Result of the analysis on the random-effect model showed a moderate but positive effect, meaning that

peer-led learning was associated with higher cognitive achievement than non-peer-led learning. Three study characteristics were examined including duration, student leaders' training, and task type. Only the task type was found significant in moderating the effect of peer-led learning. Student leaders' facilitation of problem-based learning tasks outperformed other types of tasks. Results of this study not only provided suggestions for peer-led learning designers and coordinators but also called for future research of student leaders' readiness as well as online peer-led learning.

Zonoozi, F., Narayan, M., & Becvar, J. E. (2012). *Foundation of the leaders, by the leaders, and for the leaders*. Conference Proceedings of the Peer-led Team Learning International Society Inaugural Conference, Brooklyn, NY. Available online: <http://pltlis.org/wp-content/uploads/2012%20Proceedings/Zonoozi-2012.docx>

Funding Peer-Led Team Learning (PLTL) initiatives after the grants run out has been a long-standing and often devastating issue within the greater PLTL world. We propose consideration of local independent nonprofit organizations (Local Foundations) or possibly Local Chapters within PLTLIS to advance Science, Technology, Engineering, and, Mathematics (STEM) education through the PLTL model. The proposed Foundations are envisioned as collaborations of: Academics; Industry leaders; University Students; Members of the local education district; and High School teachers to be run and funded locally from the ground up rather than from top down. This will give the Leaders and those directly interacting with them more opportunity to govern their own path without university encumbrances, such as Development Office, Administration, or System/University/College politics, restrictions and fees. The purpose of the Foundations is to provide K – 16 pupils with the requisite skills to enter and succeed in higher education STEM (or any other) disciplines. The function includes aiding instructors in the K – 12 realm to enable students toward successful transition to higher education. Independent foundations organized and overseen by the Leaders can promote PLTL using outstanding students from Universities/Colleges, High Schools and Community Colleges. Foundations can seek funding from local and federal government entities, individuals and most importantly businesses/industries and other philanthropic organizations.

Zurer, P. S. (2001). Teaching organic chemistry. *Chemical & Engineering News*, 79(16), 43-45. This article describes the use of Peer-led Team Learning (PLTL) workshops in an organic chemistry course at the University of Rochester-New York.

Structured Learning Assistance (SLA)

SLA was developed at Ferris State University (MI) in the 1994. It is available to all interested students in targeted courses which are historically difficult. SLA features weekly study and practice workshops in which students master course content, develop and apply specific learning strategies for the course, and strengthen their study skills to improve performance in the current SLA course, and for future courses. With some SLA programs, attendance is mandatory for all students until the first exam. With some SLA programs, students earning ABC grades are invited but not required to attend further (Morton, 2006). The SLA homepage is <http://www.ferris.edu/sla/>

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online: <https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

2 - Homepage of the Structured Learning Assistance Program. Available online: <http://www.ferris.edu/sla/>

This is the web homepage for Structured Learning Assistance based at Ferris State College in Michigan. A variety of descriptive information, evaluation studies, and training materials are available.

Arendale, D., R. (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>
This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all

published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing.

These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*. Department of Curriculum and Instruction, University of Minnesota. Available online: <https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational, something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Burns, F., & Frank, D. (2012). The use of electronic media for chemical education research. In M.-H. C. e. al. (Ed.), *Chemistry education and sustainability in the global age* (pp. 185-195). New York, NY: Springer Science

During spring 2010, the researcher taught a one-semester survey course of general chemistry (CHEM 114). Some of these chemistry students also elected to participate in the university’s Structured Learning Assistance (SLA) Program. These SLA students met with an advanced undergraduate student for extra instruction. SLA students typically outperformed the non-SLA students in many markers for course success in prior semesters. What happens in the SLA sections? The answer to this question could potentially improve the instructor’s entire CHEM 114 course and student learning in general. Student learning logs provide a remarkable window into student learning. Since 2007, the instructor has used electronic “learning logs” in the chemistry classroom to improve learning. On a weekly basis, students summarize their week’s work: lecture notes, laboratory tasks/experiments, and online homework. Students are also asked to reflect on the past week’s work and write down their questions, difficulties, and feelings. As a result, large amounts of high-quality information can be easily collected. Learning logs from SLA students were used to identify SLA activities and related reflections from their perspective. Based upon qualitative analysis, SLA students frequently reported formative evaluation and question and answer sessions as SLA activities. Ultimately, this research illustrates the utility of electronic media for education research and teacher development.

Diehl, T. E. (2017). Development of a Structured Learning Assistance (SLA) program. *Journal of Developmental Education*, 40(3), 32-34.

Structured Learning Assistance (SLA) was implemented to improve student performance in developmental-level math courses (introductory algebra and intermediate algebra) at an institution. The article explains how the researcher studied the SLA model from Ferris State University and adapted it for use at the institution. The results were SLA students were half as likely to earn a grade of below C on unit exams as well as the final course grade. After this successful pilot, the attempt was made to scale-up the SLA program to serve more courses. However, the institution believed it was too costly and instead created an open "math lab" for students to seek assistance.

Doyle, T. (1999). Ferris State University's structured learning assistance program. *Michigan Developmental Educational Consortium Newsletter*, 4-5, 8.

This newsletter article describes a learning model at Ferris State University. The Structured Learning Assistance Program (SLA) provides both an academic and an affective support system. SLA targets both high-risk for failure gateway and historically difficult upper division courses with four-hour per-week directed practice workshops. The SLA workshops are formally scheduled in the student schedule just like an accompanying science lab. Attendance at the workshop is required of all students the first week of the course or until the first test, quiz or other assessment is given in the class. Following the assessment, attendance is required only for students whose course grade point average falls below a 2.0 Other students may voluntarily continue to attend the SLA sessions. In addition to traditional SI program features, class professors receive regular, ongoing information about student progress, student concerns, and ways of better connecting with students. SLA sessions provide more explicit instruction in learning strategies. Research studies suggest that SLA students earn higher final course grades than nonparticipants in control groups.

Doyle, T., & Hooper, J. (1997). *Structured Learning Assistance Project. Final Report, Fall Semester 1996, Winter Semester 1997*. Unpublished manuscript. Ferris State University. Big Rapids, MI. Available online: ERIC database. (ED425772).

Initiated in 1994, Structured Learning Assistance (SLA) is a research project whose purpose is to determine if, for certain courses, grades can be improved by requiring students to attend weekly practice workshops. These SLA workshops assist students in developing the background needed to connect to the course content and to develop and apply the learning strategies most appropriate to the content area. This report details the 3-year findings of the SLA project, as well as findings for all students who participated in it during the 1996-1997 academic year, with a focus on minority students. Results indicated that SLA can significantly improve student pass rates, even for at-risk students. In nearly 85% of the 42 courses offered with SLA support, the SLA students had higher pass rates than those of all other university students taking the same courses. This improvement was especially marked in the mathematics courses, where the average pass rate increased anywhere from 24 to 45 percent. Student evaluations of the SLA project are included. Appended are minority and total student data for fall 1996 and winter 1997, statistics on the project's 3-year averages, and pass rate by subject area.

Doyle, T., & Kowalczyk, J. (1999). *The Structured Learning Assistance Program model*.

Conference Proceedings of the National Association for Developmental Education, Detroit, MI. Structured Learning Assistance (SLA) was developed at Ferris State University (OH) to meet the need of challenging 100- through 400-level courses. SLA is an in-course student community that is directly attached to courses. The article provides background to the SLA model. Data suggests the following outcomes for the SLA program: higher rates of earning C- or better in the

course, higher persistence rate at the institution, and 73% of students attributed SLA as significant to their academic achievement.

Dvorak, J., & Tucker, K. (2017). The case for intentionally interwoven peer learning supports in gateway-course improvement efforts *Improving teaching, learning, equity, and success in gateway courses* (pp. 43-52). New York, NY: Wiley

This chapter describes how peer learning support programs can be used to improve learning and success in gateway courses. It provides examples from two institutions to further illustrate how this promising approach can improve student outcomes.

Edwards, S., Willey, T., & Griggs, F. (2013). *The impact of a Structured Learning Assistance Program on performance in a managerial finance course*. Conference Proceedings of the 2013 SOBIE Annual Academic Conference, Destin, FL.

The purpose of this research is to measure the performance of students in a conventionally taught required course in Managerial Finance at a large Midwestern university versus a section taught by the same instructor using a Structured Learning Assistance (SLA) Program. The content for a SLA course is identical to a non-SLA course. The difference in the SLA approach is if a student grade falls below a C, the SLA student is required to attend weekly workshop sessions until the grade returns to the required level, or higher. Our hypothesis is the overall course grade for the experimental class (SLA section) is significantly different from the overall course grade in the control section (non-SLA section). We have collected the core data and are in the process of analyzing the results.

Freeman, J. C., & All, A. (2017). Academic support programs utilized for nursing students at risk of academic failure: A review of the literature. *Nurse Education Perspectives*, 38(2), 69-74. doi: 10.1097/01.NEP.0000000000000089.

The purpose of the literature review is to evaluate and discuss the various types of academic support programs used for at-risk nursing students to identify those that are most effective. Nurse educators are concerned about students admitted to nursing programs who are unable to successfully complete the program. To determine the format and efficacy of academic support programs, the literature review addressed the identification of at-risk students and academic support programs applicable to all student groups. Nurse educators need to develop and implement plans to support and retain students in order to address the impending nursing shortage. Replacing a student lost to academic failure is difficult. Although utilized in different manners, academic support programs are an effective retention strategy.

Garcia, B. (2004, 2004, February 18). The 11th anniversary of SLA, *Torch*.

This newspaper article recounts the history of Structured Learning Assistance (SLA) at Ferris State University. It provides interviews with creators of the program along with the early history of SLA.

Giraldo-Garcia, R. J., & Magiste, E. J. (2018). Exploring the impact of Structured Learning Assistance (SLA) on college writing. *College Quarterly*, 21(1). Available online: <http://files.eric.ed.gov/fulltext/EJ1169340.pdf>.

This study determined that the addition of Structured Learning Assistance (SLA) attendance increased passage rates (from 66.5% to 82%) of first year students in English 101 courses. The model predicts first year students' performance in college writing, controlling for variables such as American College Test scores, and gender. A quasi-experimental design and a logistic regression model of analysis were used. The results indicate that attendance to SLA has a significant and positive impact on passing English 101. The authors discuss the importance of

formal peer-tutoring and support and recommend increasing the number of SLA sessions for first-year college students.

Grant, A. R. (2015). *NCLEX-RN predictor test scores and NCLEX-RN success*. (Ed.D. dissertation), Walden University, Minneapolis, MN. Available online: <http://scholarworks.waldenu.edu/dissertations/1622/>

Health care professionals and nurse educators are concerned about increasing percentage of first time test takers failing the NCLEX-RN exam. The purpose of this retrospective study was to examine predictive accuracy of the Assessment Technologies Institute (ATI) RN Comprehensive Predictor for passing or failing the NCLEX-RN exam in a cohort of nursing students (N = 195). South Eastern Technical College in South Carolina is in jeopardy of losing accreditation for their nursing program because of the low percentage of first time test takers failing. The college's pass rate on the NCLEX-RN exam has been below the national and state averages for the last 2 years. Guided by Bloom's taxonomy and Knowles' andragogical model of learning as the theoretical mainstay, factors that predict success with the NCLEX-RN exam for first time test takers were examined. Inferential and descriptive statistics were used to determine if a relationship existed between NCLEX-RN scores and the independent variables. A Pearson r correlation test was conducted to address whether the ATI Comprehensive Predictor accurately predict student success with the NCLEX-RN exam on first attempt. Multiple regression was employed to test for a significant relationship between prenursing GPA, final GPA, age, gender, and ATI predictor scores. Regression analysis results showed ATI Predictor scores to significantly predict student success with the NCLEX-RN exam on first attempt. Based on findings, a Structured Learning Assistance program was proposed to assist in preparing students for NCLEX-RN success. Positive social change occurs within the community, nursing programs, and health care by increased NCLEX-RN pass rates enhancing the number of nurses entering into health care.

Jones, L. T. (2019). *Mindfulness, motivation, and mindset: The effects of positive language on students with deficiencies success*. (Ph.D. dissertation), Trevecca Nazarene University. This study was conducted to understand the influence of individual mindfulness, and the impact of motivation in the form of positive language on mindset, with students who have deficiencies in math. Students with academic deficiencies enrolled in co-requisite statistics courses, with required workshops attached to the course to remediate the deficiency, were studied. Workshop leaders in the treatment groups were provided positive language examples and encouraged to use those and any additional encouragement they thought appropriate. Mindfulness was measured using the MAAS survey and Mindset was measured using the PERTS survey. Predicted and final GPA's were also measured.

Morton, A. M. (2006). Improving NCLEX scores with Structured Learning Assistance. *Nurse Educator*, 31(4), 163-165. Available online: http://journals.lww.com/cinjournal/Fulltext/2008/09001/Improving_NCLEX_Scores_With_Structured_Learning.19.aspx.

This article describes the use of Structured Learning Assistance (SLA) with improving NCLEX scores for nursing students at Ferris State University (MI). SLA is attached to the nursing pharmacology course offered the first clinical semester and the three medical/surgical nursing courses offered the second, third, and fourth clinical semesters. Studies show that students obtaining higher course grades earn higher pass rates on the NCLEX examination (improved from 65% to 92%).

Nordquist, A. L., Mitchell, T. V., Overmand, P. R., Van Ness, C. J., & Gadbury-Amyot, C. C. (2017). Student Preparation for the National Board Dental Hygiene Examination: A national survey of dental hygiene program directors. *Journal of Dental Hygiene, 91*(2), 23-31.

Purpose: Dental hygiene students nearing completion of their educational programs are required to take written and clinical examinations in order to be eligible for licensure. The written licensure exam, the National Board Dental Hygiene Examination (NBDHE), is administered by the Joint Commission of National Dental Examinations (JCNDE). Failing a licensing examination is a costly experience for students and has the potential for a negative impact on a program's accreditation status. Nursing programs have published extensively on strategies used to prepare students for licensure examinations. However, there appears to be a gap in the literature as to how dental hygiene programs prepare their students to take the NBDHE. The purpose of this study was to conduct a national survey of U.S. dental hygiene program directors to determine what strategies their programs employ to prepare students to take the NBDHE and to explore the viewpoints of dental hygiene program directors regarding student preparation methods for the NBDHE. Methods: A survey instrument was developed, pilot tested, revised and mailed to directors of the 335 CODA accredited U.S. dental hygiene programs. The survey consisted of a combination of response formats including forced choice, multiple allowable answered, and open-ended written comments. Results: A total of 154 surveys were returned, yielding an overall response rate of 45% (154/341). The vast majority of directors (93%) reported they use specific methods and practices to prepare students for the NBDHE. The top two strategies identified were dental hygiene review texts (84%) and a board review course (83%). The majority of directors (84%) reported supporting student participation in non-mandatory, commercial review courses. In regard to mock board exams, directors "agreed/strongly agreed" (75%) that the mock board exam is a useful coaching tool in the overall process of NBDHE preparations. A majority (65%) indicated they were not concerned with failure rates, and 43% reported failure rates do reflect on the program. Conclusion: These results suggest that the majority of dental hygiene programs are utilizing strategies to prepare students for the NBDHE with board review textbooks and board review courses named as the top two strategies.

Salomone, M. (2017). Required peer-cooperative learning improves retention of STEM majors. *International Journal of STEM Education, 4*(19). doi: 10.1186/s40594-017-0082-3. Available online: <https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-017-0082-3>.

Background

Peer-cooperative learning has been shown in the literature to improve student success in gateway science and mathematics courses. Such studies typically demonstrate the impact of students' attending peer-led learning sessions on their learning or grades in an individual course. In this article, we examine the effects of introducing a required, comprehensive peer-cooperative learning system across five departments simultaneously at a master's public university, looking not only at students' success in supported classes, but also their retention within STEM fields two years hence. Combining institutional demographic data with students' course grades and retention rates, we compare outcomes between 456 students who took their major's introductory course in the two years prior to implementation of the program, and 552 students who did so after implementation. While these two student groups did not significantly differ in either their demographic profile or their SAT scores, the post-implementation group earned significantly higher grades in their introductory courses in each major, due largely to an erasure of the mediating effect of SAT scores on course grades. Further, this increase in introductory course grades was also associated with an increase in the two-year retention rate of students in STEM majors. This finding is significant as it suggests that implementing comprehensive educational reform using required peer-led cooperative learning may have the proximate effect of mitigating differences in academic preparation (as measured by SAT scores)

for students in introductory STEM courses. Furthermore, this increase in success leads to increased retention rates in STEM, expanding the pipeline of students retained in such fields.

Stern, C. (1996). Structured Learning Assistance in the basic writing class. In D. C. Mollise & C. T. Matthews (Eds.), *Selected conference papers, volume 2, 20th annual conference of the National Association for Developmental Education* (pp. 39-41). Little Rock, AR: National Association for Developmental Education

This paper provides an overview of the Structured Learning Assistance (SLA) program and its use in a basic writing class at Ferris State College in Michigan.

Supplemental Instruction (SI)

SI was initially developed for health science students at the University of the Missouri-Kansas City by Dr. Deanna C. Martin and her colleagues in 1973. SI was implemented in historically-difficult courses with permission of the instructor, which commonly serves “gatekeeper” introductory courses that require mastery before advancing in the subject area, invites voluntary participation in out-of-class student-led study sessions, provides extensive training and ongoing coaching of student facilitators of the study groups throughout the academic term, and evaluates outcomes in each course every time it is offered. Based on studies from hundreds of institutions in the U.S. and abroad, participating students earn higher final course grades, demonstrate lower rates of DFWI, and have higher persistence rates. Some studies also show that participation improves personal and professional development outcomes for both the participants and facilitators. Goals of SI include: (1) improve student grades in targeted courses; (2) reduce the attrition rate within those courses; and (3) increase the eventual graduation rates of students. All students in a targeted course are urged to attend SI sessions, and students with varying ability levels participate. There is no stigma attached to SI since *historically difficult courses* rather than *high risk students* are targeted. SI is scalable and can be implemented in one or more courses each academic term. There are four key persons involved with SI. The first is the *SI supervisor*, a trained professional on the SI staff. The SI supervisor is responsible for identifying the targeted courses, gaining faculty support, selecting and training SI leaders, and monitoring and evaluating the program. Once the historically difficult courses have been identified, the SI supervisor contacts the faculty member concerning SI for their course. The second key person for SI is the *faculty member* who teaches one of the identified courses. SI is only offered in courses in which the faculty member invites and supports SI. Faculty members screen SI leaders for content competency and approve selections. The third key person is the *SI leader*. SI leaders are students or learning center staff members who have been deemed course competent, approved by the course instructor and trained in proactive learning and study strategies. SI leaders attend course lectures, take notes, read all assigned materials, and conduct three to five out-of-class SI sessions a week. The SI leader is the “*model student*,” a facilitator who helps students to integrate course content and learning/study strategies. The fourth key member of the SI program are the *participating students*. The original name for SI was *Supplemental Course Instruction (SCI)*. SI is sometimes named *Peer Assisted Learning (PAL)*, *Peer Assisted Study Sessions (PASS)*, *Peer Assisted Study Schemes (PASS)*, or *Peer Assisted Study Support (PASS)*. A few times SI is named *Academic Mentoring*, *Peer Mentoring in Praxis (PMIP)*, *Academic Peer Mentoring Scheme (APM)*, and simply *Peer Mentoring*. Other than use of the capitalized SI name, some of these other names may be used to describe approaches that are different than SI both domestically in the U.S. and globally. The homepage for SI is <https://info.umkc.edu/si/>

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online: <https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental

Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

2 - Homepage of the International Center for Supplemental Instruction. Available online:
<http://info.umkc.edu/si/>

This Internet homepage maintained by the International Center for Supplemental Instruction at the University of Missouri-Kansas City provides a central location for information about SI. Some of the menu items include: overview of SI; links to homepages of SI leaders at UMKC; information about upcoming SI Supervisor training workshops; instructions on how to subscribe to the SI listserv discussion group; SI materials for sale; directory of known SI homepages from other colleges around the world; and other resources.

3 - Homepage of the Supplemental Instruction Journal. Available online:
<http://info.umkc.edu/si/journal/>

The Supplemental Instruction Journal is published by the International Center for Supplemental Instruction (<http://info.umkc.edu/si/journal/>). It is a journal that seeks to publish the latest research in the field and to be the foremost resource for advancements and discoveries related to Supplemental Instruction. siJ is peer-reviewed by national and international education professionals working with Supplemental Instruction and is intended for a wide audience.

4 - Homepage of the Email Discussion Listserv for Supplemental Instruction. Available online:
<http://info.umkc.edu/si/si-net/>

This moderated computer discussion listserv is provided by the International Center for Supplemental Instruction (SI). SI-Net is intended as a modern forum for the exchange of ideas among those interested in SI. To date, faculty and staff from over 1000 institutions in 13 countries have participated in SI Training trainings. So when you email the SI-Net, you are emailing SI supervisors, Certified Trainers, faculty members, and SI leaders around the world. Exchange of ideas and techniques between institutions Opportunities for SI leaders to participate in dialogue with SI supervisors and faculty members Identification of new educational resources and practices that would be helpful for other members of the network Discussion about customizing SI as it is implemented in specific academic content areas and institutions Announcements about SI-User group meetings, training opportunities, and job opportunities SI-Net is an independent, unmoderated, mailing-list interest group. This means it is open to all participants' mailings without editing or prior approval. Though it is made possible by the cooperation and facilities of the participating institutions, its activities or any opinions expressed through it are without the sanction of any unit, department or school. Neither the institutions nor the participating states are responsible for its content. There is no charge from the University of Missouri-Kansas City to subscribe to SI-Net. We look forward to talking with you on the network. To subscribe to the SI-Net listserv, please follow the link below and follow the directions:
<http://listserv.umkc.edu/scripts/wa.exe?SUBED1=SINET&A=1>

5 - Homepage of the Email Discussion Listserv SI Connect for SI Leaders. Available online:
<http://listserv.umkc.edu/scripts/wa.exe?SUBED1=silconnect&A=1>

Sponsored by the International Center for Supplemental instruction, SIL Connect provides SI Leaders the opportunity to have their own listserv. This is a place for Leaders to share session plan ideas, collaborative learning techniques, and to troubleshoot common issues. It's also a great place for them to network with other SI Leaders to build community around their work.

6 - Homepage of the Journal of Peer Learning. Available online: <http://ro.uow.edu.au/ajpl/>
The Journal of Peer Learning (ISSN 2200-2359) publishes research articles about peer learning across a variety of contexts, predominantly higher education. *The Journal of Peer Learning* - formerly *The Australasian Journal of Peer Learning* - is a ranked journal in the Australian Research Council's Excellence in Research for Australia (ERA) journal list. All suitable manuscripts submitted to the Journal of Peer Learning undergo a double-blind peer review process. *The Journal of Peer Learning* is open-access and does not charge authors or readers a fee. Volumes 1 to 3 of *The Journal of Peer Learning* were published as *The Australasian Journal of Peer Learning* (ISSN 1836-4306). While many of the articles relate to SI (or it is sometimes known as PAL and PASS), it publishes articles from a wide range of peer learning programs around the world.

7 - Homepage of YouTube videos related to Supplemental Instruction; Peer-Led Team Learning; and Peer Assisted Learning Program. Available online: <https://z.umn.edu/peerlearningyoutube>
This YouTube channel aggregates posted videos by peer learning programs related to Supplemental Instruction (UMKC model), Peer-Led Team Learning (CUNY model), and Peer Assisted Learning (UMN model). SI is also known by other names included PAL and PASS. Click on "playlists" tab in the main menu bar to locate the particular peer learning program or topic of interest. This YouTube channel is not formally associated with SI or PLTL but is managed by David Arendale who helped with a larger team to create the UMN PAL model. It is also a location where David Arendale posts videos of his scholarly interests with peer learning and includes interviews with student peer study group leaders and others.

8 - Homepage of the Australasia National Centre for Supplemental Instruction/PASS. Available online: <https://www.uow.edu.au/engage/pass-centre/>
The University of Wollongong (UOW) PASS program has received extensive national and international acclaim. Click here for a list of the awards the program has received. Since 2005, the UOW PASS Program has also been accredited by the International Center for Supplemental Instruction (SI), UMKC as the National Centre for PASS/SI in Australia. Hundreds of staff from dozens of institutions around the Australasian region have benefited from training and assistance delivered by PASS@UOW. UOW is also host for the Journal of Peer Learning, the premiere journal for scholarly publications related to peer learning including SI and PASS.

9 - Homepage of the Canadian National Center for Supplemental Instruction. Available online: <http://www.canadiansi.uoguelph.ca/>
In 2008, the University of Guelph was designated as the Canadian National Centre for Supplemental Instruction by the University of Missouri Kansas City, home to the International Center for Supplemental Instruction. Krista Bianco is a Certified Trainer in Supplemental Instruction, and oversees the following activities of the National Centre: Delivery of Certified SI Supervisor Training and other professional development opportunities; Liaison with existing Canadian SI Programs, and with the International Center for SI; Support and dissemination of research and evaluation initiatives as well as press coverage related to SI in the Canadian context; and Consultation services with institutions from across Canada that are implementing or considering the SI model on their campus

10 - Homepage of the European Center for SI-PASS. Available online: <https://www.si-pass.lu.se/en/>
Welcome to the European Center for SI-PASS. We are one of five centers in the world with the mission of informing, educating and evaluating SI programs. Our mission area is Europe, where we continuously offer SI methodology supervisor training. We attend conferences to

disseminate information, ensure quality and make joint evaluations of the various programs within SI-PASS.

11 - Homepage of the Southern Africa National Office for Supplemental Instruction at Nelson Mandela University. Available online: <https://si.mandela.ac.za/>
The Southern Africa National Center for SI is hosted at Nelson Mandela University in Port Elizabeth, South Africa

12 - Homepage of Northern South Africa Regional Center for Supplemental Instruction. Available online: <http://services.nwu.ac.za/ctl/supplemental-instruction>.
The Northern South Africa Regional Center for Supplemental Instruction is hosted at North-West University, Potchefstroom, South Africa.

Abraham, N., & Telang, N. (2018). *Understanding behaviors of attendance in Supplemental Instruction and subsequent academic success in a first year engineering course* Conference Proceedings of the ASEE Gulf-Southwest Section Annual Conference The University of Texas at Austin Available online:
http://www.aseegsw18.com/uploads/1/0/2/0/102073464/3a1_abraham_final_paper_understanding_behaviors_of_attendance_and_academic_success_to_supplemental_instruction_in_first_year_engineering_course_revision_12mar18.pdf

As student retention and four-year graduation rates are of institutional and national interest and frequently referred metrics for college success, the Supplemental Instruction (SI) program aims to reduce D's, F's and Q drop rates in historically difficult classes. Although previous work done by this group revealed that attending SI sessions for a first year course (Introduction to Electrical Engineering) positively impacted exam scores and subsequent course grades [1], the program continues to experience low participation rates. Emerging questions of student behaviors in relation to attendance at SI sessions are addressed in this article. The study utilizes a mixed-methods approach, incorporating quantitative data relating to grades and attendance with qualitative data relating to student awareness, use and perceptions about SI. These analyses serve to gain an understanding of the effects of SI and identify components of the program that students value. Quantitative data was collected in the form of session attendance logs, grade data, and student demographics. Qualitative data was collected in the form of pre- and post surveys administered during the third and final week of the semester.

Abraham, N., & Telang, N. (2019). *Effectiveness of the Supplemental Instruction program in first-year engineering courses - A longitudinal report (2015 - 2018)*. Paper presented at the 2019 ASEE Annual Conference & Exposition, Tampa, FL. Available online:
<https://peer.asee.org/32692>.

This Complete Research Paper examines the effectiveness of the Supplemental Instruction (SI) program implemented at our university in first year engineering courses from its inception in 2015 through 2018. As student retention and four-year graduation rates are of institutional and national interest and frequently referred metrics for college success, the historically successful and well-studied Supplemental Instruction (SI) program was introduced in 2015 through a collaboration between the School of Engineering and the campus Learning Center. The supported courses included, Introduction to Electrical Engineering, and Introduction to Computing. These are required courses for the Electrical and Computer engineering students at the university, and report high percentages of D's, F's, Q's (drops), and W's (withdraws). In the fall of 2016 this program was expanded to the Network Analyses course in the Biomedical Engineering department at the university. To improve academic success, the Supplemental Instruction (SI) program provides optional, non-remedial sessions designed to deliver content review and additional practice opportunities while developing transferable skills to benefit the

student in all coursework at the institution. The SI program is an academic support program created in 1973 at the University of Missouri in Kansas City, to improve grades in traditionally “difficult” classes, promote student retention and increase graduation rates. In the thirty years since its creation, it has become widespread and is considered an effective academic support model (Dawson et al., 2014). The program uses a peer-assisted learning model to review class material and develop transferable study skills. SI leaders, undergraduates who have completed the course successfully, are selected for interest in teaching and learning, offer two sessions per week that incorporates peer and collaborative learning strategies married with course material review. This report provides a longitudinal view of the effects of SI, an examination of aspects of the program that are successful and areas for improvement, as well as provide evidence for expansion to other courses. The study utilizes a mixed-methods approach, incorporating quantitative data relating to grades and attendance with qualitative data relating to student perceptions about SI. Over the course of three years, the collaborators have collected multiple types of data, including students’ SI session attendance and academic performance in the current course, as well as subsequent courses and semesters, students’ demographic data, and the D’s, F’s, W’s and Q drop rates (QDFW rates) for attendees and non-attendees. Qualitative data was collected in the form of surveys administered to attendees from 2015-2018. An analysis conducted for every semester starting in 2015 showed a minimum of 15 percent decrease in QDFW rates for SI attendees (students who attended 2 or more sessions) vs. non-SI attendees (students who attended 0 or 1 session). In spring semesters, the difference was even more pronounced, with SI attendees’ QDFW rates at minimum being less than half of that for non-SI attendees (see the Table 1 below). In 2017, the collaborators were able to compare students with similar SAT scores and found a more pronounced positive effect on end of semester course GPA for those students who had low SAT scores and attended SI regularly compared to those who did not attend. As the SI program’s effectiveness is assessed by aiming to reduce the QDFW rates in first year engineering courses and in turn retain more students to the ECE program, especially those students who are most at risk (first generation, women, non-dominant, etc.), we plan to provide an in-depth analysis of how the SI program affects these specific demographics, as well as compare students outcomes in the three year period using SAT scores for a more accurate reflection of the effects of SI. Table 1: % DFQW for Introduction to Electrical Engineering

Year	Non SI	SI
Fall 2015	11.6%	9.3%
Spring 2016	44%	16%
Fall 2016	17.2%	4.7%
Spring 2017	25.7%	0%
Fall 2017	12.7%	9.35%
Spring 2018	27.9%	9.5%

Adams, J. (2011). *The relationship between Supplemental Instruction leader learning style and study session design*. (Ed. D. dissertation), University of North Texas, Texas.

The purpose of this qualitative study was to examine the learning styles of Supplemental Instruction leaders at a large, public university during the fall 2010 semester and determine whether or not their personal learning styles influenced the way they designed and developed out-of-class study sessions. The total population of Supplemental Instruction leaders was 37, of which 24 were eligible to participate in the study. Of the 24 eligible supplemental instruction leaders, 20 completed the entire study. Participants in the study included nine male and 11 female supplemental instruction leaders with a median age of 22.25 years-old. Seventeen participants indicated their classification as senior, two as junior, and one as sophomore. Of the participants, 16 indicated white as a race or ethnicity, one indicated Asian, two indicated African American, and one indicated both American Indian/Alaska Native and white. Supplemental instruction leader learning style was assessed using the Kolb Learning Style Inventory. Leaders were then interviewed, and their study sessions were analyzed. Through triangulation of data from learning style, interviews and actual study session documents, four major themes emerged. The four themes were: 1) incorporation of personal experience into study session design, 2) the sense of impact on student learning, 3) a feeling of the need to incorporate varied activities into study session design, and 4) the concept that students must take ownership over

their own learning. No consistent pattern emerged among the themes; however, the results attributed out-of-class study session design to both the incorporation of personal learning style preferences as identified through the Kolb Learning Style Inventory and training conducted by the institution. Implications for future research include the need for continued research addressing how and if Supplemental Instruction leader learning style influences out-of-class study session design. Also, as institutions of higher education seek to expand academic support services to all students, future research should explore Supplemental Instruction leader training and the impact such training has on students seeking support from the Supplemental Instruction program.

Adams, J. D., & Bush, V. B. (2013). The relationship between Supplemental Instruction leader learning style and study session. *The Learning Assistance Review*, 18(2), 51-65.

The purpose of this qualitative study was to examine the learning styles of Supplemental Instruction leaders at a large, public university during the fall 2010 semester and determine whether or not their personal learning styles influenced the way they designed and developed out-of-class study sessions. The total population of Supplemental Instruction leaders was 37, of which 24 were eligible to participate in the study. Of the 24 eligible supplemental instruction leaders, 20 completed the entire study. Participants in the study included nine male and 11 female supplemental instruction leaders with a median age of 22.25 years-old. Seventeen participants indicated their classification as senior, two as junior, and one as sophomore. Of the participants, 16 indicated white as a race or ethnicity, one indicated Asian, two indicated African American, and one indicated both American Indian/Alaska Native and white. Supplemental instruction leader learning style was assessed using the Kolb Learning Style Inventory. Leaders were then interviewed, and their study sessions were analyzed. Through triangulation of data from learning style, interviews and actual study session documents, four major themes emerged. The four themes were: 1) incorporation of personal experience into study session design, 2) the sense of impact on student learning, 3) a feeling of the need to incorporate varied activities into study session design, and 4) the concept that students must take ownership over their own learning. No consistent pattern emerged among the themes; however, the results attributed out-of-class study session design to both the incorporation of personal learning style preferences as identified through the Kolb Learning Style Inventory and training conducted by the institution. Implications for future research include the need for continued research addressing how and if Supplemental Instruction leader learning style influences out-of-class study session design. Also, as institutions of higher education seek to expand academic support services to all students, future research should explore Supplemental Instruction leader training and the impact such training has on students seeking support from the Supplemental Instruction program.

Ahrens, R., George, B., Henderson, A., Marhinin, N., Power, D., & Rae, M. (1996). *Students helping students: Peer Assisted Study Sessions for students enrolled in a science content subject*. Paper presented at the 2nd State Conference of HERDSA, University of Southern Queensland, Toowoomba, Queensland, Australia.

The Peer Assisted Study Sessions (PASS) program, based upon the Supplemental Instruction (SI) program, was used at the Queensland University of Technology (Brisbane, Australia) in the Center for Mathematics and Science Education. Students enrolled in the Primary and Early Childhood area of a Bachelor of Education degree must take Science Foundations (MDB303) in their first year. The formal science backgrounds of many students enrolled in this class are inadequate. This study examined students enrolled in the class during 1995. The PASS group received higher final course grades (4.88 vs. 4.15, 0 to 7 scale) than the non-PASS participants. Qualitative research through student interviews and analysis of surveys suggested improvement gains for the PASS group as well.

Ainsworth, L., Garnett, D., Phelps, D., Shannon, S., & Ripperger-Suhler, K. (1994). Steps in starting Supplemental Instruction. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 23-30). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc.

An institution must complete a number of critical steps to effectively implement a new Supplemental Instruction (SI) program: present research-based information that suggests the effectiveness of SI; gaining administrative and faculty support; selecting a SI supervisor with sufficient release time; carefully supervising the SI program throughout the academic term; and using evaluation data for program improvement. The authors based their suggestions from past experience at Texas Tech University.

Ainsworth, L., Garnett, D., Phelps, D., Shannon, S., & Ripperger-Suhler, K. (1994). *Mathematics: Needs and approaches using Supplemental Instruction*. Unpublished manuscript. Texas Tech University at Lubbock.

This paper discusses the implementation of Supplemental Instruction (SI) at Texas Tech University (Lubbock, TX) with courses in mathematics. After a review of the literature regarding the challenges with academic achievement for students in mathematics, the authors provide suggestions on how to successfully implement a SI program: focusing on problem-solving activities in the SI sessions that clearly illustrate the protocols to solve the problems rather than focusing just on finding the correct answer; providing more structure to SI sessions in math in comparison with SI sessions in other academic disciplines; and working on developing correct use of math vocabulary.

Akao, S. E. (1996). Book review of Supplemental Instruction: Increasing achievement and retention. *Journal of College Student Personnel*, 37(3), 360.

This is a book review of the monograph Supplemental Instruction: Increasing achievement and retention (Martin and Arendale, Editors, 1994). The book review provides a short summary of each of the monograph's chapters.

Alden, E. (2018). The changing role of Supplemental Instruction in the digital age *Communicating chemistry through social media* (pp. 139-150): ACM Publications
Supplemental instruction was first implemented in 1973 at the University of Missouri-Kansas City. The program began as simple peer assisted study sessions lead by former students who had succeeded in historically difficult courses. Over the course of three years we have observed the evolution of the supplemental instruction model at Central New Mexico Community College through the integration of the Supplemental Instructor into non-traditional, flipped classrooms, as well as in the online classroom. Through the use of social media platforms and applications the supplemental instruction session can now take place virtually anywhere. The supplemental instruction model has come a long way from improving student retention and success and can now promote group collaboration, improve study skills, and encourage thinking beyond just problem solving. We propose a two-semester model that would allow students to successfully complete the general chemistry series in a hybrid learning environment with retention and success rates comparable to that of an in-person chemistry course.

Allen, A., & Court, S. (2009). Leader self-disclosure within PAL: A case study. *Australasian Journal of Peer Learning*, 2(1), 68-86. Available online: <http://ro.uow.edu.au/ajpl/vol2/iss1/1>. Peer Assisted Learning (PAL) is a variant of the Supplemental Instruction (SI) program. The PAL leaders were the subject of this study at Bournemouth University in England. The issue under investigation was self-disclosure of the PAL leaders within the learning environment and the impact on students. Qualitative and quantitative methods were used to gain insight about

the levels and nature of PAL leader self-disclosure during PAL sessions. Results show that 46% are open with their feelings and 84% often use personal examples within a PAL session. Qualitative methodology identified the types of ways disclosure was used to build trust with students and illustrate what the PAL leader was trying to communicate.

Allen, M., Kolpas, S., & Stathis, P. (1992). Supplemental Instruction in calculus at a community college. *Collaborative Learning Exchange Newsletter*, 8-9.

At Glendale Community College (Glendale, CA) an experiment was conducted in several calculus courses regarding optional and mandatory attendance. In the traditional SI model attendance in SI is optional and anonymous. In the classes where mandatory attendance was required, students received a 10 percent boost in their grade for participating and submitting additional homework assignments. SI participants earned a mean final course grade that was 20 percentage points higher (70 percentile vs. 50 percentile). In another experiment SI session strategies were integrated into the class sessions. The class instructor developed the work sheets used in the SI sessions. The students in the modified course were compared to classes where SI sessions were not integrated into them. The SI participants earned a mean final course grade nearly a full-letter grade higher than the other students. While initial comments from SI participants were negative, by the end of the term the comments were highly supportive of the SI program.

Allen, P. J., Tonta, K. E., Haywood, S. B., Perira, R., & Roberts, L. D. (2017). Predicting peer-assisted study session attendance. *Active Learning in Higher Education*, 1-14. doi: 10.1177/1469787417735613. Available online:

<http://journals.sagepub.com/doi/abs/10.1177/1469787417735613>.

Peer-assisted study session attendance is associated with multiple indicators of student success. However, attendance levels are generally low. We applied an extended theory of planned behaviour model, incorporating student role identity, to the prediction of peer-assisted study session attendance. Participants were 254 undergraduate students enrolled in 24 peer-assisted study session supported units. Attitudes, subjective norms and perceived behavioural control each had a significant direct effect on attendance intentions, which had a significant direct effect on attendance. All three predictors also had significant indirect effects on attendance, mediated by intentions. After controlling for intentions, only perceived behavioural control had a significant direct effect on attendance. The model accounted for 61% and 42% of the variance in intentions and attendance, respectively. Student role identity did not improve the predictive utility of the model. Theory of planned behaviour-informed strategies for increasing peer-assisted study session attendance are recommended.

Alstralian Centre for PASS. (2010). Peer Assisted Study Sessions (PASS) - Guidelines for best practice, Available online:

<https://documents.uow.edu.au/content/groups/public/@web/@stsv/@pass/documents/doc/uow099559.pdf>

This document outlines the guidelines for best practice for PASS (Peer Assisted Study Sessions) in the Australasian region and serves to distinguish PASS from other Peer Learning initiatives. These guidelines have been collaboratively developed by a working party representing the Australasian PASS community.

Altomare, T. K., & Moreno-Gongora, A. N. (2018). The role and impact of Supplemental Instruction in accelerated developmental math courses. *Journal of College Academic Support Programs*, 1(1), 19-24. Available online:

<https://journals.tdl.org/jcasp/index.php/jcasp/issue/view/5>.

A difficult issue for tutoring programs is low participation, especially at commuter campuses. At the University of Houston-Downtown, this problem seems particularly acute for developmental education (DE) courses. This paper describes the Supplemental Instruction (SI) program at the University of Houston-Downtown (UHD) with focus on the role of the SI Leader in accelerated DE math courses. A study was conducted between Fall 2015 and Spring 2017 to evaluate differences in student performance in two courses between sections that were staffed with an SI Leader and those that had no assistance from the SI program. The study found statistically significant differences in grade performance between SI session participants and non-SI participants. The study also found that students passed at a higher rate in accelerated Intermediate Algebra as compared to traditional biweekly sections. Finally, students passed at a higher rate in accelerated sections that were staffed with an SI Leader compared to accelerated sections without an SI Leader.

Anderson, P. (2014). *The impact of Supplemental Instruction on student success and retention of students at a university in North Carolina*. (Ph.D. dissertation), Liberty University, Lynchburg, VA.

This study measured to what extent there is a statistical difference in cumulative GPA, course grade and retention rate between first and second year students who attended Criminal Justice and Philosophy Supplemental Instruction sessions, and students in Criminal Justice and Philosophy who did not attend Supplemental Instruction sessions. In this causal-comparative research study, the researcher analyzed a cause-and-effect relationship including the independent variables of Supplemental Instruction attendance and the course. The dependent variables were the students' cumulative GPAs, final course grades and retention. The researcher divided students into six different but not mutually exclusive groups as follows: students enrolled in Introduction to Criminal Justice who attended Supplemental Instruction, students enrolled in Introduction to Criminal Justice who did not attend Supplemental Instruction, students enrolled in Introduction to Philosophy who attended Supplemental Instruction, students enrolled in Introduction to Philosophy who did not attend Supplemental Instruction, students enrolled in either Criminal Justice or Philosophy who attended any Supplemental Instruction, and students enrolled in either Criminal Justice or Philosophy who did not attend any Supplemental Instruction at a university in southeastern North Carolina. The results of this study showed that students who participated in SI sessions had better outcomes than those students who did not participate in SI sessions with regards to cumulative GPA, course grade, and retention. With the exception of one hypothesis test, all of the remaining seven hypothesis tests rejected the null hypothesis of no difference between SI participation groups.

Andersson, A. (1996). *Supplemental Instruction in Mechanics A*. Unpublished manuscript. The Lund Institute of Technology. Lund, Sweden.

This report describes the use of Supplemental Instruction (SI) in the Mechanics A course during spring of 1996 in the School of Mechanical Engineering at the Lund Institute of Technology (Sweden). The author was the SI leader for the course. The report provides a description of events that occurred during the SI sessions throughout the academic term. Suggestions from the SI leader included: be careful to schedule SI sessions at times of highest interest for the students; keep to time commitments when to start and finish SI sessions since students may have other appointments following the sessions; divide the SI participants into smaller groups so maximize student discussions; and make sure that the SI leader has a plan before the beginning of the session to provide structure.

Angrist, J., Lang, D., & Oreopoulos, P. (2006). *Lead them to water and pay them to drink: An experiment with services and incentives for college achievement*. Available online: National Bureau of Economic Research website: <http://papers.nber.org/papers/w12790.pdf>

This project was sponsored by the Canada Millennium Scholarship Foundation. This paper reports on a randomized field experiment involving two strategies designed to improve college academic outcomes among first-year undergraduates at a large Canadian university. One treatment group was offered peer advising and tutorial services. The students participated in a version of Supplemental Instruction (SI). Another was offered substantial merit-scholarships for solid, but not necessarily top, first year grades. A third treatment group combined both interventions. The financial incentive encouraged more students to participate in SI. While male students did not see much improvement of grades, females did. Females who participated in the SI program and received the financial incentive for the scholarships persisted longer at the institution. The researchers suggest that a combination of the academic intervention and the scholarship program was the most effective way to increase academic performance and student persistence towards graduation.

Anker, E. O. (1991). *Supplemental Instruction: An answer for the at-risk student in a high-risk course?* (Master of Arts thesis), Calvin College, Grand Rapids, MI.

This research paper studied the use of Supplemental Instruction (SI) during Spring 1991 at Calvin College in Grand Rapids, MI. Areas for study included: final course grades for "at risk" students; and relationships among the level of SI attendance, academic ability, and final course grades. Special admit "at risk" students were the focus of the study. A study skills class was paired with a content course (e.g., History 101) in Fall 1990 to provide academic assistance for students. The at risk students were required to enroll in the non-credit course. Thirteen special admit students from Fall 1990 were enrolled in the paired class. In Spring 1991 seven special admit students instead participated in SI rather than being enrolled in a paired study skills class. There was no significant difference regarding final course grades. Individual SI attendance for SI ranged from three to 17 for the 18 sessions offered during Spring 1991. The mean average was 8.7 sessions. There was a positive correlation between higher levels of attendance and higher academic achievement. The researcher suggested that SI was more helpful to participating students than a paired study skills course.

Anton, H. F., Dooley, J. L., & Meadows, D. C. (1998). *Developmental educators as Supplemental Instruction providers: The next step*. Conference Proceedings of the National Association for Developmental Education Annual Conference, Atlanta, GA.

This conference abstract describes the use of Supplemental Instruction (SI) as a natural outgrowth of a developmental studies process. The Developmental Studies Department at Middle Tennessee State University funded an SI pilot in the 1997 Spring semester in Anatomy and Physiology. Analysis of final course grades revealed the following: the failure rate dropped from 47% to 28.6%; course grade average was 2.4 for SI participants and 1.5 for non-participants; positive correlation between higher levels of SI attendance and higher final course grades. SI was viewed as a natural partner with other activities and services offered by the department.

Arendale, D., R. (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>
This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and

Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (1993). *Fostering multicultural education with a learning assistance model that works: Supplemental Instruction*. Unpublished manuscript. The University of Missouri-Kansas City, Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/SIMULTX.pdf>

This paper describes the use of Supplemental Instruction (SI) to serve as a part of a campus multicultural education program. Since the primary focus of SI sessions is on the academic content, the sessions attract students of different ethnicities and cultures who share a common concern for improving their personal academic performance in the course. Cultural differences naturally emerge as students deal with the common academic task and they share their perspectives concerning the academic material from their personal and cultural point of view. The small group allows students to see a multiplicity of realities concerning the academic content. Some researchers argue that collaborative learning environments -- such as provided through SI sessions -- are more conducive for learning of students from diverse cultures. This is because some are field sensitive learners and find the traditional classroom environment of abstract learning unhelpful and find opportunity during SI sessions to make connections between the course material and their personal frame of reference. Included in the article is a research study directed by May Garland and partially funded by the National Association for Developmental Education. The study included 3 institutions across the U.S. regarding academic performance of students separated by ethnicity. Students of color participated at rates equal to or exceeded rates of White students in SI sessions. Students of color who participated in SI received mean higher final course grades than students of color who chose not to participate. The results were the same regardless whether the group was all students, top quartile, and bottom quartile.

Arendale, D. R. (1993). Supplemental Instruction: Improving student performance and reducing attrition *Educational Programs that Work: The Catalogue of the National Diffusion Network* (19th ed., pp. 14.14). Longmont, CO: Sopris West, Inc.

This overview of the Supplemental Instruction (SI) program provides a narrative description of SI, minimum requirements for successful implementation of the program, and services that the National Center for SI at the University of Missouri-Kansas City can provide to institutions that wish to implement SI.

Arendale, D. R. (1994). *Understanding the Supplemental Instruction model*. New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass Publishers.

This chapter provides a basic overview of the Supplemental Instruction model: common factors in student attrition; development of the SI program in 1973; key SI program personnel; administration and funding of SI programs; connection of the SI program with other campus programs

Arendale, D. R. (1994). *Supplemental Instruction: Providing academic assistance at small colleges*. Conference Proceedings of the Freshman Year Experience 7th Annual Conference for Small Campuses Conference, Minneapolis, MN. Available online: ERIC database. (ED374765).

This paper describes the use of Supplemental Instruction (SI) in small colleges to provide academic support.

Arendale, D. R. (1995). Self-assessment for adjunct instructional programs. In S. Clark-Thayer (Ed.), *NADE Self-Evaluation Guides: Models for assessing learning assistance/developmental education programs* (pp. 49-87). Clearwater, FL: H&H Publishing Company

This chapter provides a framework for evaluating a campus Supplemental Instruction (SI) program regarding a variety of issues: mission, goals, and objectives; program activities; program administration; human resources; facilities; value system; awareness of individual differences; and program evaluation. Adjunct instructional programs (AIPs) are defined as those forms of group collaborative learning assistance that accompany a specific targeted course to serve as a supplement for that course. These AIP activities occur outside of class.

Arendale, D. R. (1996). Lessons that I have learned from students in peer study groups. *National Association for Developmental Education Newsletter*, 20(1), 1-3. Available online: ERIC database. (ED461355).

Based on comments from Supplemental Instruction leaders and participants, this newsletter article describes six lessons learned by the author in his role as a course lecturer: 1) student-led discussions are needed to make lectures and reading assignments more valuable to students; 2) sometimes the lecturer spends too much time telling and not enough time modeling the thinking process for finding the answers and developing critical thinking abilities; 3) the lecturer needs to be careful not to by accident intimidate students; 4) only through student discussions will many be able to construct and retain the knowledge from the class; 5) the lecturer needs to frequently seek student feedback to improve my classroom instruction; and 6) there is more to learn at college than what happens in class.

Arendale, D. R. (1996). *Front loaded academic support: Supplemental Instruction in two-year colleges*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/SI2YR.pdf>

This paper describes the role of Supplemental Instruction (SI) in providing academic support for new students in two-year colleges. Included are both interviews with campus SI Supervisors at two-year institutions across the U.S. and a data study of SI at 59 two-year public institutions that offered SI in 480 courses with an enrollment of 23,979 students. The data suggests that SI participants earn a final course grade that is half a letter grade higher than non-participants. In addition to examining the data in aggregate, similar findings occur when the data is separated by academic disciplines.

Arendale, D. R. (1997). *Suggestions for improving attendance in Supplemental Instruction sessions*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/SIattendance00.pdf>

This paper is a collection of suggestions developed at the University of Missouri-Kansas City and others in the field on how to increase attendance by students at Supplemental Instruction (SI) sessions. Because of the voluntary nature of SI attendance outside of course lectures, the issue of SI session attendance will be a continuing issue. A variety of factors can influence attendance. The paper provides 27 suggestions for: activities before the beginning of the term by the SI supervisor; activities by the course professor during the term; activities by the SI leader during the term; activities by the SI supervisor during the term; and activities by the SI supervisor after the academic term. It is critical that students see the relevance and connection between the activities that occur during SI sessions and what occurs during the professor's lectures.

Arendale, D. R. (1997). *Supplemental Instruction: Review of research concerning the effectiveness of SI from The University of Missouri-Kansas City and other institutions across the United States*. Conference Proceedings of the 18th Annual Institutes for Learning Assistance Professionals, Tucson, AZ. (ERIC Document Reproduction Service ED457797). Available online: http://www.lisched.net/?page_id=1044

This paper provides a narrative overview of the Supplemental Instruction (SI) model and a review of the major research studies concerning SI. The studies are based on data from the University of Missouri-Kansas City and a separate data base of nearly 5,000 research reports describing the use of SI at 270 institutions with a total student enrollment of more than 500,000 in the classes where SI was offered.

Arendale, D. R. (1998). Increasing the efficiency and effectiveness of learning for first year college students through Supplemental Instruction. In P. L. Dwinell & J. L. Higbee (Eds.), *The role of developmental education in preparing successful college students* (pp. 185-197). Monograph Series No. 19. Columbia, SC: The National Association for Developmental Education and the National Center for the Study of the Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED423794).

Supplemental Instruction (SI) can be a powerful force for increasing the efficiency and effectiveness of learning for students during the first year of college. With the paradigm shift from a focus on teaching to improvement of student learning, institutions are looking for a systematic approach to changing the campus learning culture. This chapter describes how SI addresses these needs and also provides a review of research in the U.S. and other countries regarding the impact of SI with improving student academic performance.

Arendale, D. R. (1999). *Introduction*. Conference Proceedings of the First National Conference on Supplemental Instruction/VSI, Kansas City, MO.

The author provides an introduction to the conference proceedings of the First National Conference on Supplemental Instruction/VSI held in Kansas City, MO during May 1999.

Arendale, D. R. (2001). *Effect of administrative placement and fidelity of implementation of the model of effectiveness of Supplemental Instruction programs*. (Ph.D. dissertation), University of Missouri-Kansas City, Kansas City, MO. Available online: ERIC database. (ED480590).

This 456 page research study investigated variables that may influence effectiveness of the Supplemental Instruction learning assistance and enrichment program at the University of Missouri-Kansas City and other U.S. postsecondary institutions. Study number one analyzed variables related to academic performance of University of Missouri-Kansas City students (mean final course grades, rate of course withdrawal, and rate of persistence). Study number two investigated variables at 735 U.S. postsecondary institutions related to academic performance of students and satisfaction level with the campus Supplemental Instruction program. Independent variables included: administrative placement of the SI program unit (academic affairs, student affairs, or other), age of the SI program, fidelity of the program to SI program activity constructs (SI Supervisor involvement, SI Leader involvement, SI Leader training, institutional involvement), and four dependent variables (mean final course grades, mean percent of D and F final course grades and course withdrawals, mean percent of students who participate in the program, and satisfaction level with the program). Study number one found positive correlation between higher academic achievement and persistence rates with the independent variables of SI attendance and measures of precollegiate academic achievement. The entire known population of 735 SI programs within the United States was selected for study number two. There were statistically significant positive correlations with three of the four program activity constructs (SI Supervisor Involvement, SI Leader Involvement, and SI Leader training) and the effectiveness of the program regarding improved student outcomes and higher

satisfaction ratings by the campus administrators who supervised the program. There were no statistically significant differences between the different program administrative placement locations and the dependent variables. Implications from this research include identification of key activities within the program that should be observed to maximize program effectiveness for the institution and participating students. Besides the two quantitative studies, an extensive review of the literature regarding the history of developmental education and learning assistance programs in the United States produced six discernable historical phases. Supplemental Instruction was placed within this social context in American history. The appendix includes an extensive annotated bibliography of 450 publications and other media types published by authors worldwide related to Supplemental Instruction.

Arendale, D. R. (2002). History of Supplemental Instruction: Mainstreaming of developmental education. In D. B. Lundell & J. L. Higbee (Eds.), *Histories of developmental education* (pp. 15-27). Minneapolis, MN: Center for Research on Developmental Education and Urban Literacy, General College, University of Minnesota. Available online: <http://www.education.umn.edu/CRDEUL/monographs.html>.

Postsecondary institutions throughout the nation's history have provided developmental education and learning assistance programs to meet the academic standards expected of admitted college students. This history of developmental education provides a context for creation of the Supplemental Instruction (SI) program in 1973 at the University of Missouri-Kansas City to meet immediate needs at the institution due to a high attrition rate among students enrolled in professional schools. The national, and eventual international, dissemination of the SI model was due to it meeting similar needs at other institutions as well. SI has become a widely adopted method of mainstreaming the best practices of developmental education with college-level courses.

Arendale, D. R. (2003). *Supplemental Instruction study strategies: Using the Information Processing Model*. Unpublished manuscript. University of Minnesota. Minneapolis, MN. Available online: <http://www.arendale.org/storage/pdf-documents/peer/SIandIPM.pdf>

This document describes how the Information Processing Model of learning can be applied to SI session strategies employed by the student SI leaders. Session activities are associated with each of the stages of IPM to encourage SI leaders to employ a wide variety of activities to meet the needs of students at each stage of the IPM learning model.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar

positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2008). Selected annotated bibliography for Supplemental Instruction. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 97-105). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition. This appendix provides a short annotated bibliography of important publications related to Supplemental Instruction (SI) of the past two decades.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing. These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing. These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*. Department of Curriculum and Instruction, University of Minnesota. Available online: <https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational, something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Arendale, D. R., & Martin, D. C. (1997). *Review of research concerning the effectiveness of Supplemental Instruction from the University of Missouri-Kansas City and other institutions*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO. Available online: ERIC database. (ED370502).

This report provides both a narrative overview of the Supplemental Instruction (SI) model and a review of the major research studies concerning SI. A major portion of the research concerns a meta-analysis of SI research from 270 institutions from across the U.S. The analysis reviewed 4,945 research studies of 505,738 college students between 1982-83 and 1995-96. Regardless of institutional type or academic discipline, SI participants in comparison with non-participants receive mean final course grades that are higher (2.42 vs. 2.09), higher rates of A or B final course grades (46.8% vs. 35.9%) and mean percentages of D, F and withdrawal rates that are lower (23.1% vs. 37.1%). Even when the data is separated by broad academic disciplines or individual departments or classes, the positive differences for SI participants remain. In a national study of 13 institutions and 2,410 students, the question of helpfulness of SI for students of color was examined. The study found that students of color participated in SI at rates equal or exceeding those of White students (White, 33.8%; African American, 42.0%; Latino, 50.9%; Asian/Pacific, 33.3%; and Native American, 42.9%). Students of color received higher grades than similar students (2.02 final course grade vs. 1.55, rate of 36% for D, F, or W vs. 43% for non-SI participants). Studies from the University of Missouri-Kansas City mirror those from the national studies. A study of UMKC that examines 375 courses with an enrollment of 14,667 students year by year from 1980-81 to 1995-96 found that SI participants earned high mean final course grades, higher rates of A and B final course grades and lower rates of D, F and course withdrawals. In a Winter 1996 study concerning the potential bias of student motivation the results favored the SI participants. SI participants received: final course grade of

2.78, rate of 58.9% for final grades of A or B, rate of 17.2% for D, F or W. The non-SI motivational control group received lower levels of academic achievement: final grade of 2.16, 33.9% A or B, and 26.8% for D, F or W. All other non-SI participants received grades similar to the motivated non-SI group: final grade of 2.38, A or B rate of 42.7%, and 38.6% D, F or W. In a study of UMKC students separated into quartile groups on the basis of standardized entrance test scores, the SI participants outperformed their non-SI counterpart quartile group in nearly all comparisons. Top quartile: SI group 3.29 final course grade vs. 2.83 for non-SI, 92.9% reenrollment vs. 93.1% for non-SI; Middle two quartile groups: SI group 2.67 vs. 2.28, 90.5% reenrollment vs. 77.9% for non-SI; Bottom quartile: SI group 2.10 final course grade vs. 1.77 for non-SI, 85.6% reenrollment vs. 77.9% for non-SI. A study of SI attendance during Winter 1996 suggested a positive correlation between higher academic achievement and higher levels of SI attendance: no SI attendance: 2.37 final course grade, 42.2% A or B, 39.3% D, F or W; attended one to three times: 2.77, 56.3% A or B, 21.4% D, F or W; attended four to seven times: 2.82 final course grade, 63.0% A or B, 17.4% D, F or W. In a study of UMKC students who were first-time freshmen students in 1989, SI participants had graduated at a rate of 46.0% by Fall 1996 as compared with 30.3% of students who had never participated in SI. Other studies include research questions concerning demographic variables and rival hypotheses.

Arendale, D. R., & Martin, D. C. (2001). Introduction to special issue on Supplemental Instruction with underprepared students. *Journal of Developmental Education, 24*(3), 2, 40. The guest editors provide an overview to the special theme issue of the journal that was devoted to Supplemental Instruction (SI). The introduction provides context for the collection of articles by describing the origins of the SI program.

Arendale, D. R., & McLaren, A. (1999). *Supplemental Instruction: Variations on the basic theme*. Conference Proceedings of the Annual Conferences of the Pennsylvania Association of Developmental Educators, Hershey, PA. Available online: ERIC database. (ED428632) This paper describes some of the successful variations of Supplemental Instruction (SI). After an initial overview of SI, descriptions about innovations of the model. The first concerns Video-based Supplemental Instruction (VSI). VSI is described as an information delivery system. College students enroll in telecourses that are identical to credit courses delivered live on campus by the same professor. Students enrolled in these VSI course sections attend class eight hours a week rather than three hours since the videotape lectures are frequently stopped to engage in SI session activities. Developmental level students enrolled in VSI course sections earn higher final course grades than the traditional students enrolled in the live course sections. The second variation of the SI model is to use it for faculty development and renewal. Successful models include Salem State College and Anne Arundel Community College. Common activities include: SI leader providing anonymous feedback to the course lecturer; lecturer incorporating SI session activities inside of class sessions; lecturers serving as assistant SI supervisors and expanding their instructional/learning skills by observing other professors; and other associated activities.

Armentor, M. M. (2019). *A quasi-experimental study of the effect of Supplemental Instruction on course completion and persistence at a two-year college*. (Ph.D. dissertation), Northcentral University, San Diego, CA.

The efficacy of Supplemental Instruction was investigated in this study. The problem addressed by this study is the lack of course completion and persistence for at-risk community college students. The purpose of this quantitative quasi-experimental study, which was informed by the student integration and student involvement theories espoused by Tinto and Astin, was to examine the effect of an academic support program, Supplemental Instruction, on the final course grade and persistence to the subsequent semester of at-risk students in college level

gatekeeper courses at a small southeastern Texas college. This study addressed two research questions (1) What, if any, difference exists in final course grades in gatekeeper courses for at-risk students who participate in supplemental instruction and those who do not participate in Supplemental Instruction, and (2) What, if any, difference exists in persistence to the subsequent semester for at-risk students who participate in supplemental instruction and those who do not participate in Supplemental Instruction? The study population was at-risk two-year college students enrolled in gatekeeper courses. Most data was collected at the end of the fall 2017 and fall 2018 semesters and included final course grades, attendance in supplemental instruction, age, gender, race, college status, and socioeconomic status. Persistence data was collected on the twelfth class day in the subsequent semesters. The results from data analysis demonstrated there was no statistically significant difference in final course grades or persistence between the treatment and control groups. By investigating the effect of Supplemental Instruction in two-year colleges, higher education leaders have additional information on which to make decisions about continuing Supplemental Instruction programs. While the findings of this study were not consistent with current literature, it highlights the need for additional quantitative studies in two-year colleges with larger student populations.

Ashwin, P. W. H. (1993). *Supplemental Instruction: Does it enhance the student experience of higher education?* (Ph.D. dissertation), Kingston University, London, England.

This doctoral dissertation is concerned with the student experience of Higher Education in Britain that is influenced by Supplemental Instruction (SI). The qualitative research study of SI's impact in two classes (Applied Social Science and Computer Science) at Kingston University (UK) included interviews with SI leaders and questionnaires of first year students who were enrolled in the two classes. The purpose of this case study was to examine to what extent the educational theory of SI was matched by the student experience of it. Qualitative research suggests that SI was beneficial to students who took advantage of the service. SI leaders listed the following benefits of the program for themselves: increased confidence, greater sense of community between different years of the course, greater understanding of the material they were facilitating, and increased interest by potential employers because of the cocurricular nature of the SI leader experience.

Ashwin, P. W. H. (1994). The Supplemental Instruction leader experience: Why SI is not teaching, a student's perspective. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 87-90). Birmingham, England: Staff and Educational Development Association

This chapter provides both a perspective as both a leader and supervisor in the Supplemental Instruction program at Kingston University and Newham College of Further Education in the United Kingdom. SI sessions is not about teaching for a number of reasons: new information is not given in addition to that provided by the professor; SI participants create the agenda for the SI sessions; no formal assessment is taken; equal focus is placed on the process of learning of material as well as the material itself; and students do not perceive themselves in the same type of power relationship with the SI leader as they feel with the course professor. SI leaders focus on involving all students at the sessions and having them process the course material.

Ashwin, P. W. H. (2002). Implementing peer learning across organisations: The development of a model. *Mentoring & Tutoring*, 10(3), 221-231.

This article describes different ways to implement peer learning programs at institutions in the United Kingdom. A deeper understanding of organizational change can help guide administrators as they implement new programs. A version of Supplemental Instruction (SI) has been contextualized for the British postsecondary education system. An adaptation of Lewin's theory of change (1952) is applied with implementing the peer learning programs. This is an

important area for further investigation since this is an important variable for the continued success of the SI program due to the need for strong support both from the administrators as well as a supportive culture that has embraced the program.

Ashwin, P. W. H. (2003). Peer Support: Relations between the context, process and outcomes for the students who are supported. *Instructional Science*, 31(3), 159-173. Contact the author at: Institute for the Advancement of University Learning, University of Oxford, Littlegate House, St Ebbe's Street, Oxford OX1 1PT, UK (E-mail: paul.ashwin@learning.ox.ac.uk).

This paper describes a research study with a version of Supplemental Instruction in the United Kingdom. An investigation of the outcomes of a Peer Support scheme for the students who are supported is reported. It was found that attendance at Peer Support sessions was positively and significantly correlated to academic performance. This relationship was found even when prior levels of academic performance were controlled for. However, it was also found that students who attended Peer Support sessions adopted less meaning orientated approaches to studying over the course of the academic year. It is argued that this is an indication that the quality of the learning of these students fell. Qualitative evidence suggests that this change in approach was in response to an increased awareness of the assessment demands of the course and that these students had become more strategically orientated in their approach to studying as a result of their attendance at Peer Support sessions. It is argued that these results suggest that the outcomes and operation of this Peer Support scheme were influenced by the context in which it operated. Two implications of these findings are discussed.

Attridge, R. L., LaGrange, L., Frei, B., Gottlier, H., Horlen, C., Lord, K., . . . Brady, R. L. (2017). Using admissions criteria for predicting student failure outcomes of Supplemental Instruction and remediation in a Doctor of Pharmacy programme. *Pharmacy Education*, 17(10), 75-80. Available online: <http://fipcc.com/pharmacyeducation/article/viewFile/379/418>.

Objective: To identify potential unique predictors of academic failure or success in a Doctor of Pharmacy programme using curricular experiences with supplemental instruction (SI) and remediation. Methods: We assessed correlations between admissions variables, including grade point average (GPA) and Pharmacy College Admissions Test (PCAT) scores, with curricular performance measures, including SI and remediation, in 369 students over four years. Results: Overall entry GPA, pre-requisite/pre-pharmacy GPA, and required maths and science GPA negatively correlated with number of SI enrolments and remediation. Lower PCAT verbal and quantitative ability scores negatively correlated with number of remediation sessions while lower PCAT chemistry and reading comprehension scores negatively correlated with number of SI enrolments and course failures. Overall entry, pre-requisite/pre-pharmacy, and required math and science GPA; and PCAT composite, quantitative ability, and chemistry scores positively correlated with GPA after the first academic year and at graduation. Conclusions: Students with higher GPAs and PCAT scores were less likely to need academic support. Lower GPAs and PCAT scores correlated to an increased likelihood of failure and predict need for academic assistance to ensure success.

Australasian Centre for PASS. (2011). *Peer Assisted Study Sessions (PASS): Guidelines for best practice*. Unpublished manuscript. University of Wollongong. Wollongong, Australia, NSW. Available online:

<http://www.uow.edu.au/content/groups/public/@web/@stsv/@pass/documents/doc/uow099559.pdf>

This document outlines the guidelines for best practice for PASS (Peer Assisted Study Sessions) in the Australasian region and serves to distinguish PASS from other Peer Learning initiatives. These guidelines have been collaboratively developed by a working party representing the Australasian PASS community.

Avdiu, A. (2006). *An evaluation of Access to Learning Fee program: Supplemental Instruction*. (Master of Science thesis), University of Wisconsin-Stout, Stout, Wisconsin. Available online: <http://minds.wisconsin.edu/bitstream/handle/1793/41889/2006avdiua.pdf?sequence=1>

In 1999, the students of University of Wisconsin - Stout voted for the Access to Learning Fee, which is a budget funded by student fees to improve the learning environment. Through increasing the operating hours of laboratories, providing tutoring, Supplemental Instruction (SI), childcare, and graduate assistantships, the concerned collective of the UW-Stout administration believe that attrition of undergraduates will be reduced and students overall learning experience will be improved. The SI program was implemented to target Math-120, Computer Science-142, and Computer Science-144 courses that are considered to be very difficult for and contribute to attrition of students. It is a peer-lead tutoring program that offers students assistance outside of class lectures. This program was evaluated by assessing archival data such as students' grades, frequency of sessions attended, and program satisfaction survey data. The author hypothesized that students who attend at least one SI session receive higher final grades in the course than those who do not attend any SI sessions. The findings reveal to us that students who attend SI sessions have higher grades compared to those who did not attend any SI sessions. Qualitative findings also suggest that students are highly satisfied with the program and its leaders.

Bachman, R. M. (2013). Shifts in attitudes: A qualitative exploration of student attitudes towards efforts of remediation. *Research & Teaching in Developmental Education, 29*(2), 14-29.

An interesting and exciting phenomenon emerged in the midst of discussions about tutoring, office hours, developmental courses, and review sessions. Many students described their initial feelings toward remediation as fear, embarrassment, or disdain. Many of them admitted to originally connecting remediation with being "dumb" or "not trying" hard enough. Others saw it as a "waste of time" or a delay of core coursework. However, in addition to expressing these preliminarily negative views, seven students also went on to explain how their attitudes toward remediation began to evolve as they participated in remediation at the college level. These shifts provide rich descriptions of student attitudes, feelings, beliefs, and experiences with remediation, and point to important features of embracing remediation as a positive experience for the students in this study. Four influences on these shifts are discussed through the stories of the participants.

Bailey, A., & Cooper, W. . (2009). *Supplemental Instruction versus traditional remedial classes: Which methods should be used by community colleges in the classroom?* Unpublished manuscript. University of Central Florida. Orlando FL. Available online: <http://wmacooper.pbworks.com/f/research%20proposal%20combined-final%20TO%20SUBMIT.pdf>

In this proposed study, we wish to investigate which method would benefit community college students enrolled in developmental math classes, Supplemental Instruction versus Traditional Remedial classes. The research involves an experimental design, where we will compare two major groups—one attending developmental math classes with supplemental instruction (math lab, and assigned mandatory tutors), and the other attending traditional developmental math classes. The methodology section will include the following: research design, participants, instrumentation, procedures, data analysis, threats to internal and external validity, and possible limitations of the study.

Barham, W. A. (2001). A supplemental learning assistance model for developmental learners. In V. L. Farmer & W. A. Barham (Eds.), *Selected models of developmental education programs in higher education* (pp. 167-183). Lanham, NY: University Press of America

This chapter provides a comprehensive overview of the Supplemental Instruction (SI) program. After providing a short history of developmental education in American higher education, the book chapter reviews the theoretical framework for SI, program organization, procedures for SI sessions, and a selected review of research concerning outcomes of the SI program for SI participants and the institution.

Barlow, J., & Gardiner, P. (1994). Introducing Supplemental Instruction in engineering courses. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 17-24). Birmingham, England: Staff and Educational Development Association

The authors describe the implementation of Supplemental Instruction in civil, mechanical, and electrical engineering courses at Brighton University in England. SI was introduced in response to increasing pressures in higher education with reduced resources, much wider access, and changes in academic organizations. Evaluation reports suggest improvement by both the SI participants as well as the SI leaders.

Barrett, M., Sutcliffe, P., & Smith, B. (1994, 1994). *Students as mentors: The case of management education*. Conference Proceedings of the Proceedings of the Conference of the Australian and New Zealand Academy of Management, Wellington, Australia.

This paper describes the use of Supplemental Instruction (SI) to have advanced-level students (peer mentors) help commencing students (mentees) overcome the teaching and learning problems often associated with large lecture-based introductory courses in management in several courses at Queensland University of Technology (Australia). "Management and Organization" has the primary focus for this study. Students who attended six or more sessions had significantly higher final course grades than those who attended less than six times. It appears that motivation or self-selection was not a major variable since the students who attended six or more times had a similar academic profile to students who did not attend at the same frequency. Surveys of students suggested that the mentoring program helped them to develop new study strategies and approach the material in a more effective manner. Mentors reported that they improved their interpersonal communication skills, ability to manage group dynamics, and enhanced their personal study skills.

Bartlett, G., Terblanche, N., & Eastmond, J. N. (1996). *The politics and process of student involvement in a programme of Supplemental Instruction*. Paper presented at the South African Association for Academic Development Conference, University of Fort Hare, Republic of South Africa.

This paper recounts the steps (and missteps) taken in beginning a Supplemental Instruction (SI) program in two academic departments at Border Technikon (South Africa): Accounting and Management. It documents the steps taken to draw upon the resources of the Student Representative Council (SRC) in setting policy, selecting tutors, and maintaining the program's funding base. The authors advocate that SI program success is dependent upon a partnership with faculty and students sharing a stake in the outcomes. The SRC representatives advocated that all students should be eligible for consideration as SI leaders. Their view was that even academically weaker students could be helpful since they understood the challenges in the course and could help others. Also, the SRC viewed SI as a service for students and that volunteers should be solicited. In both cases, the compromise was that all students were eligible for the SI leader position however it was felt that the SI leader should be compensated for the large time commitment required. Interviews with SI leaders suggested the following benefits: increased confidence with public speaking; more interaction with course faculty; development of teaching skills; and improved personal study strategies. Interviews with SI participants suggested improved: better understanding of course material; opportunity to practice academic

skills; freedom to discuss material in the smaller, relaxed SI session environment; and higher test scores.

Bartley-Lukula, A. (2013). *The efficacy of instructor-guided Supplemental Instruction as a strategy for helping reading-deficient college students improve testing and assessment outcomes*. (Ph.D. dissertation), Tennessee State University.

This research project examined whether the use of Instructor-guided Supplemental Instruction as a classroom scaffolding technique, might help improve testing and assessment reading outcomes for reading-deficient college students. The study was completed at Tennessee State University in Nashville, Tennessee over the 16-week Fall, 2012 semester using two intact groups of reading students (N=90). Data collection was achieved through the use of the Nelson-Denny Reading Assessment Test (Forms G & H), reading mid-term and final examinations, a case study analysis, and a research (position) paper. A Modified Survey of Reading Affect was conducted to ascertain what role, if any, affect might play in reading-deficient students' attitude towards reading. First developed at the University of Kansas-Missouri in 1973 (Martin and Arendale, 1993), traditional supplemental instruction is a peer-led support program that helps students master content in courses such as physics, chemistry, etc., that are classified as "historically difficult." Thus, supplemental instruction focuses on high-risk courses, not high-risk students. Because the United States currently faces a crisis with illiteracy particularly among the college-level population, members of the academic community that are directly involved with teaching reading now consider reading a critical subject for purposes of applying supplemental support. Proof of supplemental instruction's usefulness as a delivery modality in content reading classrooms could be a substantial break-through in improving literacy rates among reading-deficient college students because there are three important purposes of supplemental instruction that cannot be overlooked at the college level. Supplemental instruction seeks to (1) reduce attrition rates for courses targeted as "historically difficult", (2) improve performance/student grades in these same courses and (3) increase the graduation rates of students. The study employed a quasi-experimental, mixed methodology, non-equivalent, control group/pre-test/ post-test with survey design. Data analysis relied on the use of descriptive statistics with correlation analysis and t-test with Analysis of Variance (ANOVA). Results from the study determined that there were significant differences in testing and assessment outcomes between experimental and control groups pursuant to the instruments used in the study. It was determined that the use of an Instructor-guided Supplemental Instructional model as a classroom delivery modality warranted further assessment.

Battistelli, L. (2004, 2004, August 30). Cal State-Long Beach center assists students in learning, *Forty-Niner CSU-Long Beach Newspaper*.

This school newspaper article describes how the Supplemental Instruction (SI) program is part of the services provided by the California State University-Long Beach learning center.

Baum, E. (2016). *Effectiveness of Supplemental Instruction in a statistics course*. Conference Proceedings of the Georgia College Student Research Conference, Atlanta, GA. Available online: <http://kb.gcsu.edu/src/2016/Friday/6/>

At most universities, an introductory statistics course is required for the majority of the students before they begin their specific major classes. Roughly 25% of undergraduate students at a given university will take a statistics class during a single academic year. Of these students, several will fail to retain the information, making future classes more difficult, or fail to successfully pass the course, increasing the likelihood a student will not graduate on time. Providing academic support through the implementation of a Supplemental Instruction (SI) Program gives students the opportunity to receive free, out-of-class help focused on student achievement in this course. Led by a SI Leader, students are able to attend sessions to

receive conceptual help while reviewing class material, developing study strategies, and collaborating with classmates. We will be focusing on the effects SI can have on student achievement in a statistics classroom. Since statistics is a necessary and important course in several disciplines, proper academic help is crucial for the success of the students. We will share our data analysis for using SI in a statistics course over a 4-year period, providing participants the opportunity to identify the positive effects SI has on student success.

Beard, K. (2016). *The effect of Supplemental Instruction on undergraduate class grade, grade point average, and retention*. (Master's Degree Thesis), Goucher College, Baltimore, MD. Available online: <https://mdsoar.org/handle/11603/2803>

Graduating from college in four years is still the most optimal arrangement for today's student (Neuman, 2013). Currently, there are many programs that claim to support these students to succeed academically and in a timely manner (Hodges, 2001). The purpose of this study was to investigate whether an academic support program identified as Supplemental Instruction impacted student class grade, grade point average and retention within an academic year in three distinctive college freshman classes: Biology, Education and Spanish. An analysis was conducted to determine if there was a difference between the students that utilized Supplemental Instruction and the students that chose not to utilize Supplemental Instruction. The null hypothesis was used in this study. The results did not find a significant difference between the treatment and non-treatment groups. Thus, the null hypothesis was retained. Further research should utilize a larger sample size and a pre-determined amount of sessions.

Beasley, C. J. (1997). *Students as teachers: The benefits of peer tutoring*. Conference Proceedings of the 6th Annual Teaching Learning Forum, Murdoch University. Supplemental Instruction (SI) has been customized for use at several institutions in Australia. Program results for SI participants include: improved understanding and performance in the subject area involved, improved confidence and study skills, as well as on-going friendships. SI leaders also report improvement in content knowledge and personal skills. This paper focuses quantitative and qualitative analysis concerning the use of SI at Murdoch University with business students in 1995. The two courses studied were Principles of Commercial Law and Introduction to Accounting. Many of the participants were international students.

Beaumont, T. J., Mannion, A., P., & Shen, B. O. (2012). From the campus to the cloud: The online Peer Assisted Learning Scheme. *Journal of Peer Learning*, 5(1), 1-15. Retrieved from <https://files.eric.ed.gov/fulltext/EJ1154814.pdf>.

This paper reports on an online version of Peer Assisted Study Sessions (PASS), also known as Supplemental Instruction (SI), which was tested in two subjects in the University of Melbourne in 2011. The program, named the Online Peer Assisted Learning (OPAL) scheme, was implemented with the aims of extending the benefits of a successful peer learning program to students other than those who attend face-to-face sessions and contributing to scholarship on the viability of online peer learning with reference to student interest, leader and participant perspectives, and the suitability of synchronous communication platforms. Qualitative research led to mixed findings. Although OPAL was considered to be a viable online peer learning program by leaders and participants, multiple challenges were encountered. With reference to literature on related initiatives and the use of synchronous online learning platforms in higher education, this paper provides an account of the establishment and progress of the initiative, before presenting an analysis of its strengths and weaknesses and a series of recommendations for researchers and practitioners who are interested in online adaptations of face-to-face peer learning programs.

Bech, T., & Donelan, M. (2000). *Supplemental Instruction Leaders' Conference Report*. London, UK: University College London.

This report describes events at the 7th annual Supplemental Instruction (SI) Leaders' Conference. The annual conference draws together SI leaders from across the U.K. This conference was held at St. Martin's College in Ambleside in the Lake District of England from April 17 to 19, 2000.

Beckman, K., & Powell, D. A. (2004). *NDSU Supplemental Instruction*. Paper presented at the 227th American Chemical Society National Meeting, Anaheim, CA.

Supplemental Instruction (SI) was implemented at North Dakota State University to serve students in science courses such as general chemistry and organic chemistry. Studies suggest that regular attendees of the voluntary SI sessions attain higher final course grades.

Beckmann, E. A., & Kilby, P. (2008). On-line, off-campus but in the flow: Learning from peers in developmental studies. *Australasian Journal of Peer Learning*, 1, 61-69. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/8>.

At the Australian National University, peer learning is a key for improved student learning outcomes for those enrolled in the Master of Applied Anthropology and Participatory Development (MAAPD) program. Online discussions support peer learning and provided opportunities for more shared engagement in critical thinking about issues of concern raised through the courses. An online collaboration learning environment called Alliance was employed to provide a more full collaborative learning environment. Using best principles from the Peer Assisted Learning Strategies (PALS) program that used traditional face-to-face student discussions, Alliance employed a variety of learning tools for online collaboration. Threaded discussions were a key element for developing meaningful online learning. It was critical to form students into smaller work teams that had more accountability regarding their continuous participation. These discussions needed structure and also an assigned facilitator to help guide the discussion and prompt participation, much in the same way as the student facilitator was key for the face-to-face PALS sessions.

Beemer, J., Spoon, K., He, L., Fan, J., & Levine, R. A. (2018). Ensemble learning for estimating individualized treatment effects in student success studies. *International Journal of Artificial Intelligence Education*, 28(3), 315-335. Available online:

<https://kopernio.com/viewer?doi=10.1007/s40593-017-0148-x&route=1>.

Student success efficacy studies are aimed at assessing instructional practices and learning environments by evaluating the success of and characterizing student subgroups that may benefit from such modalities. We propose an ensemble learning approach to perform these analytics tasks with specific focus on estimating individualized treatment effects (ITE). ITE are a measure from the personalized medicine literature that can, for each student, quantify the impact of the intervention strategy on student performance, even though the given student either did or did not experience this intervention (i.e., is either in the treatment group or in the control group). We illustrate our learning analytics methods in the study of a supplemental instruction component for a large enrollment introductory statistics course recognized as a curriculum bottleneck at San Diego State University. As part of this application, we show how the ensemble estimate of the ITE may be used to assess the pedagogical reform (supplemental instruction), advise students into supplemental instruction at the beginning of the course, and quantify the impact of the supplemental instruction component on at-risk subgroups.

Bengesai, A. (2011). Engineering students' experiences of Supplemental Instruction: A case study. *Alternation*, 18(2), 59-77.

This article explores Engineering students' experiences of Supplemental Instruction (SI). SI is a student engagement approach that is meant to provide 'support' to students with the aim of improving pass rates. The sample population used in the study was constituted from the 2009 Chemical Engineering cohort. From this broad sample, the performance scores of 15 regular SI attendees were tracked over a period of three semesters. Qualitative data was also collected through focus-group discussions with six of the regular attendees. The data was analysed using an interpretive methodology. The findings from the study suggest that SI has the potential to provide positive learning spaces for students, enabling them to effectively engage with learning materials. However, the results also underscore the need to modify the programme to ensure that students do not become overly reliant on it. SI was introduced at the Faculty of Engineering in the University of KwaZulu-Natal (UKZN), South Africa, in 2008. This project was conceived and enabled through a Faculty grant from the Department of Higher Education and Training to improve throughput and curb attrition rates.

Bengesai, A. V., & Paideya, V. (2018). An analysis of academic and Institutional factors affecting graduation among engineering students at a South African university. *African Journal of Research in Mathematics, Science and Technology Education* doi: 10.1080/18117295.2018.1456770.

The study investigated the relationship between timely graduation and academic and institutional factors for a cohort of Engineering students at a South African university. The sample was restricted to 1595 incoming students beginning during 2009–2011 who were tracked to 2016, allowing for an eight-year graduation period for the initial cohort. Both descriptive statistics and regression models were employed in the analysis. The results demonstrate that the characteristic profile of a student graduating on time in the Engineering programme is likely to be non-African, have high admission point scores (above 40), pass more than 75% of their credits in the first year, have financial aid and make regular use of Supplemental Instruction. In other words, students who have financial and prior academic advantages are the most likely graduates. These results suggest that universities should give serious consideration to academic support and financial aid provision.

Best, G., Hajzler, D., Ivanov, T., & Limon, J. (2008). Peer mentoring as a strategy to improve paramedic students' clinical skills. *Australasian Journal of Peer Learning*, 1, 13-25. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/4>

This paper documents the rationale and outcomes of a peer mentoring program based on Supplemental Instruction (SI) in which selected third year paramedic students took on the role of mentors within a second year clinical practice subject. Participating students reported an improvement with their clinical skills. At Victoria University in Australia the SI program has been customized and renamed Peer Assisted Study Sessions (PASS). This approach was designed to improve students' clinical skills and judgment and to improve their confidence and use of clinical equipment. The PASS mentors reported gains in assistance with projects, revitalized interest in work, and increased self-confidence. Mentees reported increases in their learning and development, increased personal support, and an increase in confidence. The program also provided students with a leadership role to extend their own competency with the content material. The authors suggested that the PASS program could be enhanced in the future to further improve its impact on leadership development of the mentors.

Best, G., Hajzler, D., Pancini, G., & Tout, D. (2011). Being 'dumped' from Facebook: Negotiating issues of boundaries and identity in an online social networking space. *Journal of Peer Learning*, 4(1), 24-36. Available online: <http://ro.uow.edu.au/ajpl/vol4/iss1/5>.

Social networking spaces such as Facebook were investigated as an enhancement to a Peer Assisted Study Sessions (PASS) at Victoria University in Melbourne, Australia. PASS is based

on the Supplemental Instruction (SI) model. The authors suggest careful consideration as well as explicit negotiation among PASS staff and student participants to set appropriate boundaries for the use of Facebook within PASS. The PASS program created a Facebook account to facilitate communication among the PASS participants. The PASS administrative staff members were 'dumped' from the Facebook account because the students' perspective due to staff breaking boundaries due to their interactions. This paper provides a case study approach to understanding the complex relationships and expectations among students and staff members in a shared social space. Student PASS participants found the Facebook social space very helpful, even more so without non students.

Bidgood, P. (1994). *The success of Supplemental Instruction: Statistical evidence*. Birmingham, England: Staff and Educational Development Association.

Research studies from Kingston University (United Kingdom) suggest that Supplemental Instruction has been helpful in a wide range of courses. Several studies suggested that higher levels of SI attendance are correlated with higher final course grades: Computer Systems, 1990-91: 68.2 percentile vs. 61.3 percentile for non-SI and 1991-92: 61.9 vs. 61.0; Information Systems, 1990-91: 67.5 vs. 59.2 and 1991-92: 59.4 vs. 54.1; Software Engineering, 1990-91: 52.9 vs. 50.4 and 1991-92: 48.6 vs. 42.9; Mathematics, 1990-91: 61.6 vs. 56.7 and 1991-92: 58.5 vs. 53.5; and Average Mark for All Courses, 1990-91: 62.7 vs. 56.9 and 1991-92: 57.0 vs. 52.8. Additional studies examined final course grades for comparable entry qualifications.

Bin Ibrahim, M. D., & Aaijaz, N. . (2011). Dynamics of peer assisted learning and teaching at an entrepreneurial university: An experience to share. . *International Journal of Humanities and Social Science*, 1(12), 93-99.

The process of Peer Assisted Learning (PAL) is a situation in which "people from similar social groupings who are not professional teachers help each other to learn and learn themselves by teaching. It is this reciprocity of learning among other things that makes PAL such an attractive idea to educationists. One mission of the FKP (in Malay language - Fakulti Keusahawanan dan Perniagaan) i.e. Faculty of Entrepreneurship and Business at University Malaysia Kelantan is to teach a curriculum developed on the model of "Continuous or Lifelong Learning Process" and "Learning Outcomes" (LO) for students with the help of novel processes like PAL, Collaborative Learning, PBL (Problem Based Learning) etc. We prepare our undergraduate students for successful transition into the entrepreneurial world. For this reason, most of our teaching experience at the University has been focused in this area. Noteworthy researches done in this area are - Jean Piaget (1896-1980), a Swiss psychologist, whose cognitive development theories have been widely discussed in both psychology and educational fields, identified that students must be active agents in creation of their own knowledge. Lev Vygotsky, a Russian psychologist, was interested in applying Marxist social theory to individual psychology (1978). Vygotsky's research also differentiated between our higher and lower mental functions conceiving our lower or elementary mental functions to be those functions that are genetically inherited, our natural mental abilities. In contrast, he saw our higher mental functions as developing through social interaction, being socially or culturally mediated (Wertsch, 1991:18)

Birkett, M., Neff, L., & Deschamps, E. (2017). Low high school GPA: Another reason to try SI. *Supplemental Instruction Journal*, 3(1), 24-37. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

The purpose of this project was to investigate the effect of participation in Supplemental Instruction (SI) on first-year students' academic performance after controlling for relevant non-programmatic factors. Student academic performance was compared in quartiles determined by high school core grade point average (HS Core GPA). A total of 2,436 student SI participants and non-participants were matched based on six academic readiness and demographic

covariates. The results revealed that SI participants had significantly higher course grade averages and passing rates compared to non-participants. Participants in the lowest HS Core GPA quartile had the largest gains in course grade with the largest effect size when compared to matched nonparticipants. The results of this study suggest that first-year students with low HS Core GPA may experience the greatest benefit of SI participation.

Bjorsten, K., & Soderlund, S. (2004). *Variation of the model: Using study mentors and SI leaders*. Unpublished manuscript. Linkoping Institute of Technology. Sweden.

A variation of the Supplemental Instruction (SI) model is being used at the Linkoping Institute of Technology in Sweden during 2003. SI was offered to student in rigorous Calculus and Chemistry courses. Students were asked to complete surveys regarding their satisfaction with the SI program. While the students found the SI program useful, the grade improvement for them was not satisfactory according to the SI program directors. Results of this evaluation was to more carefully select the future SI leaders and provide more training for them.

Black-Heiman, D. K. (1999). *Effect of a relational type intervention on college students' self regulated learning*. (Ph.D. dissertation), The Ohio State University, Columbus, OH. Dissertation Abstracts International database. (2811A).

The topics of learning and achievement have been of interest since the early 1900's. In the 20th century, the work of many prominent researchers has led to a better understanding of how factors such as human behavior, personality, cognition, learning styles, and motivation influence individual learning. Current research on academic achievement includes two areas: a relational type study skills intervention, Supplemental Instruction, and self regulated learning.

Supplemental Instruction (SI) was an intervention designed by Deanna Martin in the early 1970s. Many studies have shown that students who receive SI for a specific course get better grades than students who do not participate in supplemental instruction for that course. The success of the intervention is due to the fact that difficult courses are targeted rather than at-risk students, study skills are taught within the context of one course, and that the group of students are led by a peer who has recently taken the course and done well. Research on self regulated learning has shown that individuals who achieve academic success share similar characteristics. Self regulated learners are motivated to learn, use cognitive strategies such as rehearsal, elaboration, and organization when they study, and they do particularly well in metacognitively knowing when and how to apply those cognitive strategies when they study. The current study attempted to implement the concepts of self regulated learning into a modified version of SI for a college level history course. The treatment was referred to as a relational type intervention (RTI). Students in the treatment group at Ohio State University discussed their motivation for the course, were taught study skills specific to history, and were taught when and how to implement such strategies. The current treatment differed from original SI in that RTI occurred within a regularly scheduled recitation time rather than outside of class time, students consented to treatment but did not volunteer to participate, a student with a master's degree implemented the treatment rather than a peer who recently did well in the course, and new material was sometimes introduced during recitation so time was not only devoted to study skill implementation. Due to these differences, careful consideration was taken not to compare the current study with SI. Multivariate analysis of variance was used to determine what effect SI had on students' self regulated learning. The results indicated that there were no statistically significant differences between the treatment and control groups on posttest dependent measures: motivation, cognitive strategy use, and metacognitive strategy use. The instrument used to measure self regulated learning components was the Motivated Strategies for Learning Questionnaire.

Blanc, R. A., DeBuhr, L., & Martin, D. C. (1983). Breaking the attrition cycle: The effects of Supplemental Instruction on undergraduate performance and attrition. *Journal of Higher Education, 54*(1), 80-89.

This article concerns an evaluation of the Supplemental Instruction (SI) program at the University of Missouri-Kansas City. The research study looked at the academic performance of 746 students enrolled in seven Arts and Sciences courses during Spring 1980. A variety of research studies were completed using data gathered from this and subsequent academic terms. SI participants in comparison with non-SI participants of similar demographic background earned higher levels of academic achievement. The first study looked at mean final course grades and the rate of D, F and course withdrawals for three groups: SI participants, non-SI participants, and motivational control non-SI participants. Students assigned to the motivational control group were those who, on a Likert scale, indicated higher interest in attending SI sessions, but who were prevented from attending because of scheduling conflicts (e.g., work, class). The final course grades favored the SI participants (2.50, DFW rate of 18.4%, $p < .01$) over the motivational control non-SI group (2.36, DFW rate of 26.5%) and other non-SI group (1.57, DFW rate of 44.0%). SI and non-SI participants were tracked regarding reenrollment rates for two succeeding academic terms. In both cases the results favored the former SI participants (Fall 1980: SI 77.4% vs. non-SI 67.3%; Spring 1981: SI 73.2% vs. non-SI 60.0%). When the students were separated by quartile groups on the basis of standardized entrance exams, SI participants outperformed their counterparts (Top quartile: final grade SI 3.10 vs. non-SI 2.30, reenrollment following term SI 86% vs. non-SI 78%; Bottom quartile: final grade SI 1.72 vs. non-SI 0.88, reenrollment following term SI 74% vs. non-SI 62%). There were long-term reductions in the percentage of D, F and withdrawals in the courses where SI was offered to students (from 34% before introduction of the SI program down to 18% during the SI program's second year). This article was the first one published outside of developmental education publications to gain national attention concerning the SI model.

Blanc, R. A., & Martin, D. C. (1994). Supplemental Instruction: Increasing student performance and persistence in difficult academic courses. *Academic Medicine: Journal of the Association of American Medical Colleges, 69*(6), 452-454.

The authors describe the use of Supplemental Instruction (SI) with medical students to earn higher final course grades in historically difficult courses. The SI process has been used successfully with students who are preparing for the USMLE Step I examination. The authors state that SI can strengthen a prematriculation program for students whose MCAT scores place them in the high-risk category for completing the medical school curriculum. To maximize learning efficiency for students in the prematriculation program, the authors suggest that a small-group preview session precedes each lecture and a small-group review follows. The article concludes with a short overview of Video-based Supplemental Instruction (VSI).

Blat, C., Myers, S., Nunnally, K., & Tolley, P. (2001, 2001). *Successfully applying the Supplemental Instruction model to sophomore-level engineering courses*. Conference Proceedings of the Proceedings of the 2001 American Society for Engineering Education Annual Conference & Exposition.

Supplemental Instruction (SI) has been used at the University of North Carolina at Charlotte for 15 years with mixed success in various academic content areas. In the past four years SI has been used in the College of Engineering in Statics (MEGR 2141), Mechanic of Solids (MEGR 2144), Network Theory II (ECGR 2112), and Applied Calculus for Engineering Technology students (EGET 3171). Research suggests that SI contributes to higher final course grades and lower rates of D, F, or course withdrawals. SI participants who attend five or more sessions during the academic term are more likely to persist for an additional academic term than students who do not. There were no significant differences regarding SI participation by gender,

ethnicity, average Math SAT, average Verbal SAT, or average predicted GPA. The chapter concludes with recommendations for implementation of SI at a campus.

Blat, C., & Tolley, P. (2009). *Improving retention through peer mentoring, Supplemental Instruction, and tutoring*. Unpublished manuscript. William States Lee College of Engineering at the University of North Carolina at Charlotte. Charlotte, NC.

This PowerPoint presentation provides an overview of how Supplemental Instruction (SI) and other forms of academic assistance are used at the William States Lee College of Engineering at the University of North Carolina at Charlotte. Some data studies are shared as well to validate their effectiveness.

Blat, C. M., & Nunnally, K. (2004). *Successfully applying the Supplemental Instruction model to engineering and pre-engineering*. Conference Proceedings of the Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition.

Supplemental Instruction (SI) was used at the University of North Carolina-Charlotte in engineering and pre-engineering classes to increase student grades in the courses. Final course grades are higher and the rates of D, F, and course withdrawals are lower.

Blunt, R. (2008). A comparison of medical students' preferences for structured and unstructured peer-learning. *Australasian Journal of Peer Learning*, 1, 40-50. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/6>

At St. George's University in Grenada Supplemental Instruction (SI) is used to enhance both student learning outcomes as well as provide the academic support needed to earn high grades in rigorous courses in the medical school. This article discusses a survey that students were invited to complete concerning the SI program. About 20 percent of the students participate in the voluntary SI program. The most common reasons for participating in SI were: developing understanding, finding help when they could not understand something, preparing for exams, and keeping themselves motivated, focused and working hard. Students were twice as likely to ask for academic help from a fellow student than the faculty member for the course.

Bocock, J. (1993). Supplemental Instruction: Striking a balance in the curriculum. *The Lecturer (The University & College Lecturers' Union)*, 7.

The Supplemental Instruction (SI) program is cited by Jean Bocock, Assistant Secretary for Higher Education in the United Kingdom, as one way to deal with a number of pressing educational needs: dealing with rising student to teacher ratios [8.5:1 in 1980 to almost 20:1 today]; shifting towards student-centered learning; and capitalizing upon the resources of students to teach other students. One concern expressed by NATFHE, the University & College Lecturers' Union, is that SI not be used as a cheap alternative to hiring trained staff and paying them a proper salary.

Bonsangue, M. V., Cadwalladerolsker, T., Fernandez-Weston, C., Filowitz, M., Hershey, J., Moon, H. S., . . . Engelke, N. (2013). The effect of Supplemental Instruction on transfer student success in first semester calculus. *The Learning Assistance Review*, 18(1), 61-75.

This study focused on the impact of Supplemental Instruction (SI) on student achievement in first semester Calculus for transfer students over a three-year period. Transfer students participating in SI achieved dramatically higher passing rates and course grades than did non-transfer students, despite no significant differences in academic predictors between the two groups. The results here indicate that while SI has been shown to be an effective tool for many students, the academic and social elements of SI may be especially significant for STEM transfer students enrolled in gateway courses such as first semester Calculus.

Botha, L., Van der Merwe, A., & De Klerk, E. (1996, 1996, November). *Tutor programme vs. Supplemental Instruction at the University of Stellenbosch*. Conference Proceedings of the South African Association for Academic Development Conference, University of Fort Hare, Republic of South Africa.

The Division of Academic Programmes (DADP) at the University of Stellenbosch (South Africa) runs academic development programs serving the twelve faculties of the University. Both a traditional tutor program and Supplemental Instruction (SI) was provided as support and enrichment for the students. At the time of this paper's publication, quantitative data was not available for summative evaluation and comparison of the two approaches to academic assistance. Interviews with students suggested high satisfaction with the SI program for several reasons: high motivation level of SI leaders; opportunity to work on writing effective summaries during SI sessions; developing understanding of basic concepts and subject specific terminology; development of study strategies; and improved skills for completing essay examination questions.

Bowles, T. J., & Jones, J. (2003). An analysis of the effectiveness of Supplemental Instruction: The problem of selection bias and limited dependent variables. *Journal of College Student Retention, 5*(2), 235-243.

This article extends beyond the usual reliance upon single equation regression models to evaluate Supplemental Instruction (SI) and employs a simultaneous equation, limited dependent variable evaluation model. Results of the research study at Utah State University at Logan suggest that students with below average academic ability are more likely to attend SI and that common measures of student ability included in single equation models fail to adequately control for this characteristic. The authors suggests that the older evaluation models have underestimated the effectiveness of SI.

Bowles, T. J., & Jones, J. (2003). The effect of Supplemental Instruction on retention: A bivariate probit model. *Journal of College Student Retention, 5*(4), 431-437.

This study investigated the effectiveness of Supplemental Instruction (SI) with increasing student academic outcomes. While many previously published studies on SI have been single equation regression models, this study was a bivariate probit model. Two important issues investigated by these researchers included: both SI attendance and retention are categorical variables; both of these variables are jointly determined endogenous variables. This study suggests that single equation models are likely to overestimate the effect of SI participation.

Bowles, T. J., McCoy, A. C., & Bates, S. (2008). The effect of Supplemental Instruction on timely graduation. *College Student Journal, 42*(3), 853-859. Available online: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1103&context=psych_facpub.

This research study examines the use of Supplemental Instruction (SI) to increase the rate of timely graduation by participating students. Many state legislatures and education leaders demand for policy and financial reasons that students graduate with a bachelor's degree in four years rather than taking an extended time to complete their undergraduate degree, thereby requiring more institutional resources such as teaching faculty, housing, and other services. Self-selection bias is controlled in first-year level courses to investigate the potential impact of SI. During fall semester of 2001 and spring semester of 2002, 3,905 students at a large western land-grant institution, Utah State University, enrolled in first-year courses supported by SI. SI participant status was established as having attended SI sessions three or more times during their first-year course. Students were examined again in four years to determine their college graduation status. Holding all other variables constant, SI participation increases the probability of timely graduation by 11 percent.

Boylan, H. R. (1999). Exploring alternatives to remediation. *Journal of Developmental Education*, 22(3), 2-4, 6, 8, 10.

In this journal article Dr. Hunter Boylan, Director of the National Center for Developmental Education, the author explores five alternative ways to serve students who previously may have been served through traditional developmental education courses: (1) freshman year seminars; (2) Supplemental Instruction; (3) learning communities and collaborative learning; (4) paired courses; and (5) critical thinking instruction. For students that do not need the extensive time required by full academic-term length developmental courses, the five alternatives explored in the article might be as effective with the benefit of shorter investment of time, personnel, and money. The author cited three studies where SI has been especially effective with developmental students: (1) Blanc, DeBuhr, & Martin, 1983; (2) Commander, Stratton, Callahan, & Smith, 1996; and (3) Ramirez, 1997.

Boylan, H. R., Bonham, B. S., & Bliss, L. B. (1992). *National study of developmental education: Students, programs and institutions of higher education*. Boone, NC: National Center for Developmental Education.

Through a grant from the EXXON Education Foundation, the National Center for Developmental Education conducted the most extensive study of developmental education. The 1989 to 1992 study included 116 institutions representing a wide diversity of types. More than 6,000 students were subjects of the longitudinal study. The purpose of the study was to determine what is actually done in developmental education, to explore whether or not developmental programs actually contribute to student success, and, if so, to identify what types of programs and services have the greatest impact upon student success. Among the list of instructional factors related to student success, Supplemental Instruction (SI) is one of the items. Other items listed were: mastery level performance, frequent testing, immediate feedback, required remediation, individualized instruction, lab activities, integrated teaching of critical thinking skills, and close proximity of classrooms and support services.

Bradley, P. (2007). Supplemental Instruction programs showing results. *Community College Week*, 20(1), 7.

This brief report indicates that Supplemental Instruction (SI) at Tidewater College in Norfolk, VA. Interviews with students share their positive comments about the usefulness of the SI program with supporting their academic success. The pass rate in an introductory English class increased from 60 to 70 percent after SI was attached to the course. The SI program is partially funded by a Lumina grant to support its Achieving the Dream initiative.

Brantley, F. (2009). *Supplemental Instruction: Working together to achieve success*.

Unpublished manuscript. Kennesaw State University. Kennesaw, Georgia. Available online: http://www.cfder.org/uploads/3/0/4/9/3049955/supplemental_instruction__working_together_to_achieve_success.pdf

This report has provided statistical evidence of the effectiveness of the SI program at Kennesaw State University. Specifically, SI participation was found to have a positive and beneficial effect on all student outcomes investigated. In all cases, however, the effect of SI participation on the student outcomes of interest was found to be mediated by some measure of previous academic achievement, either high school GPA, in the case of final grades, or standardized math test performance, in the case of DFW rates and current term GPA. The reason for an effect mediated by one over the other is not clear and will require further research. It is possible that these measures of academic achievement include other incidental or secondary characteristics of the students differentially. For example, it may be that high school GPA measures academic achievement as well as a substantial amount of student motivation, determination, and/or persistence while standardized math test performance may incidentally measure more aptitude

and/or test-taking skills, etc. More research into these issues is needed. SI participation was not found to be significantly mediated by verbal test performance. This may be attributable to the fact that the majority of historically difficult classes at Kennesaw State University are either science or math classes. As a result, math test performance is most likely more telling of a student's performance in these classes. In all cases, the variation between SI leaders was found to be negligible. This result provides evidence that SI participation is equally beneficial for students regardless of which SI leader is providing service. This may be interpreted as evidence validating the training of these leaders and the SI program at Kennesaw State University. These findings suggest that the recruitment and training of these individuals is producing a relatively homogeneous population of leaders who are equally effective at delivering SI services. As further research is done, we will examine this further. In contrast, all of the analyses found that the variation among instructors was statistically significant. This provides some evidence for the conventional wisdom that some instructors are more effective than others. The estimated variation between instructors was not substantial and may not be of practical importance. Further investigation into this issue is needed. Finally, the present analysis does not provide evidence of a causal relationship between SI participation and any of the student outcomes investigated. In other words, it is not possible to claim that SI participation causes positive changes in these outcomes. Simply, the reported effect of SI participation may be the result of other variables not represented in the data. One of the most likely candidates being student motivation. For example, with regard to the investigation of transferable skills measured by current term GPA: are students generalizing SI skills to their other classes or are more serious, motivated students simply choosing to go to SI more and also obtaining higher levels of achievement in their other classes which they would have obtained anyway? The current study was not designed to address these issues. In order to prove a causal relationship, a designed experiment would have to be performed where students are randomly assigned to different levels of SI participation during data collection. Congos and Schoeps (1993) noted, however, that the self-selection bias remains an inherent problem in the evaluation of the program. While remaining mindful of this fact, the present analysis did include variables such as high school GPA and standardized test performance that surely serve as proxies for student motivation to some extent. In other words, a student's motivation certainly impacts their high school GPA as well as their academic performance in college. Because these proxy variables were included in the present analysis, student motivation has been accounted for to some un-known extent. Future investigation is needed to further delineate these relationships and their impact. This data is compelling; however, the voices of our students speak loudest when we begin to look at the success of our program:

Brazelton, W., Schmidlein, P., & Baugher, M. (1981). *Reducing student attrition in the first-year economics course through skill-based Supplemental Instruction*. Paper presented at the University of Missouri Economics Conference, Columbia, MO. pages

This paper discusses the use of Supplemental Instruction (SI) to improve student academic performance in introductory college-level economics courses at the University of Missouri-Kansas City. Data suggests that SI participants receive higher mean final course grades (66.6% A and B final course grades for SI participants vs. 45.6% for non-SI participants) and a lower rate of D, F or course withdrawals (14.8% vs. 21.1%). The total percent of unsuccessful enrollments (D, F or course withdrawal) for the course was reduced from 34 percent before the introduction of SI to 19 percent during the second year that SI was offered to the students in the course.

Bridgham, R. G., & Scarborough, S. (1992). Effects of Supplemental Instruction in selected medical school courses. *Academic Medicine: Journal of the Association of American Medical Colleges*, 67(10), 569-571.

This article describes the use of Supplemental Instruction (SI) in the College of Human Medicine of Michigan State University with courses in biochemistry, physiology, pharmacology, genetics, gross anatomy, and histology. SI attendance was mandatory for all first- and second-year students who are on probation and optional for all others. A study of students enrolled in Biochemistry, Physiology, and Pharmacology courses between 1988 and 1990 suggests that SI attendance was correlated with higher mean final course grades. The authors suggest about twenty specific activities for SI sessions. In general, SI participants earned higher mean final course grades. The authors mentioned that the success of the SI program has encouraged the College to maintain an admissions policy that encourages a more diverse student population.

Briere, P., Congos, D. H., & Wallace, J. (Writers). (1995). Promoting the Supplemental Instruction program [Videotape]. In D. R. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape discusses various aspects of promoting the Supplemental Instruction (SI) program. Discussion participants reviewed a variety of topics including recruiting SI leaders, promoting attendance among students, and gaining support from faculty and administrators. The panelists are campus SI supervisors as well as Certified Trainers with the SI program. Wallace is the Certified Trainer from the United Kingdom.

Briere, P., Garland, M., Visor, J. N., & Browning, S. (Writers). (1995). The use of Supplemental Instruction with target populations [Videotape]. In D. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape records a panel discussion concerning the use of Supplemental Instruction (SI) with targeted subpopulations of students. Generally the SI program is provided for all students on campus. Due to specific needs and restricted funds, the SI program may be targeted with success for any of the following groups: students on academic probation; academically underprepared students; student-athletes; Upward Bound high school students; international students; and programs that limit grant funds to eligible populations (e.g., Carl Perkins Vocational, TRIO programs). The panelists discuss how to market to these student groups and conduct appropriate evaluation systems. The panelists are campus SI supervisors as well as Certified Trainers with the SI program.

Brittain, J. S. (2013). *The effect of Supplemental Instruction on consecutive-semester sequence STEM classes at community colleges*. (Ph.D. dissertation), California State University, Northridge, Northridge, CA. Available online: <http://scholarworks.csun.edu/bitstream/handle/10211.2/3609/Brittain-Joy-thesis-2013.pdf?sequence=1>

This ex-post facto study using secondary data assessed the impact of Supplemental Instruction (SI) in consecutive-semester science, technology, engineering, and mathematics (STEM) courses at two community colleges. It also looked at the impact SI had on successful persistence of students. SI engages students through their own learning via social interaction. Prior studies have shown that SI to have greater successful persistence and higher course grades. This study attempted to determine if an additional semester of SI would have an added effect on course grade for both credit-bearing and developmental classes. Secondary data were collected from two community colleges using a sample size of 6194 students from Community College A and 1534 students from Community College B. Using an independent samples t-test, the study found a significant and positive difference between course grades of SI-users and non-SI users with an average of $\frac{1}{2}$ letter grade increase. Using regression analysis, the study found that SI utilized in developmental math did not have an impact on the grade in the subsequent developmental-level math course within the sequence. The study did show an impact that was positive and significant when students utilized SI for consecutive-

semester STEM classwork. SI was shown to have a positive and significant outcome in successful persistence. There was an overall 18.8% increase in successful persistence with developmental coursework and a 25% increase in credit-bearing STEM coursework. These findings advocate for the use of SI in developmental coursework in contrast to prior studies, which suggested SI was not an appropriate service to use for students in developmental courses. The findings also imply that there is an additive effect of learning, thus SI may be utilized more effectively in a course sequence as opposed to just individual classes. The study suggests that SI is a contributor to the successful persistence of students in community colleges, especially in STEM, an area where there is normally a low completion rate. Finally, the information in this study will aid community colleges in deciding where best to spend their funding for student services

Brock, L. (2003). *Effect of Supplemental Instruction on academic performance of community college students*. (Master of Arts thesis), California State University, Stanislaus, CA. This study examined the potential impact of Supplemental Instruction (SI) with public community college students enrolled at Modesto Junior College (CA). The analysis included both the level of involvement in SI as measured through sessions attended as well as the preentry attributes of the students: prior academic achievement, prerequisite course grades, interest, and self-efficacy.. Nine sections of the following courses which offered SI were selected for the study: College Algebra, Elementary Statistics, Elementary Algebra, English Basic Composition and Reading. Voluntary participation in SI ranged from one-third to two-thirds of the classes in the nine course sections. In nearly all the courses both the decision of participate in SI and the number of times that SI sessions attended were found to be statistically significant with higher final course grades. In several sections there were no statistically significant differences between SI and non-SI participants. The preentry attributes of the students did not significantly contribute to higher grades. The researcher made several recommendations for further research including a study of the impact of early participation in SI rather than waiting until later in the academic term. There are no reported studies of SI that have evaluated this variable for its possible impact on student grades in the course.

Bronstein, S. B. (2007). *Supplemental Instruction: Supporting persistence in barrier courses*. (Ph.D. dissertation), University of Massachusetts Amherst. The purpose of this single-case descriptive study was to explore student and instructor perceptions of Supplemental Instruction (SI) in an upper-level chemistry course (Physical Chemistry). The course has a reputation for being particularly challenging, an academic hurdle or barrier for students in the science, mathematics and engineering (SME) disciplines. This study provided an opportunity to better understand why students in an advanced "barrier" course participate in SI, and why SI is perceived as an effective resource in upper-level courses. Determining the perceived benefit of SI as a way to overcome these barriers may positively contribute to persistence. In designing this study, the researcher sought to answer two primary questions: (1) Why do students in Physical Chemistry participate in SI; and (2) is SI an effective strategy supporting persistence in SME majors? These questions were explored through a case study methodology that included a focus group, one-on-one interviews with instructors and six enrolled students, document review and class and SI statistics. Findings indicated four major factors that related to students' participation in these SI sessions: (1) anxiety about the course initiated by the reputation of this difficult required course; (2) the course content, complicated by the use of mathematics and composition of the subject matter; (3) characteristics of enrolled students; and (4) nature and benefit of academic resources. The combination of course anxiety and a required course with difficult content generates the cycle of an academic barrier. Results also suggested several interrelated conclusions about the value of SI as an academic resource. SI seemed to reduce anxiety, and supported students' learning. A comparison of course grades

before and since the inclusion of SI in Physical Chemistry demonstrated a statistically significant increase in higher grades. This combination of academic success and positive social experiences suggests that SI is a valuable resource for overcoming academic barriers and positively contributing to student persistence.

Bronstein, S. B. (2008). Supplemental Instruction: Supporting persistence in barrier courses. *The Learning Assistance Review, 13*(1), 31-45.

Courses that interfere with undergraduate students' persistence are barriers that appear all along the undergraduate continuum. Supplemental Instruction (SI) may contribute to students' achievement in a barrier course and, therefore, to their persistence in their academic program. The purpose of this single-case descriptive study was to explore student and instructor perceptions of SI in an upper-level chemistry course with a reputation for being a barrier to academic success. The case study methodology used included a focus group, one-on-one interviews with instructors and students, document review, and class and SI statistics. Results indicated that faculty and students perceived SI to be a valuable resource in achieving persistence or academic success.

Brookshire, R. G., & Palocsay, S. W. (2005). Factors contributing to the success of undergraduate business students in management science courses. *Decision Sciences: Journal of Innovative Education, 3*(1), 99-108.

This article examines the use of Supplemental Instruction (SI) in an introductory management science course that has been historically-difficult within the business school curriculum. This study uses multiple regression to examine the potential usefulness of SI to meet the needs of the students.

Brown, K., Naim, K., van der Meer, J., & Scott, C. (2014). "We were told we're not teachers...It gets difficult to draw the line" Negotiating roles in Peer-Assisted Study Sessions (PASS). *Mentoring & Tutoring: Partnership in Learning*. doi:10.1080/13611267.2014.902559.

Peer learning models in pre-service teacher education are in the early stages of implementation. In this article, we evaluated a pilot Peer-Assisted Study Sessions (PASS) program that supplemented a course for pre-service teachers at one New Zealand university. PASS participants discussed experiences of the program, revealing tensions between what students and facilitators felt should happen in PASS, and how they acted differently. We explained these tensions by considering how social and cognitive congruence operated between students and facilitators. The majority of our peer facilitators were pre-service teachers, suggesting these intersecting roles offered important considerations for reciprocity in near-peer relationships, and joint negotiations of roles and responsibilities. We conclude this article with implications for future training of PASS facilitators, including those training as teachers.

Browning, S., Minkoff, D., Wallace, J., & Zerger, S. (Writers). (1995). The use of Supplemental Instruction for faculty and SI leader development [Videotape]. In D. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City. This videotape records a panel discussion on the uses of Supplemental Instruction (SI) for both faculty and SI leader professional development. Topics covered included: faculty development in the United Kingdom and the U.S.; SI leaders serving as partners with faculty members to improve classroom learning; using SI as an anonymous feedback mechanism for faculty members; and developing a faculty focus on increased student learning. The panelists are campus SI supervisors with the SI program. Wallace is Certified Trainer for the United Kingdom with Minkoff and Zerger trainers for the U.S.

Bruno, P. A., Love Green, J. K., Illerbrun, S. L., Holness, D. A., Illerbrun, S. J., Haus, K. A., . . . Sveinson, K. L. (2015). Students helping students: Evaluating a pilot program of peer teaching for an undergraduate course in human anatomy. *Anatomical Sciences Education*. doi: doi:10.1002/ase.1543. Available online: <http://onlinelibrary.wiley.com/doi/10.1002/ase.1543/epdf>.

The educational literature generally suggests that Supplemental Instruction (SI) is effective in improving academic performance in traditionally difficult courses. A pilot program of peer teaching based on the SI model was implemented for an undergraduate course in human anatomy. Students in the course were stratified into three groups based on the number of peer teaching sessions they attended: nonattendees (0 sessions), infrequently attended (1-3 sessions), and frequently attended (≥ 4 sessions). After controlling for academic preparedness [i.e., admission grade point average (AGPA)] using an analysis of covariance, the final grades of frequent attendees were significantly higher than those of nonattendees (P50.025) and infrequent attendees (P50.015). A multiple regression analysis was performed to estimate the relative independent contribution of several variables in predicting the final grade. The results suggest that frequent attendance (b50.245, P50.007) and AGPA (b50.555, P<0.001) were significant positive predictors, while being a first-year student (b520.217, P50.006) was a significant negative predictor. Collectively, these results suggest that attending a certain number of sessions may be required to gain a noticeable benefit from the program, and that first-year students (particularly those with a lower level of academic preparedness) would likely stand to benefit from maximally using the program. End-of-semester surveys and reports indicate that the program had several additional benefits, both to the students taking the course and to the students who served as program leaders.

Bruzell-Nilsson, M., & Bryngfors, L. (1996). *Use of Supplemental Instruction to improve student learning in Sweden*. Paper presented at the International Conference on the First-Year Experience, St. Andrews, Scotland, United Kingdom. Available online: ERIC database. (ED398792).

This chapter in the conference proceedings describes the use of Supplemental Instruction (SI) at postsecondary institutions in Sweden. Both a basic overview of the SI model and adaptations to the SI model for use in Sweden are shared.

Bryan, K. N. (2013). *Assessing the impact of faculty-led Supplemental Instruction on attrition, GPA, and graduation rates*. (Ph.D. dissertation), Walden University.

The purpose of this quasi-experimental, quantitative study was to investigate the effectiveness of Supplemental Instruction (SI) as a means to address the existing high attrition and low graduation rates evidenced at a rural southern community college. The research problem addressed the high attrition rates in barrier courses and low graduation rates evidenced at the community college. Students unable to successfully complete barrier courses often alter their educational goals or eventually drop out. Following the constructivism and social constructivism theories, which state that learning is shaped by social interaction, the research questions examined the impact of SI on GPA, graduation rates, and persistence in identified barrier courses. Additional subgroup comparisons between adult learners and traditional students participating in SI were completed. A convenience sample of 70 students currently enrolled in barrier courses was used. Independent samples t tests were conducted and found no significant differences in grades, GPA, or graduation rates for those participating in SI versus those who did not. Independent samples t tests also revealed no significant differences between graduation rates and GPA of adult students versus traditional students participating in SI. Based on the data, the SI model was found to be minimally effective. These findings, along with recommendations to complete a formal, summative evaluation and incorporate professional development training, were presented in the culminating project, a white paper. This study may

contribute to social change by helping decision makers properly assess the value of SI to both traditional and nontraditional students, benefiting all who attended the studied site, as well as indirectly impacting the community.

Bryngfors, L., & Barmen, G. (2000). *The LTH Program: A structured introductory process to improve first year students' performance and learning*. Unpublished manuscript. The Lund Institute of Technology. Lund, Sweden. Available from the authors: Lund Institute of Technology, PO Box 118, SE-221 OO LUND, Sweden, Leif.Bryngfors@kansli.lth.se

Higher education in Sweden faces many of the same challenge as the rest of Western Europe and the United States. The LTH Program combines an orientation process with a support system to help new students in their transition from secondary school to university studies. Essential components of the program stimulate the learning process of students while encouraging them to find a balance between academic and social activities. Three years' experience with the LTH program shows an increase in first-year performance and retention by as much as 50 percent. Supplemental Instruction is a critical component of the LTH program.

Bryngfors, L., & Barmen, G. (2003). The LTH Program -- A Structured introductory process to improve first-year students' performance and learning. *National Association for Student Personnel Administrators Journal*, 40(4), Article 3.

This article focuses on a comprehensive approach to student persistence at the Lund Institute of Technology in Sweden in a manner consistent with Swedish ethos. The explorations led to the development of the LTH (*Swedish abbreviation for Lund Institute of Technology*) program, which combines an orientation process with a support system to help new students in their transition from secondary school to university studies. Essential components of the program seek to stimulate the learning process of students, while encouraging them to find a balance between academic and social activities. Three years' experience with the LTH program shows an increase in first-year performance and retention by 50%. Supplemental Instruction (SI) is an important component of the LTH program.

Bryngfors, L., & Bruzell-Nilsson, M. (1997). *Supplemental Instruction: An experimental project with the method of Supplemental Instruction*. Unpublished manuscript. The Lund Institute of Technology and The Faculty of Science. Lund, Sweden.

This report provides an overview of the expansion of the Supplemental Instruction (SI) program into Sweden. Research studies in 1996 from Lund University (Lund, Sweden) suggest that SI participation contributes to higher percent of students passing the final examination for the course (46 percent vs. 39 percent), and a higher rate of reenrollment (15 percentage points higher). The mean average of students participating in SI was 46 percent. Interviews with SI participants, SI leaders and the course professors who had SI attached to their class reported positive comments concerning the impact of the SI program. SI leader comments could be placed into three categories: contact with and the opportunity to assist in the learning process of the new students; deeper knowledge of the subject; and deeper knowledge of the learning process and leadership experiences. Faculty members mentioned the following reasons for supporting the SI program: received feedback from students concerning problems that students encountered but did not disclose to the course instructor; SI sessions provided another forum for students to engage in deeper understanding and problem solving; students appeared more ready to participate in class oral examinations due to practice of similar activities in SI sessions; students were more skilled in participating in collaborative learning activities required by the course professor; and students appeared to have higher morale since they established working relationships with other students who could support their academic work. The authors for this report also serve as the Certified Trainers for SI in Sweden and surrounding countries.

Bryngfors, L., & Bruzell-Nilsson, M. (1997). Supplemental Instruction: An experimental project with the method of Supplemental Instruction. In R. B. Ludeman & S. Hubler (Eds.), *Quality student services around the world: Bridging student needs and student success* (pp. 221-246). Washington, D.C.: National Association of Student Personnel Administrators

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Bryson, D. (1987, 1987, March 8). Study sessions help medical students get over the hump of board tests, *Daily American Republic Newspaper*, p. 5.

This newspaper article describes an adaptation of the Supplemental Instruction (SI) model with medical students who are studying to pass their licensure examination so that they may continue with their clinical studies. The article includes interviews with Dr. Robert Blanc, Coordinator of Curriculum Development at the UMKC medical school and Dr. Deanna Martin, Director of the Center for Academic Development. Some of the activities of the semester-length board preparation program mentioned by students interviewed in the article are: students learn how to work in groups to learn new material, students must be able to explain concepts to one another to assure understanding, students focus on the thinking process as much as the content, and students develop confidence in their ability to do well with challenging examinations.

Buchanan, E. M., Valentine, K. D., & Frizell, M. (2017). *Supplemental Instruction: Understanding academic assistance in underrepresented groups*. Missouri State University. Available online: <https://osf.io/xn4kf/>

Student retention rates are increasingly important in higher education. Higher education institutions have adopted various programs in the hopes of increasing graduation rates and grade point averages (GPAs). One of the most effective attempts at improvement has been the Supplemental Instruction (SI) program. We examined our SI program on three facets: attendance, attendance's influence on final scores, and graduation rates for students who had participated in these courses. These questions were also investigated focusing on specific comparison groups, as we looked into how these effects differed for Minority students and nontraditional students, when compared to their White and traditional peers. Overall, SI attendance led to positive outcomes: increased final course grades and graduation rates, even after adjusting for previous achievement.

Buchanan, E. M., Valentine, K. D., & Frizell, m. L. (2018). Supplemental Instruction: Understanding academic assistance in underrepresented groups. *Learning, Instruction, and Cognition*, 288-298. doi: 10.1080/00220973.2017.1421517.

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Buchanan, E. M., Valentine, K. D., & Frizell, M. L. (2018). Supplemental Instruction: Understanding academic assistance in underrepresented groups. *The Journal of Experimental Education*, 87(2), 288-298. doi: 10.1080/00220973.2017.1421517.

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Burmeister, S. L. (1994). The challenge of Supplemental Instruction: Improving student grades and retention in high risk courses. In M. Maxwell (Ed.), *From access to success: A book of readings on college developmental education and learning assistance programs* (pp. 209-214). Clearwater, FL: H&H Publishing Company

This chapter provides a general overview of the Supplemental Instruction (SI) program, its history and components. Review of significant research studies of the SI model is included (e.g., course grade and reenrollment by entry-test score, graduation rates). A new study suggests that SI attendance was correlated with higher final course grades in three types of mathematics courses: College Algebra (2.21 vs. 1.98), Calculus (2.28 vs. 1.83), and Statistics (2.49 vs. 2.32). The study included data from 45 institutions with a total of 11,252 students enrolled in 177 classes. SI participants earned mean final course grades that were higher than non-participants in all three categories of mathematics courses. Suggestions are provided for improving the effectiveness of campus SI programs.

Burmeister, S. L. (1996). Supplemental Instruction: An interview with Deanna Martin. *Journal of Developmental Education*, 20(1), 22-24, 26.

This is the transcript of an interview with Dr. Deanna Martin, creator of the Supplemental Instruction (SI) model. Issues discussed in the interview include: new innovations in the SI model; cost effectiveness of the model; use of SI in other countries; current educational climate in higher education; disagreement with mandatory testing and placement of students into tracked developmental education programs; challenges with lecture-based educational delivery systems with increasing student learning mastery; and future opportunities for use of SI and Video-based Supplemental Instruction

Burmeister, S. L., Carter, J. M., Hockenberger, L. R., Kenney, P. A., McLaren, A., & Nice, D. L. (1994). *Supplemental Instruction sessions in College Algebra and Calculus*. New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass.

Based on their observations of math Supplemental Instruction sessions, the authors review several active learning strategies that have been effective for students of the discipline. Critical activities for SI participants include: active involvement by all SI session participants; test their approaches to problems; precise use of math vocabulary; attention to precision; practice solving problems under time constraints; vocalize their thinking process regarding problem solving to each other; and set part of the agenda of SI sessions. SI leaders need strong support from the SI supervisor for such activities to characterize SI sessions.

Burmeister, S. L., Kenney, P. A., & Nice, D. L. (1996). Analysis of effectiveness of Supplemental Instruction sessions for college algebra, calculus, and statistics. In J. J. Kaput, A. H. Schoenfeld & E. Dubinsky (Eds.), *Research in Collegiate Mathematics Education II* (pp. 145-154).

Providence, RI: American Mathematical Association and Mathematical Association of America
After an overview of the Supplemental Instruction (SI) model, this article focuses on a research study concerning the effectiveness of SI for 11,252 students enrolled in 177 courses in college algebra, calculus and statistics from 45 different institutions. In comparison with non-SI participants, SI participants earned higher mean final course grades and experienced lower rates of withdrawals: algebra (2.21 vs. 1.98); calculus (2.28 vs. 1.83); and statistics (2.49 vs. 2.32).

Burmeister, S. L., McLaren, A., & Zerger, S. (Writers). (1995). Supplemental Instruction in the content areas: English, Humanities, and Mathematics [Videotape]. In D. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City
This videotape records a panel discussion on the subtle differences and needs for Supplemental Instruction in different content areas. Topics included: differences in problem-based and vocabulary-based curriculums; use of SI in laboratory situations; strategies for mastering vocabulary; relationships between lectures and textbooks in different content areas; and the degree to which strategies for curriculums overlap with each other. The panelists are all campus SI supervisors as well as Certified Trainers with the SI program.

Bushway, S. D., & Flower, S. M. (2002). Helping criminal justice students learn statistics: A quasi-experimental evaluation of learning assistance. *Journal of Criminal Justice Education*, 13(1), 35-57.

This article describes a quasi-experimental study of the use of Supplemental Instruction (SI) in a statistics course taken by students enrolled in criminal justice and criminology at a large public university. Three other modifications were made in the class: (1) participation in SI was mandatory for at-risk students and voluntary for all others in the class; (2) offering web-based quizzes; and (3) mandatory lecture class attendance for at-risk students. SI and the quizzes contributed to increased success of students while the mandatory attendance did not have an apparent effect. The intent of the online quizzes was to increase reading of the textbook.

Buth, J., & Hasbun, J. E. (2017). Student led Supplemental Instruction to improve success in classical mechanics. *Georgia Journal of Science*, 51(1), Article 98. Available online: <http://digitalcommons.gaacademy.org/gjs/vol75/iss1/98/>.

The goal of this research is to explore the effectiveness of Supplemental Instruction in a classical physics class. The class involves physics projects associated with real classical physics problems which were based on writing the equations of motion for analytically solvable conditions. The projects are based on extensions of the analytical solutions to include terms in

the equations that made the problems unsolvable analytically. Numerical solutions were to be obtained and compared with the analytically examined solutions and study the effects of the modifications. To accomplish this, the students would write or modify MATLAB programs in order to compare the numeric and analytic solutions. My task was to lead my peers in supplemental instruction (SI) sessions to help with the physics of the various projects and with their MATLAB coding while answering questions in the form of hints. I would finish my coding projects early to get it checked over by the professor and then hold SI sessions to give feedback to my peers. Personally, I have seen a greater understanding in the students in regards to the MATLAB coding projects and the classical physics problems. The SI sessions seemed to improve student understanding in classical physics. Financial support from UWG SEEP program is acknowledged.

Bye, L. A. (2005). *Student achievement and retention in relation to Supplemental Instruction provided for two first-year science courses*. (Master of Arts thesis), University of South Dakota, Vermillion, SD.

This research was conducted at the request of university administration to determine if the program was valuable as a tool in retention. Information specifically about the benefit vs. cost at the institution was deemed necessary in order to make budgetary decisions. This study examined differences in mean course grades and term GPAs based on SI attendance of students enrolled in two first-year college natural science courses. In addition, the relationship between course grades, term GPA, and reenrollment was also investigated. Analyses of variance (ANOVAs) were used to discover differences in students' course and term grade point averages between groups based on attendance level at SI sessions. A Pearson product-moment correlation was conducted to determine the relationship between level of attendance at SI, course grades, and term grade point averages. For subjects in the study, attendance in SI seemed to provide a useful intervention to increase targeted course grades. This examination supports the hypothesis that going to SI sessions on a regular basis produces a significant mean difference of the groups. Course grade averages were significantly higher for students who attended SI more often in comparison to the course grade averages of students who did not attend. Students participating in SI more often also had significantly higher term grade point averages than those who did not attend. A positive correlation was found between attendance at SI sessions and course grade and also between attendance and term GPA. Finally, a chi-square analysis revealed that student attendance at SI sessions had a positive relationship with retention of students in the university.

Caldarello, B. A. (2017). *The effect of Supplemental Instruction on student academic achievement in a STEM-related general biology course at a public university*. Saint Louis University, St. Louis, MO.

The object of this quantitative study was to determine if there were significant differences in the academic achievement of students within a STEM-related class, General Biology, for the students who voluntarily chose to attend Supplemental Instruction (SI) sessions and students who did not choose to attend SI sessions. The data containing the number of SI sessions students attended, student gender, incoming ACT or SAT scores, and high school grade point average (HSGPA) scores were used to evaluate the possible relationships between student demographics, academic preparedness, level of participation in SI and academic success.

Campbell, M. L. (1994). *The cognitive effect of Supplemental Instruction on student achievement in general biology*. (Master's of Education thesis), Slippery Rock University, Slippery Rock, PA.

Supplemental Instruction (SI) was studied at Slippery Rock University (PA) with a college-level general biology class. SI participants attended SI sessions twice each week and were compared

to a similar group of students who did not participate but had equivalent academic preparation level. The SI group outperformed the control group by half a letter grade, $p < .0285$. Qualitative interview procedures were employed to confirm the effectiveness of SI session attendance with higher final course grades.

Campbell, M. L. (2002). Supplemental Instruction academic assistance within Pennsylvania's ACT 101 Program for disadvantaged students [Dissertation, University of Pittsburgh, 2001]. *Dissertation Abstracts International*, 62(12), 4083.

Supplemental Instruction (SI) is a specialized form of group academic support developed to increase student performance and retention by proactively integrating study skills acquisition strategies into voluntary out-of-class sessions targeting content from high-risk courses (Martin & Arendale, 1993). SI features faculty partnerships, sessions focused upon peer collaborative learning, SI leaders who attend class lectures, and on-going assessment (Martin & Arendale, 1994). To determine how to foster SI academic assistance within programming like Pennsylvania's Act 101 initiative for disadvantaged students, this study determined the differences in perceptions of SI between Act 101 tutorial coordinators with established SI programs and those who may potentially start new SI programs. A self-administered questionnaire was developed by the researcher using current SI literature and mailed to each of the state's Act 101 program tutorial coordinators. Of the 79 subjects, 56 (71%) returned completed questionnaires. Though 27% of the Act 101 tutorial coordinators were unaware of SI, 46% reported familiarity with and usage of the model. Act 101 SI efforts were characterized as small in scale, nascent in development, and lacking many recommended elements of the SI model (e.g., faculty partnership). Act 101 tutorial coordinators lacking SI programs, yet aware of the potential, tended to underestimate the benefits of such programming like the emphasis on high-risk courses, integration of study skills, and lack of remedial stigma. Moreover, they tended to overestimate the difficulty associated with overcoming challenges to program administration like program costs and recruiting students to SI sessions. However, most Act 101 tutorial coordinators valued similar program characteristics such as promoting student persistence and meeting academic needs as influencing the use of SI. Finally, perceived limitations in program funding, professional supervision, and campus support emerged as the most prevalent issues impeding the expansion of SI within Act 101.

Cantwell, S., Bonadurer, G. F., Pawlina, W., & Lachman, N. (2015). Near-peer driven dissection selective: A primer to the medical school anatomy course. *Clinical Anatomy*, 28, 985-992. doi: 10.1002/ca.22630.

In the anatomy laboratory, skill remains a critical component to unlocking the true value of learning from cadaveric dissection. However, there is little if any room for provision of instruction in proper dissection technique. The researchers describe how near-peer instructors designed a supplemental learning activity to enhance the dissection experience for first-year medical students. This study aimed to evaluate the efficacy of this curriculum in improving participants' understanding of dissection technique and its impact on perceived challenges associated with the anatomy course. Curriculum was designed under faculty guidance and included didactic sessions, low-fidelity models, dissection, student presentations, and clinical correlations. Participants' ($n = 13$) knowledge of basic dissection techniques and concepts were assessed before the selective, and both participants' and nonparticipants' ($n = 39$) knowledge was assessed at the end of week one and week seven of the anatomy course. Scores were compared using repeated measures ANOVA followed by post hoc t-tests. Thirteen deidentified reflective essays were reviewed by four independent reviewers for themes that aligned with learning objectives. Participants in the selective course scored higher on assessment of dissection techniques and concepts one week after the selective compared to both nonparticipants and their own baseline scores before the selective. Analysis of student

reflections resulted in four themes: confidence with dissection skill, sharing resources and transfer of knowledge, learning environment, and psychological impact of perceived challenges of the anatomy course. Near-peer driven supplemental exercises are effective in facilitating dissection skills. This dissection primer increases student confidence and alleviates apprehension associated with anatomy courses.

Capstick, S. (2004). *Benefits and shortcomings of Peer Assisted Learning (PAL) in higher education: An appraisal by students*. Unpublished manuscript. Bournemouth University. Bournemouth, United Kingdom.

The benefits and shortcomings of a Peer Assisted Learning (PAL) scheme [based upon Supplemental Instruction] are described from the perspective of its student participants. Qualitative methodology is used to investigate and describe student outcomes, together with an analysis of influence of PAL on marks in one course. A wide range of benefits are reported for students engaged in PAL, as well as for those students responsible for managing PAL discussion groups. PAL leaders improved presentation skills, group speaking, and confidence. Some PAL leaders said the experience helped them during job interviews as well as promoting interest in teaching as a career. Negative aspects of PAL as described by the PAL leaders was the rule that they are not permitted to make short lectures to clear up confusion by the participants. This rule is common among British SI-like programs to clearly define how SI is different than what professional tutors and the course instructor does. It is argued that qualitative benefits of PAL are more pronounced and demonstrable, and more appropriately portray the scheme, than quantitative outcomes.

Capstick, S., Aisthorpe, A., Fleming, H., Haynes, S., & Spiers, M. (2003). *Peer assisted learning in Business Education: Innovative student support with wide-ranging benefits*. Unpublished manuscript. Bournemouth University. Bournemouth, United Kingdom.

Peer Assisted Learning (PAL), an adaptation of the Supplemental Instruction (SI), was used at Bournemouth University (United Kingdom) in the Business School. The manuscript describes the PAL program, short history of the introduction of SI to the United Kingdom, theories of group and individual learning, and operational issues associated with implementing the PAL program. PAL is offered by 80 PAL leaders in 13 courses: computing, conservation sciences, hospitality, business information technology, business information systems management, communication, and law.

Capstick, S., & Fleming, H. (2002). Peer assisted learning in an undergraduate hospitality course: Second year students supporting first year students in group learning. *Journal of Hospitality, Leisure, Sport, and Tourism Education*, 1(1), 69-75.

This article describes the use of Peer Assisted Learning (PAL) in the Management Foundation Course within the School of Services Industries at Bournemouth University (United Kingdom). The PAL program is an adaptation of the Supplemental Instruction (SI) program. The article first provides an overview of the PAL program and how it has been adapted from the SI model for use within the UK education system.

Capstick, S., Fleming, H., & Hurne, J. (2004). *Implementing Peer Assisted Learning in Higher Education: The experience of a new university and a model for the achievement of a mainstream programme*. Unpublished manuscript. Bournemouth University. Bournemouth, United Kingdom.

The experience of implementing Peer Assisted Learning in Higher Education over a three-year period is described. Developments in methods of implementation are placed in the context of embedding the scheme at an institutional level and conditions for success when setting up such a scheme are proposed. A timetable for effective implementation of PAL over the course of an

academic year is put forward, and experiences and recommendations are placed in the context of Ashwin's (2002) model for implementing peer learning schemes.

Carbon, D. (1995, August 1). Universities give peer program top marks, *Courier Mail Newspaper*.

This newspaper article reports on the implementation of Supplemental Instruction (SI) at three postsecondary institutions in Australia (Queensland University of Technology, University of Queensland, and the University of Southern Queensland). Henry Loh, QUT anatomy professor, reported reducing students' failure rate from 20 to 5 percent after the introduction of the SI program. However, he implemented the program more to increase academic performance than to just reduce student failure rates. Barbara Kelly of UQ reports that SI leaders regularly provide feedback to the course professors regarding the comprehension level of the students. At UQ the SI program is being used in biochemistry, microbiology, engineering, chemistry, and law. Kelly requires SI leaders to maintain diaries to record SI session activities, student behaviors, and suggestions to improve the program. SI leaders report improvement of their confidence levels, developed better communication skills, and believed that their employment prospects were improved.

Carlsen-Landy, B., Falley, B., Wheeler, A., & Edwards, D. (2014). Adaptations of Supplemental Instruction: Our course assistants wear many hats. *Supplemental Instruction Journal*, 1(1), 7-21. Available online: <http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf>.

In this mixed methods study, the influence a grant-funded Supplemental Instruction program had on students' academic performance at a university in the southwestern United States was examined. Data collection consisted of students' class absences, exam scores, final course grades, hybrid Supplemental Instruction and tutoring (SIT) attendance, and required Program Coordinator meetings. Analysis of the fall 2013 data demonstrates that students in the treatment sections outperformed students in the control sections. In addition, students within the treatment classes who attended the minimum number of required SIT sessions were more successful in class than those who did not attend the minimum number of sessions, and the faculty, students, and course assistants overwhelmingly supported and participated in the program.

Carr, A. R. (2002). *A study to determine the effect of a university's Supplemental Instruction program on retention*. (Master's of Arts thesis), Northern State University.

The topic to be investigated in this study was whether regular use of Supplemental Instruction (SI) by at risk freshmen students during the fall semester of 2001 at Northern State University (SD) would result in an increase in persistence from the fall semester of 2001 to the fall semester of 2002 when compared to freshmen students who were also at risk but did not regularly use SI. Courses supported by the SI program included Principles of Sociology, History of Western Civilization II, General Chemistry, General Psychology, American Government, and Biology Survey. All students in the study met the income guidelines of federal TRIO programs for designation as at-risk by being economically-disadvantaged and/or first-generation college. To be considered a SI participant, a threshold was established of attending four or more sessions during the academic term. The results favored the SI participants as they persisted at a rate of 59% as compared with a peer group who persisted at a rate of 52%.

Carr, B. B., & London, R. A. (2019). The role of learning support services in university students' educational outcomes. *Practice and Evidence of the Scholarship of Teaching and Learning in Higher Education*, 2(1). doi: 10.1177/1521025117690159.

Learning Support Services at the University of California, Santa Cruz is intended to aid students—particularly those who are at highest risk of academic failure—to master the required

material and succeed in their courses. It includes two primary components: modified supplemental instruction (MSI) and tutoring. This study uses data from administrative records kept by University of California, Santa Cruz on its students' academic experiences in the 2010–2011 to 2013–2014 academic years to examine the extent of utilization of MSI and tutoring, the types of students engaged in these activities, and the role of Learning Support Services in aiding students to improve their course grades, remain in school, and graduate in 4 years. The study addresses gaps in the literature on both supplemental instruction and tutoring by offering a new method to reduce selection bias in comparing participating to nonparticipating students and by focusing on the extent of participation in programs, rather than whether participation occurred or not. Students who participated in MSI and tutoring earned higher course grades when compared with other students and, in the case of MSI, compared with themselves in courses where they did not participate in MSI. Tutoring, but not MSI, was associated with improvements to retention, and neither was associated with improvements to 4-year graduation.

Carr, R. A., Evans-Locke, K., Abu-Saif, H., Boucher, R., & Douglass, K. (2018). Peer-learning to employable: learnings from an evaluation of PASS attendee and facilitator perceptions of employability at Western Sydney University. *Journal of Peer Learning*, 11(1), 41-64. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1127&context=ajpl>.

This study examines student experiences of Peer Assisted Study Sessions (PASS) at Western Sydney University (WSU), investigating attendee and facilitator perceptions of the relationship between peer-learning and employability. It defers to contemporary higher education scholarship and related sector definitions of employability as an objective criteria for evaluating outcomes which may result from student experiences with PASS. This investigation observes the extent to which such definitions are evident in the skills and attributes students have acquired via their participation in PASS through both quantitative and qualitative research. Quantitative and qualitative data was collected across two consecutive semesters at WSU (Autumn and Spring) in 2015. Survey responses were collected from 297 PASS attendees and 45 PASS facilitators, further incorporating data collected via focus groups with 46 PASS attendees. The evidence allowed the researchers to examine how students perceived they had gained attributes from PASS that render them more employable. The research results highlight the benefits and limitations of the methods utilised to collect data from PASS participants, and this article elaborates key insights gained as a result of the research process that may be useful to peer-learning practitioners beyond WSU. The study found that attendees and facilitators of the WSU PASS program perceive that the program contributes to student employability in a variety of ways such as improving participants' core technical skills, organisational skills, social skills, professionalism and business acumen, appreciation of mentoring, and critical thinking skills.

Carroll, D. (1994, 1994, September 13). UMKC to work with South African school, *The Kansas City Star Newspaper*, p. B3.

This newspaper article describes an agreement between the University of Missouri-Kansas City and the University of Port Elizabeth (UPE) in South Africa concerning the Supplemental Instruction (SI) program. UPE has been successfully using the SI program already for one year.

Carson, D., & Plaskitt, N. (1994). *A descriptive study of the attitudes of first year students at the University of Port Elizabeth toward Supplemental Instruction and evaluation thereof*. (Ph.D. dissertation), University of Port Elizabeth, Port Elizabeth, Republic of South Africa.

This dissertation study of Supplemental Instruction (SI) was conducted at the University of Port Elizabeth in the Republic of South Africa. The study examined students' perceptions of the effectiveness of SI in helping them to acquire skills such as critical thinking, essay writing, and reading of textbooks. The study surveyed Sociology and Economics students' perceptions of the

values of SI and found that students perceived four main reasons why SI is effective: improvement of learning ability; increased interest in the subject; a forum to meet new friends; and SI leader support. A need for greater structure within SI sessions was offered as the most common response for improvement of SI.

Carter-Hanson, C., & Gadbury-Amyot, C. (2016). Implementing Supplemental Instruction online to create success in high-stakes coursework for pre-doctoral dental students. *Supplemental Instruction Journal*, 2(1), 53-75. Available online: <http://info.umkc.edu/si/wp-content/uploads/2016/09/siJ-Volume-Two-Issue-One.pdf>.

There is a critical shortage of culturally diverse dental practitioners in the United States. In addition, many underrepresented minority (URM) and disadvantaged students have difficulty with the course material needed to pursue a dental degree. One strategy for helping students achieve higher grades and persist in difficult course work is the implementation of Supplemental Instruction (SI). The purpose of this study was to describe the outcomes of using SI online for the first time as part of the University of Missouri-Kansas City, School of Dentistry's (UMKC-SOD) Admissions Enhancement Program (AEP). The AEP program was designed to provide URM and disadvantaged pre-dental students with increased academic skills training in Biology, Chemistry, Organic Chemistry, and Math via online modules. Students met with their SI Leader three times per week at a specified time in a synchronous format to review course material, problem solve, and work collaboratively with fellow classmates. Twelve URM and disadvantaged students participated in the AEP from 2011 to 2014 for a total of 48. Success in the AEP was measured by an increase the student's Dental Admission Test (DAT) score and admission to dental school. At the end of each year's program, students completed a survey regarding all aspects of the AEP. The study found that AEP students who were admitted to dental school had a significantly higher DAT score than those students who were not admitted. Students also reported that the required time for SI sessions and test taking instruction helped them prepare for the DAT. Over 72% of students responded favorably that SI contributed to their success in the AEP and to taking the DAT. Students reported that attending the SI sessions helped them work through problems in the course material. This study found evidence that SI is a viable strategy for helping URM and disadvantaged students be successful in high stakes courses needed to move forward and pursue health profession degrees.

Carter-Hanson, C. L. (2014). *The outcomes of an innovative hybrid pre-dental admission enhancement program among underrepresented minority and disadvantaged students*. (Ph.D. dissertation), University of Missouri-Kansas City.

This study examined the outcomes of a hybrid pre-dental admission enhancement program (AEP) with regard to the Dental Admissions Test (DAT) scores, admission rates, and satisfaction among underrepresented and/or disadvantaged students at the University of Missouri, School of Dentistry (UMKC SOD). Additionally, data from 48 students who completed the AEP from years 2011-2014 were evaluated regarding their experience participating in the AEP. The program's unique hybrid design provided both a residential and online experience. The onsite experience exposed students to critical skills training encompassing time management, essay writing, learning styles, study skills, test taking skills, test anxiety, reading skills, and mentoring with the dental school application process. Students were able to prepare a rough draft of the dental school application essay and receive faculty feedback. This enabled students to have a well-written essay for their application. Additionally, AEP students participated in hands-on lab exercises and shadowed dental students providing patient care in the clinic. Technology allowed students to access the academic content of the AEP including Math, Chemistry, Organic Chemistry and Biology, 24/7 in an asynchronous format. Students were also mentored by supplemental instructors (SI) from the International Center for Supplemental Instruction (ICSI) three times per week in live synchronous sessions through

Blackboard Collaborate™ support. Students were asked to complete a program evaluation, which posed questions in a 5-point Likert scale format ranging from 1 = strongly disagree to 5 = strongly agree, has yes/no questions and allows for student comments. Frequency statistics, Pearson correlations and a Regression Model were used for statistical analysis of the data. All tests were conducted at $p < 0.05$ or less with a group of 48 students. Students admitted to dental school are continually monitored throughout their dental education until graduation.

Cerna, O., Platania, C., & Fong, K. (2012). *Leading by example: A case study of peer leader programs at two Achieving the Dream colleges*. MDRC. Washington, D.C. MDRC studied the use of Supplemental Instruction and another model at two Achieving the Dream community colleges: Northern Essex Community College and Bunker Hill Community College in Maryland. A qualitative study of key stakeholders at the institution found SI effective: administrators, faculty members, and participating students. Out of class and out of SI session contact between the SI leaders and the participants helped to build motivation and trust for the students to participate. The SI leaders reported personal, professional, and academic benefits. Also, gifted students selected as SI leaders received payment for services which reduced their stress and need for additional part-time jobs. The role as SI leader may have contributed to some of them considering careers in teaching. It also gave them additional opportunities to be mentored by the professors for whom they served as academic support. Institutional leaders cited the cost-effectiveness of SI, especially when compared with hiring full-time professional staff members.

Cezar, T., & Gordy, K. (1985). *Supplemental Instruction: A model of academic support*. Paper presented at the Midwest Regional Association of Developmental Educators, St. Louis, MO. This paper describes the use of Supplemental Instruction (SI) with improving academic achievement of students in historically difficult courses.

Chambers-Turner, R. C. (2017). *Supplemental Instruction and the promotion of construction of knowledge*. (Ph.D. dissertation), Walden University. Available online: <http://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=5611&context=dissertations> Supplemental instruction (SI), a peer assisted learning model, improves course performance, retention, and graduation rates of post-secondary education students. Researchers have questioned if the success of SI is due to students becoming more aware of assessment demands or if SI also promotes construction of new knowledge. The purposes of this case study were to describe techniques utilized by SI peer leaders, explore how sociocognitive learning techniques are implemented, and explore the perceptions of Supplemental Instruction program stakeholders regarding sociocognitive learning techniques. The research questions focused on what techniques peer leaders are trained to implement and what peer leaders' perceptions of sociocognitive learning techniques are. Piaget's theories on cognitive conflict and construction of knowledge, Vygotsky's theories on zone of proximal development and sociocognitive learning, and Chi's framework on interactive learning provided the conceptual framework for the study. The case study was conducted at a Northeast United States community college, using interviews with SI administrators and peer leaders ($n = 8$), voice recordings of SI sessions, and review of training material. The constant comparative method analysis of findings suggest that peer leaders trained in traditional tutoring and sociocognitive learning techniques promote construction of knowledge, and while programmatic and peer leader goals align with sociocognitive learning techniques, student goals do not. One recommendation is to clarify the distinction of SI versus traditional tutoring. This study would lead to positive social change by contributing to expanded goals of SI resulting in enhanced quality of learning for student participants at higher education institutions.

Chandler, J. (1994, 1994, December 24). Peer guidance tutors: Group study sessions led by 'A' students help some struggling with 'killer' math and science courses at community colleges, *Los Angeles Times Newspaper*, pp. B1, B6.

This newspaper article describes the use of Supplemental Instruction (SI) program in several colleges in the Los Angeles, CA area (Pierce College, Glendale Community College, Cal State Northridge, Pasadena City College, Valley College in Van Nuys). At Pierce College in a biology course 76 percent of the SI participants earned a grade of A, B, or C while the non-SI participants earned a similar grade only 50 percent of the time. Glendale Community College has a large program with 50 SI leaders. A challenge mentioned by administrative leaders some of the SI programs was finding stable funding to continue the program each year. Several interviewees mentioned that the SI program was important for all students, not just the ones in severe academic trouble.

Channing, J., & Okada, N. C. (2019). Supplemental Instruction and embedded tutoring program assessment: Problems and opportunities. *Community College Journal of Research and Practice*. doi: doi:10.1080/10668926.2019.1575777.

Many scholars have sought to measure the effectiveness of diverse Supplemental Instruction programs. Nevertheless, it is difficult to generalize about Supplemental Instruction or compare data, given methodological and statistical incongruities and diverse approaches and student populations at various institutions. Quantitative and qualitative data suggest that Supplemental Instruction and embedded tutoring programs facilitate learning and success in all disciplines. We describe best practices for embedded tutoring and Supplemental Instruction across disciplines and course modalities, evaluate metrics used to assess community college embedded tutoring and Supplemental Instruction programs, and suggest mixed methods models for assessing these programs.

Chen, M.-H. (2004). *The effects of Supplemental Instruction on mathematics education for students in Taiwan*. (Ph.D. dissertation), University of Arkansas, Fayetteville, AR.

The purpose of this study was to examine the effects of Supplemental Instruction (SI) on mathematics education in Taiwan and to understand the relationship between the attendance of SI and the achievement of students in mathematics. The sample for the study was 248 students from two different school systems and two different school districts. The survey was completed from one rural and one urban school in the general high school system and one school in the vocational high school system. Approximate one half of respondents were from tenth grade, and the other half were from the eleventh grade. The descriptive statistics were utilized to analyze the first research question. Attendance of SI by students at the general high school was higher than students of vocational high school. Attendance by students from urban general high school was higher than students from rural general high school. A one-way analysis of variance (ANOVA) was computed for the second research question. Results revealed that instructions from supplemental tutor and from schoolteacher significantly improved the students' math skills more than supplemental instruction from family members and from video-related and drill books supplemental materials, but that instructions from supplemental tutor and from schoolteacher were not significantly different from each other. Additionally, supplemental instruction provided more learning strategies, academic achievement, and competition with peers than providing students' motivation to learn. Paired samples t test and chi-square test were run respectively to analyze the third research question. Results indicated that no significant difference existed between the supplemental tutor and schoolteacher in teaching skills and strategies. Some of the factors were more important than others in the selection of SI. A regression analysis was conducted to examine the last research question. Attending SI to improve math scores, attending SI because of parents' expectation, and attending SI to reduce the anxiety of math

learning explained 15% of the variance in receiving math SI, while the predictor variable peer's influence cannot be used to predict attending math SI or tutoring.

Cheng, S., & Johnston, S. (2014). Participation in peer-led academic support services: One adaptation of a natural sciences peer learning model to enrichment in the humanities. *Journal of Peer Learning*, 7(1), 23-35. Available online:

<http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1051&context=ajpl>.

Supplemental instruction (SI) has proven highly effective at improving success rates in high-risk first and second-year courses, in part because peer-led SI sessions inculcate best-practice study skills in a specific learning context which provides opportunities for skill mastery. A successful SI program in the Faculty of Science at the University of Regina, Canada, was adapted to support high-risk classes in the Faculty of Arts. A number of challenges around student participation in SI sessions for arts emerged. This paper provides a brief case study of the adaptation and outlines factors which impact student participation in academic support sessions.

Chilvers, L. (2013). Facilitators and barriers to the development of PASS at the University of Brighton. *Journal of Pedagogic Development*, 3(2). Available online:

http://www.beds.ac.uk/__data/assets/pdf_file/0010/257581/Facilitators-and-Barriers-to-the-Development-of-PASS-at-the-University-of-Brighton.pdf.

This journal article describes the PASS program at the University of Brighton in the United Kingdom. PASS is a name often used in the United Kingdom to describe programs based on the Supplemental Instruction (SI) model from the University of Missouri-Kansas City. The article provides an overview of the PASS program at the institution and identifies the barriers that had to be overcome in order to implement it. Due to the newness of the program, students had some initial misunderstandings of the approach by some: PASS was remedial, PASS student leaders were expected to reteach material rather than facilitate group processing of it, reliance upon volunteer labor by the program organizers and student leaders, access to classrooms when the PASS sessions are best scheduled, and developing the institutional support for the program. These results are not uncommon to other institutions when first trialing the PASS program and it is anticipated that it will grow through the barriers to have a successful program like others in the U.K.

Chilvers, L. (2014). Communities of practice for international students: The role of Peer Assisted Study Sessions in supporting transition and learning in higher education. *Supplemental Instruction Journal*, 1(1), 90-115. Available online: <http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf>.

There is growing interest in understanding how international students can best be enabled to adjust to, participate in and learn from higher education (HE). This paper examines findings from a recent study in the UK which explored the contribution the Peer Assisted Study Sessions (PASS) scheme makes to this process. An earlier study used in-depth interviews with international students to generate data; following findings related to engagement with a learning community, this current study rescrutinised that data using Lave and Wenger's (1991) social-learning theory, Communities of Practice, as a theoretical lens. Themes of community, practice and participation were used to explore and understand the role of PASS in supporting international students' transition and learning in HE. Findings illuminated the role of PASS in helping international students to socially integrate with students of other nationalities, developing friendships with peers and PASS leaders, which literature evidences contributing to an increased sense of belonging to a community. Through the mutual engagement of attendees and leaders, students developed shared language, values and practices relating to their discipline and studying in UK HE. Established PASS leaders shared experiences of first year

with 'newcomer' international students, supporting their transition into UK HE culture and enabling their legitimate peripheral participation to develop more fully. Participation in PASS fostered students' engagement with learning activities and independent study habits. Limitations to the study and suggestions for further research will also be discussed.

Chilvers, L., McConnell, C., & Carlton, S. (2012). *Peer Assisted Study Sessions (PASS): The transition experience of student attendees and PASS leaders through Higher Education*. Conference Proceedings of the Annual Learning and Teaching Conference, Brighton, United Kingdom.

Chilvers, L., & Waghme, J. (2018). Exploring PASS leadership beyond graduation. *Journal of Peer Learning*, 11(1), 5-26. Available online:

<http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1137&context=ajpl>.

Developing University graduates' employability is of increasing strategic institutional focus in the UK. Existing research evidences the role of Peer Assisted Study Sessions (PASS) in supporting students to develop personal, professional and employability skills. This research explores the impact of the PASS Leader role on graduates' job application experiences, their employability and effectiveness in their current roles. PASS Leader graduate survey (n=62) and interview (n=12) findings demonstrated participants referred to their PASS Leader Role significantly on their CVs, application forms and in job interviews. Respondents said that PASS Leadership, aided by reflection, enabled them to clearly evidence their development of employability skills, which they perceived as enabling them to stand out from other job candidates. Interview participants explained their PASS Leadership informed their development of a range of employability skills and attributes, including communication, confidence, teamwork, facilitation and leadership. PASS Leadership was regarded as addressing gaps in their course curriculum for developing skills they perceived as important for their current roles, highlighting the value of co and extra-curricular programmes, such as PASS.

Christie, R., & Cheah, S. (1995). *Support structures for students in information technology at Queensland University of Technology*. Unpublished manuscript. Queensland University of Technology at Brisbane. Queensland, Australia.

This paper describes the use of Supplemental Instruction (SI) at the Queensland University of Technology (Australia) in information technology courses. Based on qualitative research studies, the following results occurred: 1) SI participants: were appreciative of opportunity to share their academic problems and doubts with someone who had successfully completed the course; 2) SI leaders: improved their skills in leadership, interpersonal communication, problem solving, study and time management; and 3) course instructors: improved their teaching by receiving timely feedback from the students. There was a positive correlation between higher levels of SI attendance and receiving high marks (6 or 7) in the course.

Clark, C. (1997). *Report by the National Centre for Supplemental Instruction Southern Africa at the University of Port Elizabeth*. Unpublished manuscript. University of Port Elizabeth. Port Elizabeth, Republic of South Africa.

This paper describes results from the 1997 Supplemental Instruction (SI) national South Africa survey. Currently 53 tertiary institutions comprising more than 140 faculty and staff members have been trained in use of SI by the Southern African Center for SI based at the University of Port Elizabeth (UPE) in the Republic of South Africa. Continuing technical assistance and professional development workshops are offered by the National Center at UPE for institutions with SI programs.

Clark, C., & Brophy, B. (1995). *Student perceptions of the Supplemental Instruction (SI) programme at the University of Port Elizabeth*. Paper presented at the South African Association for Academic Development Conference, Technikon Free State, Republic of South Africa.

This paper describes the use of Supplemental Instruction (SI) at the University of Port Elizabeth (South Africa). A questionnaire investigated the attitudes of: attenders and non-attenders, regular and irregular attenders, prepared and underprepared students, humanities and science students, and finally, pass and failures. This paper focuses on prepared and underprepared students. The underprepared students often only attended SI when they had problems in the course. As a group that studied by themselves. The more prepared students found the SI sessions useful due to the use of collaborative learning techniques.

Clark, C., & Koch, E. (1997). Supplemental Instruction for the South African context: A case study at the University of Port Elizabeth. In R. B. Ludeman & S. Hubler (Eds.), *Quality student services around the world: Bridging student needs and student success* (pp. 124-146).

Washington, D.C.: National Association of Student Personnel Administrators

This paper describes how the Supplemental Instruction (SI) program was adapted for use at the University of Port Elizabeth (UPE) in the Republic of South Africa. Issues discussed in the paper include: perceptions and academic performance of first year students; diversity in student composition in terms of language, culture and educational background; departments and curriculum developments; and the personal growth of SI leaders. SI is offered to students in 19 departments offering 25 courses in the Faculties of Science, Arts, Law, Economics, Social Science, and Health Science. The SI program is supervised by the Centre for Organizational and Academic Development (COAD). In a qualitative and quantitative study of students from Fall 1995 SI participants earned higher grades than nonattendees in nearly all courses. Follow up in the other courses suggested that SI was less than effective due to heavy time tabling of the students that precluded their regular attendance in SI sessions. Feedback provided through the SI program led to curricular reform in several courses where many students experienced academic challenges. SI was found to be equally effective for students from racially diverse and academically disadvantaged backgrounds. Faculty development activities occurred when lecturers attended SI leader training workshops and embedded SI session activities inside their traditional classroom presentations. The researchers suggested that participating lecturers changed their lecture style, made changes to the curriculum, and became more sensitive to diversity issues. SI leaders reported changes due to their involvement: reinforced knowledge of the academic discipline; improved personal academic performance; increased their facilitation and interpersonal skills; increased personal self esteem and confidence levels; and increased career opportunities due to skills in group facilitation

Clark, C., & Mallon, P. (1998). *Supplemental Instruction as a tool to improve student success at South African tertiary institutions*. Unpublished manuscript. University of Port Elizabeth. Port Elizabeth, Republic of South Africa.

This unpublished manuscript describes the use of Supplemental Instruction (SI) with students at the University of Port Elizabeth (UPE) and other institutions in the Republic of South Africa. UPE was selected by UMKC to serve as the training and technical assistance center for Africa. To date national workshops have been conducted 14 times with 140 faculty and staff members from 53 tertiary institutions in South Africa. This paper describes the historical development of SI with Historic Black Universities, Historic White Universities, and Technikon/Colleges. Often the SI program is located within the academic development unit. It is common that SI programs have been introduced to redress inequalities in academic preparation by the newly admitted students from widely diverse ethnic backgrounds and academic preparation levels.

Clark, K. M., & May, I. C. (2014). Upper-division transfer students: Designing a Supplemental Instruction program for nursing students within a science based curriculum. *Community College Journal of Research and Practice*, 1-16. doi: 10.1080/10668926.2013.849622.

The transition to upper-level course work of transferring students, predominantly students from 2-year/community colleges, has been explored in recent education research literature. Yet, it has not been sufficiently explored whether and what academic support programs could be successful in supporting transfer students with the transfer process. This article demonstrates the success of an academic support program for a discipline-specific cohort of transfer students entering their junior year in a nursing program at a public university within the University System of Maryland. The study explored prior academic preparation, results of Nursing Entrance Test scores, and interventions provided by an academic support initiative. For a course in pathopharmacology, this collaborative environment (facilitated by successful peers based on Supplemental Instruction, workshops on accelerated learning techniques, and individual tutoring) indicates that participation in such a comprehensive program resulted in an overall higher grade point average at the end of the first semester. There was also a reduced rate of failure or drop out from 15% to 7% in subsequent semesters. Overall, such an initiative could serve as a model for other institutions.

Clark, L. R. (1997). *Outcomes of Supplemental Instruction for History 1310 and 1320 at Southwest Texas State University*. (Masters of Arts thesis), Southwest Texas State University, San Marcos, TX.

This study sheds light on the effectiveness of Supplemental Instruction (SI) in achieving student academic goals, enhancing student performance in difficult entry level college classes and impacting the success of students with varying abilities between Fall 1995 and Spring 1997 at Southwest Texas State University in History 1310 and History 1320. SI participants outperformed non-SI participants on the three academic outcomes examined: final course grades (mean grade difference: 2.91 vs. 2.17 and rate of A, B, or C: 95.5% vs. 73.3%), D or F course rates (18.9% vs. 37.0%), and institutional persistence (81.1% vs. 63.0%). SI attendance was defined as attending five or more times during the academic term. SI was equally effective with general (2.91 vs. 2.17), non-traditional (2.89 vs. 2.44) and part-time (2.78 vs. 1.90) populations. This research also indicated minority students participated in SI in greater proportions than non-minority students. A significant cross-over or repeat SI population was found. This research concluded that participation in SI result in higher final course grades and successful course completion; the resulting grade improvement is reflected in improved retention (84.2% vs. 72.6%). The researcher noted that the impact of SI may be understated due to analysis of entry level characteristics of the students that suggest that the SI participants tend to be less academically prepared than the non-SI participants (lower high school rank and SAT scores).

Clulow, V. G. (1998). *Supporting student learning in high risk university subjects and the interrelationship to effective subject teaching: An analysis of a peer tutoring experience*. (Master of Arts thesis), University of Melbourne, Parkville, Victoria.

This dissertation is concerned with the detailed accounts of 21 students who participated with Supplemental Instruction (SI) in a Statistics for Marketers course. The focus of the qualitative research design was how can students' critical awareness of their learning experience while participating in an SU group, inform the teaching practice in universities, at a time when the institution is facing difficult challenges. The critical findings from the study were that: students were highly sensitive to factors that influenced the effectiveness of their learning, and these included: class size, workload, learning effectiveness in class time and opportunity for participation in classes. SI was found to be significant for improving student involvement in the course that resulted in higher academic outcomes for the students. Students found that SI

enabled guide learning from a subject 'champion' symmetry in the teaching/learning communication, an effective use of learning time and the opportunity to work in small groups.

Clulow, V. G. (2000). An analysis of a peer tutoring experience in a first-year business subject. *Journal of Institutional Research*, 9(1), 89-99.

This article describes a study of the use of Supplemental Instruction (SI) in an introductory business course in Australia called statistics for marketers. This study focused on the students' perceptions of the influence of SI as a learning strategy. Positive outcomes for the participating students included: freer flow of questions about the course material, less inhibition to participate in the discussion, greater confidence that their problems were not isolated, better understanding of the course material, environment to express their questions in an unhurried manner and know that they were heard, and finally the opportunity to work through a problem until they had understood it.

Cobb, R. (1997). Learning is the lesson: Center illuminates path to understanding. *Illinois State Scholar*, 7(1), 16-17.

This article describes the University Center for Learning Assistance at Illinois State University (Normal, IL). In an interview with Julia Visor, acting director of the center, an overview of the Supplemental Instruction (SI) program at the university is provided. During the Spring 1997 semester, SI was offered to students enrolled in Chemistry and Society, General Psychology, Principles of Microeconomics, Principles of Macroeconomics, Introduction to Non-Western Politics, American Government and Politics, History of the United States to 1865, and Human Biology. Some of the SI participants include students in Student Support Services, one of the federally-funded TRIO programs. A short summary of several research studies concerning SI's impact on affective variables conducted by Visor and others is shared.

Cobb, S. L., McPherson, M. A., Molina, D. J., Quintanilla, J., Rasmussen, E., & Rous, J. J. (2018). Teaching economics to the masses: The effects of student help centers on academic outcomes *International Review of Economics Education*, 27, 16-23. Available online: <https://reader.elsevier.com/reader/sd/7BFA2DEE65FB0E4E7750D348D3ACD35C351F6EBCE4A1F1682ABE6886C1EE23A0AC79E4CC63D6C8995337C1DB94209E05>.

Many institutions of higher education have some form of voluntary peer tutoring. There have been a number of efforts to examine the effects of such programs on student outcomes. Many of these fail to acknowledge the possibility of self-selection bias. Should such endogeneity exist, estimates regarding the extent to which help centers improve student performance will be biased. We examine the determinants of student participation in peer tutoring among students taking Principles of Economics, and we test for self-selection bias. Finally, we examine the factors that affect student performance in these classes over two semesters – approximately 1400 students. We find that students who live a greater distance from campus are less likely to participate; student ethnicity and gender also affect this choice. We also find that the number of visits to our help center is exogenous. Finally, we find that supplemental instruction significantly improves student performance.

Coe, E., McDougall, A., & McKeown, N. (1990). Is Peer Assisted Learning of benefit to undergraduate chemists? *Chemistry Education*, 3(2), 72-75.

This article describes the benefits of Supplemental Instruction at a U.K. institution.

Coe, E. M., McDougall, A. O., & McKeown, N. B. (1999). Is peer assisted learning of benefit to undergraduate chemists? *University Chemistry Education*, 3(2), 72-75.

Peer Assisted Study Sessions (PASS), based on Supplemental Instruction (SI), was implemented at the University of Manchester (UK) Chemistry Department in 1995 for first-year

courses. About half of students enrolled in the classes where PASS is offered participate in the program. The drop out rate was reduced by half after the introduction of PASS (from 20% to 10%). PASS Leaders also reported advantages for their participation including their communication skills.

Cole, K. (2013). PAL experience. *Journal of Pedagogic Development*, 3(2).

This journal article is the personal story of a student study group leader from the University of Bedfordshire in the United Kingdom that was involved with the campus PAL program. PAL is a common name in the United Kingdom for programs based on the Supplemental Instruction (SI) model from the University of Missouri-Kansas City. The author provides a unique perspective by the person who is actually delivering the program to the students. The student PAL leader describes her nervousness in preparing for the PAL sessions, the manner in which the students interacted within them, and her perception of the overall program.

Coletti, K. B., Wisniewski, E. O., Shapiro, R. L., & DiMilla, P. A. (2014). *Correlating freshman engineers' performance in a general chemistry course to their use of Supplemental Instruction*. Conference Proceedings of the 121st ASEE Annual Conference and Exposition, Indianapolis, IN. Available online: <https://www.asee.org/public/conferences/32/papers/9436/view>

This study examines the correlation between first year engineering students' use of supplemental instruction and their performance in a required general chemistry course at Northeastern University. Research has shown that supplemental instruction is positively correlated with measurable factors, such as higher grade point averages and timely graduation rates, as well as less-easily measured factors, such as long-term retention of course material, teamwork, communication skills, information processing skills, and motivation. Previously we examined what grade level triggered students to seek out supplemental instruction in a required general chemistry course and what factors affected whether a student used a form of supplemental instruction.¹ However, data were unavailable to correlate with grades. In order to understand a student's pre-disposition and ultimate choice to participate in supplemental instruction as well as to determine correlations with grade distribution, honors and non-honors students in a required general chemistry course were given pre-surveys at the beginning and post-surveys at the end of the semester. Analysis of pre-surveys allowed identification of a student's predisposed "trigger point" at which s/he decides to seek extra help upon entering college. The availability of data for different types of course assessments, including exams, homework, and class participation, enabled correlation among individual trigger points, grades, and the use of different forms of supplemental instruction. Previously we had investigated how important convenience factors are to students in their decision to use supplemental instruction. This year's study examined this question further to determine what factors deter students from using specific resources for supplemental instruction. An overarching intent of our study was to identify how females and males differ in their use and attitudes towards supplemental instruction. Using this study based on a freshman general chemistry class as a model for student behavior in freshman courses, this paper presents the survey results, methodology used, conclusions, and recommendations for increasing the usage of supplemental instruction by first year engineering students.

Collins, N., & Ronaldson, A. (1995). *Supplemental Instruction: Its effectiveness within the ambit of the Social Work Department of the University of Port Elizabeth*. (Ph.D. dissertation), University of Port Elizabeth, Port Elizabeth, Republic of South Africa.

This dissertation examines the effectiveness of Supplemental Instruction (SI) at the University of Port Elizabeth in the Republic of South Africa. This study replicates findings from a dissertation by Carson and Plaskitt (1994) from the same institution. Two additional reasons were identified by Collins and Ronaldson concerning reasons for the effectiveness of SI: easy participation in SI

sessions and adjustment to university life. They concluded that the focus of SI correlates with the needs of students and that SI has helped students to develop important skills, for example, understanding key concepts, lecture note taking, understanding the textbooks and exam preparation. Depending upon the structure of the course, SI participants reported wanting varying levels of structure during the SI sessions. Some students wanted open agendas for the group to select the areas covered and processes used. Other students reported wanting more structure in the SI sessions from the SI leader.

Collins, W. (1982). Some correlates of achievement among students in a Supplemental Instruction program. *Journal of Learning Skills*, 2(1), 19-28.

This article examined the effectiveness of Supplemental Instruction (SI) at Cornell University by comparing the course-grade earned in four subjects (chemistry, mathematics, biology, and physics) and the GPA of 301 students enrolled in these courses with College Board Scholastic Aptitude Scores (Verbal and Math), assistance requested by the student, and high school rank. Even when SAT-scores and high school rank are held constant as in the standard multiple regression procedure used with this study, the results suggest that SI attendance made a significant contribution to the academic achievement of SI participants both with the individual course (Biology, Chemistry Mathematics) and the overall cumulative GPA. The research suggested when comparing students of equivalent SAT scores and high school rank, the following predictions would be warranted, SI participants would receive the following higher grades when compared with the non-SI counterparts: one full letter grade higher in Biology; three-fourths of a letter grade higher in Mathematics; and one-half letter grade higher in Chemistry. There were no predictive variables regarding final course grades in physics. The authors suggest that the strategies learned in SI are transferred to other courses and help improve academic achievement in those courses as well. The SI program is aimed at students admitted to Cornell through the Committee on Special Education Projects (COSEP). Most of these students are members of ethnic groups or from disadvantaged backgrounds.

Commander, N. E., Callahan, C. A., Shatton, C. B., & Smith, B. D. (1997). *Adjunct courses and Supplemental Instruction: A ten step workshop*. Conference Proceedings of the National Association for Developmental Education, Volume 3, Denver, CO. Retrieved July 1, 2004, from <http://www.nade.net>

At Georgia State University there has been a transition from focusing on developmental courses for some to offering learning support for all students. The authors provide ten questions that can guide an institution as they consider offering Supplemental Instruction (SI) and adjunct courses. In 1996 the institution was offering SI in 28 course sections with a combined enrollment of 3,900 students. About one-third of the students participated in SI sessions. SI participants earned between one half to a full letter grade higher in comparison with similar non-SI attendees. The ten questions that the authors suggest when designing a new learning support program are: 1. What makes your campus unique? 2. What population do you wish to serve? 3. What courses will you target? 4. How will you build faculty support? 5. How will you market your program? 6. How will you design your curriculum? 7. What results will you share with colleagues in your institution? 8. What results will you share with colleagues outside your institution? 9. How will you secure campus resources? 10. What problems are unique to your situation and what are possible solutions?

Commander, N. E., & Smith, B. D. (1995). Developing adjunct reading and learning courses that work. *Journal of Reading*, 38(5), 352-360.

This article explores a variation of the Supplemental Instruction (SI) program to provide more time for students to develop reading and learning strategies. Rather than using the voluntary peer facilitated study review sessions based on the SI model, the learning assistance center at

Georgia State University (Atlanta, GA) chose to create an adjunct course model. Like the SI model, a historically-difficult content course (History 113) was paired with an adjunct course (Learning Strategies for History or LSH). Students enrolled in both courses. Unlike SI, most students enrolled in the strategies courses were developmental. The LSH required students to apply the learning strategies to the companion History 113 course. Considering that the LSH students were less prepared academically than the general student population in the History 113 course, data suggests that the adjunct course was helpful since three quarters of the students passed the History 113 course with a final course grade of C or higher and their mean final course grade (2.3) with nearly the same as the other students (2.5). One of the recommendations for potential adopters of this model is that all students in the LSH course be enrolled in the same section of the content course (e.g., History 113). Failure to do so creates confusion in the LSH course if there are multiple sections of the content course with professors who may be teaching at with different rates, textbooks or content material.

Commander, N. E., Stratton, C. B., Callahan, C. A., & Smith, B. D. (1996). A learning assistance model for expanding academic support. *Journal of Developmental Education*, 20(2), 8-10, 12, 14, 16.

This article provides a model for expanding the role of academic support in higher education. A learning program that formerly offered primarily developmental classes and a tutorial center later expanded to include course-related services of Supplemental Instruction (SI) and adjunct courses at Georgia State University (Atlanta, GA). During Fall 1993 a study in Political Science 101 suggested that SI was correlated with higher mean final course grades (2.7 for regular SI attenders, 2.4 for occasional attenders, and 1.9 for non-SI attenders). The authors suggest ten steps for expanding academic support: 1) consider campus uniqueness; 2) identify population; 3) identify courses; 4) build faculty support; 5) staff adjunct courses with seasoned faculty and SI learning sessions with thoroughly trained leaders; 6) market programs at several levels; 7) provide feedback to the professor of the content course throughout the quarter or semester; 8) involve the administration; 9) keep records; and 10) disseminate information.

Congos, D. H. (1993). A model for Supplemental Instruction in Introductory Chemistry. *Supplemental Instruction Update*, 1, 3.

This article describes the use of Supplemental Instruction (SI) at The University of North Carolina at Charlotte in Introductory Chemistry courses. Four suggestions are made for problem solving activities: 1) SI leader models problem solving steps; 2) SI participants verbalize and write down the steps to solve the problem and how they arrived at their answers; 3) students ask each other questions during the problem solving process; 4) rules for solving the problem are written on the black board; 5) students work by themselves to solve similar problems; 6) students work on recognizing problem types; 7) SI leaders facilitate the discussion process of the students; 8) each step in the problem solving process is identified and numbered; and 9) students continue to practice on problems till they master the process.

Congos, D. H. (1997). *Supplemental Instruction models for introductory chemistry and physics*. Unpublished manuscript. Central Piedmont Community College. Charlotte, NC.

This paper provides several models for Supplemental Instruction (SI) leaders to use when facilitating sessions in introductory chemistry and physics courses. Problem-solving activities are essential for students enrolled in these courses since many of them are unable to recognize problem patterns and the needed procedures to solve them. In chemistry the following seven steps often are needed: 1) read the problem; 2) rewrite the problem in students' own words; 3) write down what the student is trying to find; 4) list the tools that are given for solving the problem; 5) do factor labeling; 6) check the answer in the book for correctness; 7) if the students' answer is incorrect, return to step #3.

Congos, D. H. (2001). How Supplemental Instruction (SI) generates revenue for colleges and universities. *Journal of College Student Retention: Research, Theory, & Practice*, 3(3), 301-309. The writer discusses how supplemental instruction (SI) can generate revenue for higher education institutions. He shows how SI can create retained tuition revenue far beyond the costs of an SI program in both state-supported and private colleges and universities and notes that SI reduces recruiting costs and retains incoming tuition dollars for longer time periods, supplements the quality of the educational experience, and has the potential to affect an institution's fund-raising efforts. He presents formulas that can be used to determine the amount of retained revenue that can be generated by SI for individual colleges.

Congos, D. H. (2002). How Supplemental Instruction stacks up against Chickering's 7 principles for good practice in undergraduate education. *Research and Teaching in Developmental Education*, 19(1), 75-83. This article discusses the Supplemental Instruction (SI) model and compares it with Chickering's 7 Principles for Good Practice in Undergraduate Education. SI shares many of the same outcomes cited by Chickering such as: increased student persistence towards graduation, higher final course grades, improved thinking and study skills, and higher satisfaction with the college experience.

Congos, D. H. (2003). Health checklist for Supplemental Instruction (SI) programs. *The Learning Assistance Review*, 8(2), 29-45. This article provides a checklist of recommended policies and practices for Supplemental Instruction (SI) programs. The document provides a means for conducting a program review with 90 recommended practices. The categories covered by the evaluation tool include: SI leader pre-semester training, SI faculty training, SI leader training during the academic term, SI session observation and feedback, in-class introduction of SI, end-of-term evaluation,

Congos, D. H. (2003). Is Supplemental Instruction (SI) help helpful? *Research & Teaching in Developmental Education*, 19(2), 79-90. This article explores the issue of the "helpfulness" of Supplemental Instruction (SI) sessions for students. Does participation in SI programs lead to independent learning by students, or are they dependent upon the help of the group for academic achievement? Key factors in the theoretical framework cited by the author for developing independent learners are: reciprocal trust, cooperative learning, mutual growth, reciprocal openness, shared problem solving, non-directive modeling, autonomy, and experimentation.

Congos, D. H., & Bain, D. W. (2001). A board work and note formatting model for learning mathematics coursework using writing. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2001/Jul01/index.htm>. This article presents a model for teaching math that illustrates the value of using writing within a step-by-step approach to help students understand and learn math solutions. This process was adapted for use with Supplemental Instruction (SI) sessions in mathematics and other problem-solving courses.

Congos, D. H., Langsam, D. M., & Schoeps, N. (1997). Supplemental Instruction: A successful approach to learning how to learn College Introductory Biology. *The Journal of Teaching and Learning*, 2(1), 2-17. This article reviews the use of Supplemental Instruction (SI) at the University of North Carolina at Charlotte with students enrolled in Introductory Biology (Biology 1110), the first course of a two semester introductory biology sequence for non-majors. The data from Fall 1990 and Spring

1991 suggests that participation in SI has a positive impact on student academic performance. The final score for the SI participants was higher (Fall 1990: 2.72 vs. 1.94; Spring 1991: 2.83 vs. 1.95); the rate of A, B and C final course grades was higher (Fall 1990: 86.3% vs. 65.4%; Spring 1991: 78.6% vs. 62.5%); and the rate of D, F and course withdrawals was lower (Fall 1990: 13.7% vs. 34.6%; Spring 1991: 21.4% vs. 37.5%). A variety of additional statistical tests were conducted to test for the intervening nature of other variables (e.g., SAT verbal, SAT quantitative, SAT sum of SATV and SATQ, high school rank, predicted grade point average before matriculation based on SAT verbal and quantitative). After these additional tests, participation in SI was still found to be statistically significant.

Congos, D. H., & Mack, A. (2005). Supplemental Instruction's impact in two freshman chemistry classes: Research, models of operation, and anecdotes. *Research & Teaching in Developmental Education, 21*(2), 43-64.

Supplemental Instruction (SI) was used at the University of Central Florida to improve student academic performance in several chemistry classes. In addition to the evaluations study, the article provides an overview of the five modes of operation that occur during SI sessions: build complete and accurate lecture and text notes; formulating potential exam questions and answers; build complete and accurate steps in solutions to problems; practice with sample exam; and finally conduct a post-test review to evaluate performance and make behavior modifications for the next exam. Extensive data records were collected to compare student performance in the course both before and during the time of the academic intervention. Significant shifts of student grades in a positive direction occurred after introduction of SI to the introductory chemistry courses. Data was run twice, once comparing SI participants and nonparticipants. A second time it was run with SI participation defined as attending five or more sessions during the term. In both cases, SI attendance was a significant factor in higher grades. When analyzing students who attended five or more times, there was a dramatic drop in the DFW rate and an increase by nearly a full letter grade in final course grade achievement for these SI participants.

Congos, D. H., McLaren, A., & Visor, J. N. (Writers). (1995). Clinical supervision of Supplemental Instruction sessions [Videotape]. In D. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City
This videotape records a discussion by a panel regarding various issues related to supervision of the Supplemental Instruction program: role of the Assistant SI Supervisor; components of a clinical supervision protocol; the limit of capacity for supervision; mentoring and evaluation in clinical supervisory debriefing sessions; and protocol for debriefing SI sessions. The panelists are campus SI supervisors as well as Certified Trainers with the SI program.

Congos, D. H., & Schoeps, N. (1993). Does Supplemental Instruction really work and what is it anyway? *Studies in Higher Education, 18*(2), 165-176.
The authors describe the Supplemental Instruction (SI) program as it operates at the University of North Carolina at Charlotte from 1987 to 1990. The initial portion of the article provides a general overview of the SI program. The Fall 1988 research study suggested that SI participation was positively correlated with higher mean final course grades (2.391 vs. 1.894) and lower withdrawals (17.7% vs. 37.9%). These favorable results are so in spite of the fact that SI attendees enter college with lower predicted academic potential.

Congos, D. H., & Schoeps, N. (1994). Does Supplemental Instruction really work and what is it anyway? *Educational Administration Abstracts, 29*(1), 52-53.
This is a short summary of the authors article -- Does Supplemental Instruction really work and what is it anyway? -- that originally published in the British journal of Studies in Higher

Education (1993), vol. 18, no. 2, pp. 165-176. The authors describe the Supplemental Instruction (SI) program as it operates at the University of North Carolina at Charlotte from 1987 to 1990. The Fall 1988 research study suggested that SI participation was positively correlated with higher mean final course grades (2.391 vs. 1.894) and lower withdrawals (17.7% vs. 37.9%).

Congos, D. H., & Schoeps, N. (1997). A model for evaluating retention programs: Data from a Supplemental Instruction program. *Journal of Developmental Education*, 21(2), 2-4, 6, 8, 24. This article presents a step-by-step model for analyzing the impact of retention programs on students. Data from a Supplemental Instruction (SI) program is used to demonstrate how this research is done. The seven steps include: identify the relevant variables; for each student in the class, gather the data on the independent variables chosen in Step 1; maintain on-going data on the information needed for the dependent variables; enter the data into a computer in an organized format that eases analysis; define the criteria that determines who is an attendee or participant; analyze the data using an appropriate data analysis software package; and set up the results in a readable manner, including relevant narratives necessary to explain and clarify the data. To illustrate the seven-step method, the researchers analyze the SI data from their campus regarding improved final course grades, reduction of D/F/W, and projected cost savings.

Congos, D. H., & Schoeps, N. (1998). Inside Supplemental Instruction sessions: One model of what happens that improves grades and retention. *Research & Teaching in Developmental Education*, 15(1), 47-61.

After providing an overview of the Supplemental Instruction (SI) model, the authors describe three basic modes of operation in SI sessions: 1) building complete and accurate lecture notes; 2) formulating possible examination questions and answers; 3) conduct post examination survey. The cost effectiveness of the SI program was calculated on the basis of increased retention rates of SI participants. A study was conducted at the University of North Carolina at Charlotte with students enrolled in Introductory Biology (Biology 1110), the first course of a two semester introductory biology sequence for non-majors. The data from Fall 1990 suggests that participation in SI has a positive impact on student academic performance. The final score for the SI participants was higher (2.59 vs. 1.94); the rate of A, B and C final course grades was higher (86.3% vs. 65.5%); and the rate of D, F and course withdrawals was lower (13.7% vs. 34.5%). A variety of additional statistical tests were conducted to test for the intervening nature of other variables (e.g., SAT verbal, SAT quantitative, SAT sum of SATV and SATQ, high school rank, predicted grade point average before matriculation based on SAT verbal and quantitative). After these additional tests, participation in SI was still found to be statistically significant.

Congos, D. H., & Schoeps, N. (1999). Methods to determine the impact of SI programs on colleges and universities. *Journal of College Student Retention: Theory, Research, & Practice*, 1(1), 59-82.

This article presents three categories of approaches to assess the impact of Supplemental Instruction (SI) on an institution: anecdotal information, descriptive statistics, and inferential statistics. For SI programs required to justify their existence, the methods in this article presents assessment devices from simple testimony to rigorous inferential statistical data.

Congos, D. H., & Schoeps, N. (2003). Inside Supplemental Instruction sessions: One model of what happens that improves grades and retention revisited. *Journal of Student Centered Learning*, 1(3), 161-172.

This article is a revision of one earlier published earlier by the authors: *Research and Teaching in Developmental Education*, 15(1), 47-61. The first section of the article is devoted to an overview of the Supplemental Instruction (SI) model. The next part provides a financial cost-benefit analysis of the economic return of the SI program due to it contributing to higher student persistence. The authors describe five types of activities that occur inside of SI sessions: note building, question/answer, problems and solutions, sample test, and post-test survey. A study was conducted at the University of North Carolina at Charlotte with students enrolled in Introductory Biology (Biology 1110), the first course of a two semester introductory biology sequence for non-majors. The data suggests that participation in SI has a positive impact on student academic performance. The final score for the SI participants was higher (2.59 vs. 1.94); the rate of A, B and C final course grades was higher (86.3% vs. 65.5%); and the rate of D, F and course withdrawals was lower (13.7% vs. 34.5%). A variety of additional statistical tests were conducted to test for the intervening nature of other variables (e.g., SAT verbal, SAT quantitative, SAT sum of SATV and SATQ, high school rank, predicted grade point average before matriculation based on SAT verbal and quantitative). After these additional tests, participation in SI was still found to be statistically significant.

Congos, D. H., & Stout, B. (1997). The benefits of Supplemental Instruction (SI) leadership experience after graduation. *Research & Teaching in Developmental Education*, 29(1), 29-41. The benefits of Supplemental Instruction (SI) for the students who facilitate the sessions is described in this article. The authors used an open ended survey instrument to gather data from former SI leaders for this study. Participating institutions in the study included the University of Pittsburgh, Central Florida University, and Palm Beach Community College. Responses gathered through the survey were categorized into the following categories: interpersonal relations skills, learning skills, leadership skills, work related skills, content knowledge, and other. The most frequently cited benefit of serving as a SI leader was the improvement of personal interpersonal communication skills.

Congos, D. H., & Stout, B. M. (2001). Twenty FAQ's from faculty about Supplemental Instruction programs. *Research & Teaching in Developmental Education*, 18(1), 41-49. As experienced Supplemental Instruction coordinators, we regularly field a variety of questions from faculty about the SI program. This is anticipated since SI is attached to their courses and they have a natural vested interest in the SI program and the impact that it has on student achievement and satisfaction with the course which potentially can affect student evaluations for the course professor. Many of these questions are expected and not difficult to address. The paper lists twenty of the most frequently asked questions.

Conroy, G. J. (1996, 1996, May 28). Supplemental Instruction program shows results first year, *The Observer Newspaper*, pp. 3-4.

This newspaper article describes the use of Supplemental Instruction (SI) at Southern Illinois University at Edwardsville. SI sessions were offered in an introductory biological sciences course (Biology 120). The article indicated one of the SI program benefits was that SI leaders who were biology education majors learned pedagogical methods. The SI supervisor reported a preference for hiring education majors. According to data from Fall 1995 in Biology 120, SI participants to attended four or more sessions earned a mean grade of a low B, whereas those who attended one to three sessions averaged a C. Those who did not attend any SI sessions averaged a D.

Cooper, R. (2018). Connecting embedded and stand-alone peer mentoring models to enhance student engagement. A Practice Report. *Student Success*, 9(2), 87-93. Available online: <https://studentsuccessjournal.org/article/view/525>.

his paper outlines the Trident Student Mentoring Program that runs in the College of Engineering at Victoria University, Melbourne, Australia. The program offers both embedded and stand-alone models of peer mentoring services to the same cohort of first-year students. It shows that by forming strong links between these two types of peer mentoring models, the inherent challenges of both, such as low attendance rates in stand-alone models and short periods of peer to peer time in embedded models, are mitigated.

Corey-Legge, K. P. (2010). *Does mandatory Supplemental Instruction work in developmental math education? A study of students enrolled in developmental math courses at a suburban community college in the Northeast.* (Ed. D. dissertation), Temple University, Maryland. The number of students entering the community college in need of developmental math has not changed, remaining at a steady 60% over the past seven years. This study compared the success rate of Mandatory Supplemental Instruction (MSI) sessions within four sections of a developmental math course compared with the success rates of students enrolled in both the Traditional Classroom setting and the Individualized format at Suburban Community College (SCC) during the Fall 2009 semester. These MSI format courses were compared with both the Individualized format of MAT 060 and the Traditional Classroom format of the same course. The students included in these sections were a combination of students who were: (1) suggested by advisors to enroll in this developmental math course after receiving a low score on the college's Accuplacer placement test for algebra or continuing the progression of developmental math from the lower level arithmetic class; (2) mandated to attend MSI after successful completion of the Jump Start Math Program, or (3) self-selected into the MSI group anticipating the need for additional help in the course. The two primary data sets available for this study are student math final grades and student participation/attendance records. Secondary sets of data include informal focus group notes, final exam scores, student attendance records for both class lectures and MSI sessions, and Supplemental Instruction Leader anecdotal records. The findings of this study conclude that success rates of students enrolled in the MSI sections of developmental math do not differ significantly from those enrolled in the Traditional Classroom format of developmental math; however, both groups did differ significantly from the Individualized format of developmental math, in that the students enrolled in the Individualized format succeeded at a lesser rate and withdrew at a greater rate than their MSI or Traditional Classroom counterparts. This study also concluded that female, full-time students succeeded at a greater rate across the board, which is consistent with the literature. These findings were significant for a number of reasons. Although the difference between the treatment group and the Traditional Classroom group was not significant, there are a variety of reasons at the program level as to why this may have been so and there are many future constructs that SCC can put in place to strengthen and reassess the MSI program. Although this study was focused on the MSI treatment, the data revealed a greater issue existing in the Individualized format of developmental math at SCC. Future considerations can be made in this particular delivery method to improve success rates of students involved in this program. Future research on MSI in the form of persistence and retention rates, graduation rates, transfer rates, subsequent math course grades and success in other college-level classes can be explored to provide the MSI program with more data to determine if particular groups of students are benefiting from this format.

Costanza, M. N., Leibrecht., B. C., Cooper, W., & Sanders, W. R. (2009). *Peer-to-peer training facilitator's guide: Development and evaluation. Research Report 1911.* U. S. Army Research Institute for the Behavioral and Social Sciences. Arlington, VA. Available online: http://www.dtic.mil/dtic/tr/fulltext/u2/a508309.pdf?lipi=urn%3Ali%3Apage%3Ad_flagship3_messaging%3Bny%2BqNiwJR065QQYsXra5TA%3D%3D

The research involved 1) a review of the literature and training practices to identify best practices for P2P training 2) the development of the Facilitator's Guide which provides a framework for developing, delivering, and assessing P2P training, and 3) the formative evaluation of the Facilitator's Guide by representative Army officers. The review of training practices included interviews with experienced P2P facilitators, observations of the learning activities present in Battle Command Knowledge System (BCKS) and Stryker Symposiums, and participation in a Supplemental Instruction Workshop at the University of Missouri-Kansas City. The Facilitator's Guide was developed through a process of cross-walking P2P training principles against the requirements to develop, deliver, and assess training. A formative evaluation of the Facilitator's Guide was conducted with representative Army officers participating in peer group discussions in both face-to-face and video teleconference environments. Findings: Results indicated that Army officers benefited from the knowledge exchange during the P2P training sessions, with the majority commenting on the constructive value of the guide and the effectiveness of the P2P training sessions. Feedback on the guide was mostly positive with facilitators indicating that the guide provided an appropriate amount of information and a usable format and tools for structuring and promoting group discussions.

Couchman, J. A. (1997). *Report on the pilot study of the Supplemental Instruction program: 51002 Introduction to Accounting*. Unpublished manuscript. University of Southern Queensland. Toowoomba, Queensland, Australia.

A 1997 research study at the University of Southern Queensland (Toowoomba, Queensland, Australia) involved all enrolled students in Introduction to Accounting (51002). By use of the external student cohort as a control group, it was claimed by the researchers that Supplemental Instruction resulted in a positive impact on the overall pass rate for the unit, raising it from 39% in 1996 to 55% in 1997. SI participants averaged 1.15 of a grade point higher on a 7 GPA scale than non-participants. SI participants were: only one-third as likely to fail; nearly four times more likely to gain an HD, approximately equally likely to gain an A grade; over twice as likely to gain a B grade; and three-quarters as likely to gain a C grade than non-participants. When examining a subpopulation of international students, they had a 78% pass rate compared with 48% for those international students who did not participate.

Couchman, J. A. (1997). *Supplemental Instruction: Peer mentoring and student productivity*. Conference Proceedings of the Researching education in new times, Brisbane, Toowoomba, Australia.

The Supplemental Instruction (SI) program was implemented in a first year accounting subject (51002: Introduction to Accounting) in the Faculty of Commerce at the University of Southern Queensland (Australia). The results, in both quantitative and qualitative terms supported the utility of SI regarding student achievement and higher institutional revenue. While the failure rate did not change between the control and treatment groups, the rate of final course grades of high distinction tripled. SI Leaders reported increases in both their communication and leadership skills.

Couchman, J. A. (1999). *Distance PALS in real and virtual classes*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

As a major provider of distance education programs in Australia, the University of Southern Queensland has a unique interest in the development of flexibly delivered and supported distance education study programs. In 1996, to enhance the success and retention of its distance education students, the Distance PALS (Peer Assisted Learning Sessions) program was developed on the basis of the Supplemental Instruction program. During semester one, 1997 and 1998, it was implemented and evaluated in a first year foundation economics course

in selected off-campus study centers. The quantitative and qualitative data collected confirm the success of the PALS program and indicate modification to further enhance its success. Attendees received a difference of 0.96 on a seven point scale higher score and were twice as likely to pass the course.

Couchman, J. A. (2001). Peer-assisted teaching and learning in distance education. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student-assisted teaching: A guide to faculty-student teamwork* (pp. 110-115). Bolton, MA: Anker Publishing Company. Available online: ERIC database. (ED449713).

As a major provider of distance education programs in Australia, the University of Southern Queensland has a unique interest in the development of flexibly delivered and supported distance education study programs. In 1996, to enhance the success and retention of its distance education students, the Distance PALS (Peer Assisted Learning Sessions) program was developed on the basis of the Supplemental Instruction program. During semester one, 1997 and 1998, it was implemented and evaluated in a first year foundation economics course in selected off-campus study centers. The qualitative data collected confirm the success of the PALS program and indicate modification to further enhance its success. Attendees received a difference of 0.96 on a seven point scale higher score and were twice as likely to pass the course. The program was cost effective based on the higher persistence rate of students.

Couchman, J. A. (2009). An exploration of the 'lived experiences' of one cohort of academic peer mentors at a small Australian university. *Australasian Journal of Peer Learning*, 2(1), 87-110. Available online: <http://ro.uow.edu.au/ajpl/vol2/iss1/5>.

While the benefits of Supplemental Instruction (SI) have been widely reported, the benefits for the SI leaders involved with the program have not. After a literature review of previous research efforts with investigating this issue, the article describes a qualitative study with 11 undergraduate SI leaders at a university in Australia. Themes that emerged from the research include: empathy, collaborative techniques, inclusiveness, reflective practice, mutuality, increased learning, growing confidence, developing communication skills, establishing friendships, and other results.

Couchman, J. A. (2009). *Report on a Pilot Study of the Peer Assisted Learning Sessions (PALS) program: Introduction to Information Technology (4478) Semester 1, 2009*. Unpublished manuscript. University of Canberra. Bruce, Australia.

In semester 1, 2009, with the support of unit convener of Introduction to Information Technology, the PALS program was implemented as part of a suite of student success and retention initiatives. Recently students enrolled in Introduction to Information Technology had recorded lower than acceptable pass rates. PALS was considered to be an appropriate program to provide student support because of its proven effectiveness with higher education student success and retention both overseas and in Australia over a number of years. Students from all GPA levels attended at least one PALS. PALS intervention resulted in a positive impact on the final grades of students who attended, regardless of GPA. The data showed that improvement of 11.8% in the nett pass rate compared with that of semester 1, 2008 · students who attended PALS frequently (more than four times) had better DI and CR rates than either occasional or non-attendees · students who attended PALS frequently had a lower fail rate than that of other students · low UAI students who attended PALS had a pass rate one-third higher than that of those who did not attend. Student feedback on PALS through an end of semester questionnaire was positive and indicated that PALS had enhanced respondents' revision, exam preparation and assignment preparation and over 90% would recommend PALS to other students. The efficacy of PALS as implemented in this unit has been demonstrated.

Couchman, J. A., & Pigozzo, R. (1997). *Report on the Supplemental Instruction program: 51008 Economics*. Unpublished manuscript. Unpublished manuscript, University of Southern Queensland. Toowoomba, Queensland, Australia.

This 1997 Supplemental Instruction (SI) study was conducted at the University of Southern Queensland (Toowoomba, Queensland, Australia) in the 51008 Economics course. SI participants averaged 0.83 of a grade point higher on a 7 GPA scale than non-participants. The results suggested that only one-fifth of SI participants were likely to fail; one-third more likely to gain an HD, two and a half times more likely to gain an A grade; twice as likely to gain a B grade; and over one and a half times as likely to gain a C grade than non-participants. International students who attended SI sessions regularly had a 93% pass rate compared with 63% for those international students who chose not to attend regularly.

Couchmann, J. A. (2008). Who am I now? Accommodating new higher education diversity in Supplemental Instruction. *Australasian Journal of Peer Learning*, 1, 80-90. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/10>

The Supplemental Instruction (SI) model is extended regarding its theoretical foundations by analyzing the recent transformations in higher education and evaluating the adequacy of SI's current foundations in light of these transformation. The author advocates inclusion of a multiliteracies perspective to recognize the growing diversity of the higher education student population. This is done through use of critical discourse analysis which is a blend of linguistic analysis and ideology critique. This is an important area for further investigation to keep SI relevant for the changes in higher education world-wide.

Craig-Claar, D. (1994). Starting Supplemental Instruction at Maple Woods Community College. *Supplemental Instruction Update*, 1-2.

The author is the Associate Dean of Instruction at Maple Woods Community College (MO). She describes the development of the Supplemental Instruction program at her campus. The article describes the administrative steps that were taken to initiate the program. A creative solution to compensate the SI leaders was that they were paid with fee waivers rather than the more common monthly paycheck.

Crisp, G., & Taggart, A. (2012). Community college student success programs: A synthesis, critique, and research agenda. *Community College Journal of Research and Practice*, 37(2), 114-130. doi: 10.1080/10668920903381847.

A narrative review was developed to add to the discussion and dissemination of research on community colleges. The review adds to existing work by synthesizing and critiquing the empirical research to date specific to three of the most prevalent programmatic efforts presently seen on community college campuses: (a) learning communities, (b) student success courses, and (c) supplemental instruction. Empirical investigations or evaluations of student success programs from academic journals, conference presentations, dissertations, unpublished policy reports, and book chapters were identified, summarized, and critiqued. The review concludes with a proposed research agenda to advance research on program effectiveness at community colleges and implications for practice.

Cross, I. G. (1997). *Peer support through Supplemental Instruction for civil engineering students*. Conference Proceedings of the 2nd Working Conference on Engineering Education: Professional Standards and Quality in Engineering Education, Sheffield, England.

This article describes the use of Supplemental Instruction for civil engineering students in the United Kingdom.

Cui, J., Kevin, H. T., Cortese, C. L., & Pepper, M. (2015). Reflections on a bilingual peer assisted learning program. *International Journal of Educational Management*, 29(3), 284-297. doi: 10.1108/IJEM-12-2013-0175.

The purpose of this paper is to identify and evaluate faculty and academic staff perceptions, experiences and expectations with respect to a voluntary, bilingual peer assisted learning (PAL) program, which operates for the benefit of students studying in the Faculty of Business at a regional Australian University. A survey instrument and semi-structured interviews were used to faculty executive and academic staff in order to collect information about the perceived benefits of the program and identify opportunities for improvement. Based on an analysis of student results, the bilingual PAL program is shown to have a positive effect on performance of students participating in the program. Results from interviews with executive and academic staff indicate a high level of support for this type of student learning program. Although the value of both bilingual teaching and PAL has been explored in the teaching and learning literature, few studies have examined the integration of these two approaches. This research contributes to the literature by exploring the practical contribution of integrating these approaches. This research also provides valuable information regarding executive and academic perceptions of PAL programs, which is infrequently addressed in the literature. Findings may be used to inform institutions of the value of bilingual PAL programs in relation to international student retention and learning support and provide a starting point for discussions around the practical implications of such programs.

Cummings, D. J., & Sheeran, N. (2019). Do academic motivation and personality influence which students benefit the most from peer-assisted study sessions? *Psychology Learning & Teaching*, 16(3). doi: 10.1177/1475725719840502.

Previous research investigating the relationship between peer-assisted study sessions (also called supplemental instruction or peer-assisted learning) and academic performance has a number of concerns. These include the lack of inclusion of important variables such as academic motivation and personality. This study (N = 233) investigated how motivation, personality, and control variables (prior subject attempts, number of university semesters completed, prior academic achievement) have an impact on the relationship between peer-assisted study sessions attendance and academic performance for psychology students. The results indicated that peer-assisted study sessions attendance predicted academic performance when controlling for academic motivation, personality, and control variables; however, the magnitude of the relationship was almost halved ($r = .27$ to $\beta = .13$). Peer-assisted study sessions attendance mediated the relationship between neuroticism ($\kappa^2 = .04$) and prior academic achievement ($\kappa^2 = .05$) and academic performance, indicating that participants with these characteristics benefit from the sessions. Finally, adjunct peer-assisted study sessions focused on assessment items appear to be a large part of its efficacy in this sample.

Curtis, E., Wikaire, E., Kook, B., Honey, M., Kelly, F., Poole, P., . . . Reid, P. (2014). What helps and hinders indigenous student success in higher education health programmes: A qualitative study using the Critical Incident Technique. *Higher Education Research & Development*, 34(3), 486-500. doi: 10.1080/07294360.2014.973378.

Tertiary institutions aim to provide high quality teaching and learning that meet the academic needs for an increasingly diverse student body including indigenous students. Tātou Tātou is a qualitative research project utilising Kaupapa Maori research methodology and the Critical Incident Technique interview method to investigate the teaching and learning practices that help or hinder Maori student success in non-lecture settings within undergraduate health programmes at the University of Auckland. Forty-one interviews were completed from medicine, health sciences, nursing and pharmacy. A total of 1346 critical incidents were identified with 67% helping and 33% hindering Maori student success. Thirteen sub-themes were grouped

into three overarching themes representing potential areas of focus for tertiary institutional undergraduate health programme development: Māori student support services, undergraduate programme, and Māori student whanaungatanga. Academic success for indigenous students requires multi-faceted, inclusive, culturally responsive and engaging teaching and learning approaches delivered by educators and student support staff.

Cusik, A., Camer, D., Stamenkovic, A., & Zaccagnini, M. (2015). Peer Assisted Study Sessions for research trainees. *Journal of Peer Learning*, 8, 18-33. Available online: <http://ro.uow.edu.au/ajpl/vol8/iss1/>.

Research training should facilitate effective researcher role development. While researcher roles require the performance of specialised knowledge and skill, they also require development of personal research identities within social contexts. Interaction with research peers can provide opportunities for reflective role development. Ad-hoc cohort-specific peer interventions are relatively common in research training, but these can lack standardisation and clear conceptual frameworks to underpin strategies. Peer Assisted Study Sessions (PASS) provide a structured approach to peer support for learning. As such, we aimed to develop, implement and evaluate a PASS program for research trainees. Participants (N = 21; (9 male, 12 female; exercise science n=5, biomedical science n=7, science n=2, public health n= 4, nutrition n= 3) were post-bachelor honours students and PASS was provided on a weekly basis. Demographic, academic, and PASS data were collected from institutional records. Students completed standardised PASS satisfaction evaluations. Standard undergraduate PASS administrative, funding, and reporting strategies were successfully applied. Leader selection, training, and PASS resource development processes were adapted for the research training context. Attendance and student satisfaction was high as was timely completion of research related assessments. PASS has been shown to provide methodological consistency and a transparent conceptual framework to frame expectations about the process, leader and participant roles, and mechanisms to evaluate impact. PASS enables institutionally sanctioned but peer driven opportunities for social exchange wherein reflective approaches to research role development can be considered.

Dagneault, M. (2011). Supplemental Instruction in learning communities: A semester of trials, successes, and reflections *In the pockets of yesterday's pants: Theory, practice, theory* (pp. 33-39). Overland Park, KS: Johnson County Community College
Description of the experience of a SI Leader working with a learning community of several courses at a two-year institution.

Dalton, C. (2011). *The effects of Supplemental Instruction on pass rates, academic performance, retention and persistence in community college developmental reading courses*. (Ed. D. dissertation), University of Houston, Houston.

The purpose of this research was to measure the effects of the peer tutoring program Supplemental Instruction (SI) on pass rates, academic performance, retention, and persistence in community college developmental reading courses. Prior research indicated that SI improves final grades, attendance, retention, persistence, and graduation rates in college credit-bearing courses. However, the minimal research documented in the literature on the use of Supplemental Instruction in developmental education courses contained conflicting information. Archival data, collected from five semesters of comparative SI and non-SI developmental reading courses at an urban fringe community college, were analyzed to determine whether a significant statistical difference existed between the two groups. The pass rates, i.e. the number of A, B, and C grades, for the SI and non-SI groups were 75% and 70% respectively. However, a chi-square analysis revealed there was not a statistically significant difference between the pass rates of the two groups (chi-square value .520). The academic performance measure, i.e.

a statistical analysis of the SI and non-SI classes' scores on the developmental reading exit test/final exam, revealed that the mean scores were 82% and 81% respectively. An independent samples t-test confirmed there was not a statistically significant difference between these means ($t=.345$, $\alpha=.05$). The retention analysis, i.e. the number of students who attended classes through to the final exam, revealed that 80% of the students in the SI supported classes and 79% of the students in the non-SI supported classes were retained. A Difference in Proportions Test confirmed there was not a statistically significant difference in the retention rates between the two groups ($z = .1568$, $p = .5636$). The persistence analysis revealed that 74% of the students from the SI supported classes and 69% of the students in the non-SI classes registered for classes in the subsequent long semester. However, a Difference in Proportions Test revealed there was not a statistically significant difference between the persistence rates of the two groups ($z = .784$, $p = .7823$). The researcher concluded that the widely touted positive effects of Supplemental Instruction are diminished in community colleges with well-developed developmental education programs with courses currently exhibiting pass rates of 70% or higher. Therefore, the researcher recommends targeting the implementation of SI in developmental reading courses with traditionally high failure rates, e.g. courses created during the first week of the semester to accommodate late registering students. Also, community colleges without well-developed developmental education programs could implement Supplemental Instruction to accommodate for a lack of other support services and programs for developmental education students. In addition, the research revealed that the voluntary attendance aspect of traditional SI programs in developmental reading courses led to low attendance at SI sessions. Therefore, the researcher recommends course instructors assign mandatory graded assignments that require completion with the SI leader to boost attendance at SI sessions. Developmental reading programs could also create a mandatory lab attached to a course dedicated to SI peer led tutoring. Encouraging serendipitous observations warrant further investigation, including the effects of SI on the affective domain, the SI leader, and the course instructor.

Dalton, C., & Saxon, D. P. (2013). The effects of Supplemental Instruction on developmental reading, part 1. *Research in Developmental Education*, 25(1), 1-6.

This article is part one of two part examining the effect of Supplemental Instruction (SI) with developmental reading. Part one provides an overview of SI and describes the study and methods employed in conducting the research concerning the use of SI with developmental reading.

Dalton, C., & Saxon, D. P. (2013). The effects of Supplemental Instruction on developmental reading, part II. *Research in Developmental Education*, 25(2), 1-6.

This article reports the results, discussion, and conclusions of the study of Supplemental Instruction (SI) with developmental reading courses. The pass rate for the SI supported developmental reading courses was five percentage points higher than for non-SI supported courses. There was not a statistically significant difference between the pass rates of the SI and non-SI groups. There also was no statistically significant differences between the two groups regarding final course grades. Voluntary attendance practices with the traditional use of SI are not effective with less motivated students enrolled in developmental reading. It does not appear that SI is cost effective for use in developmental reading courses.

Dancer, D., Morrison, K., & Tarr, G. (2015). Measuring the effects of peer learning on students' academic achievement in first-year business statistics. *Studies in Higher Education*, 40(10), 1808-1828. doi: 10.1080/03075079.2014.916671. Available online: <http://srhe.tandfonline.com/doi/pdf/10.1080/03075079.2014.916671?needAccess=true>.

Peer-assisted study session (PASS) programs have been shown to positively affect students' grades in a majority of studies. This study extends that analysis in two ways: controlling for ability and other factors, with focus on international students, and by presenting results for PASS in business statistics. Ordinary least squares, random effects and quantile regression models have been used to model data from first-year business statistics students. The findings indicate that the impact of PASS has remained highly significant in both years for both local and international students but is more pronounced for international students. We also find that lower-achieving students derive a higher marginal benefit from attending PASS than higher-achieving students using quantile regression. These findings are significant for institutions implementing similar programs as well as institutional efforts to enhance student performance and improve student retention, or specifically to support international students more effectively.

Daskalovska, N., Dimova, V., Kuzmanovska, D., Kirova, S., Ivanova, B., Ulanska, T., . . . Hadzi-Nikolova, A. (2017). The role of Supplemental Instruction in improving students' language competence at the faculty of philology. *KNOWLEDGE International Journal*, 19(3), 1181-1186. Available online:

<http://eprints.ugd.edu.mk/18284/1/THE%20ROLE%20OF%20SUPPLEMENTAL%20INSTRUCTION%20IN%20IMPROVING%20STUDENTS%E2%80%99%20LANGUAGE%20COMPETENCE%20AT%20THE%20FACULTY%20OF%20PHILOLOGY.pdf>.

The focus of this paper is the project "Supplemental Instruction as a tool for improving students' language competence at the Faculty of Philology". Students who enroll in the first year of studies at the Faculty of Philology in Stip have different levels of language competence, so that lower proficiency level students face difficulties in achieving the learning objectives of Contemporary Macedonian/English/German courses. Therefore, the aim of this project is to determine the effects of supplemental instruction on improving students' language competence which would help them attain the learning outcomes of the language courses and would serve as a basis for achieving better results in the course of their studies. Before the beginning of the supplemental instruction, all participants will be tested in order to determine their language competence. Based on the results, the participants in each department will be divided into two groups – A and B. The supplemental instruction will include two lessons per week during the first two semesters. Group A will be the experimental group and group B will be the control group in the first semester. The supplemental instruction for Group A will focus on explicit learning of grammar and vocabulary as well as on developing the language skills by using different exercises and activities in accordance with the communicative approaches to language learning. Group B will not attend supplemental instruction. At the end of the semester, both groups will be tested in order to determine the effect of the supplemental instruction on students' language knowledge and skills. A survey will be conducted with group A to find out their opinions and attitudes regarding the benefits of supplemental instruction. In the second semester Group A will be the control group and group B will be the experimental group. Group A will not attend supplemental instruction, while group B will learn the language implicitly by using literary texts according to the principles of language-based approaches to using literature in the language classroom. At the end of the second semester, the participants will be tested again in order to determine the effect of this approach on their language competence. A survey will be conducted with group B to determine their experience and opinions about the effect of this type of supplemental instruction. All results will be summarized at the end to see if supplemental instruction contributes to improving the knowledge and language skills of first year students as well as the effects of the two different approaches in the implementation of the supplemental instruction.

Daskalovska, N., Ulanska, T., & Hadzi-Nikolova, A. (2019). The effects of explicit Supplemental Instruction on students' language competence. *KNOWLEDGE International Journal*, 30(5),

1151-1155. Available online:

<http://eprints.ugd.edu.mk/21883/1/The%20Effects%20of%20Explicit%20Supplemental%20Instruction.pdf>.

The aim of this study was to investigate the effects of supplemental instruction on the improvement of the participants' language abilities. Even though the treatment lasted for a short time and it was not organized in the same way as the traditional supplementary instruction, the results are promising and indicate that organizing additional lessons for students who have difficulties with certain courses would enable them to gain more knowledge and skills that would make their learning easier and improve their results. Therefore, in order to make university studies easier and more productive and to prevent students from dropping out of universities, we need to find ways to help students in their pursuit of academic achievement, one of which may be providing supplemental instruction for all students that may require it.

Davies, E., & Vorster, J. (1994). *The SI leader as a teaching resource*. Paper presented at the South African Association for Academic Development Conference, University of Natal, Republic of South Africa.

In 1994 a Supplemental Instruction (SI) program was introduced in the Law Faculty at Rhodes University (South Africa). Two courses were initially selected for a pilot program: Legal Theory I and Commercial Law I with joint funding from the Academic Development Program and the Law School. Interviews with students suggested that the SI leader empowered the students to be more active in their own learning process and take additional responsibility for mastery of content mastery rather than being passive in the classroom. The SI activities were more student controlled while the formal tutorial program was viewed as more rigid and prescriptive.

Davies, J., & Johnston, S. (1994). The institutional implementation of Supplemental Instruction. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 55-63). Birmingham, England: Staff and Educational Development Association

This chapter describes the implementation of Supplemental Instruction at the University of Plymouth in the United Kingdom. Proponents of the SI program were careful to generate wide support rather than having the program implemented solely by the top institutional leaders. The "SI Working Group" was formed to carefully explore key questions before a final decision was made regarding SI implementation. Liaison relationships were established with the faculty staff, students, and the Dean. While there were challenges during the pilot implementation of SI, the program continues to develop.

Davis, E. E. (1999). *Student mentors: Experiences of being a Supplemental Instruction leader*. (Master of Science thesis), Indiana University.

The purpose of this Master Thesis was to examine the experience of serving as a Supplemental Instruction (SI) Leader upon the individual at Indiana University Purdue University Indianapolis (IUPUI). A qualitative research study was conducted of SI leaders during Fall 1997. Some common benefits cited were improved: communication skills, problem solving skills, subject matter knowledge, people skills, friendships, knowledge of campus layout and resources, time management skills, involvement and knowledge of campus activities, leadership skills, and feelings of connection to the campus. Some mentioned that SI opened doors to new experiences that drew them closer to their desired career goal.

Dawson, P. (2014). Beyond a definition: Toward a framework for designing and specifying mentoring models. *Educational Researcher*, 43(3).

More than three decades of mentoring research has yet to converge on a unifying definition of mentoring; this is unsurprising given the diversity of relationships classified as mentoring. This

article advances beyond a definition toward a common framework for specifying mentoring models. Sixteen design elements were identified from the literature and tested through specification of two different mentoring models from higher education contexts. This framework provides researchers and practitioners with a detailed yet concise method of communicating exactly what they mean when using the word mentoring; it may also act as a useful set of prompts for educators designing new mentoring interventions.

Dawson, P., van der Meer, J., Skalicky, J., & Cowley, K. (2014). On the effectiveness of Supplemental Instruction: A systematic review of Supplemental Instruction and Peer-Assisted Study Sessions literature between 2011-2010. *Review of Educational Research, 20*(10), 1-31. doi: 10.3102/0034654314540007. Available online:

<http://dro.deakin.edu.au/eserv/DU:30070540/dawson-ontheeffectiveness-post-2014.pdf>.

Supplemental instruction (SI)—variously known as peer-assisted learning, peer-assisted study sessions, and other names—is a type of academic support intervention popular in higher education. In SI sessions, a senior student facilitates peer learning between undergraduates studying a high-risk course. This article presents a systematic review of the literature between 2001 and 2010 regarding the effectiveness of SI. Twenty-nine studies met the inclusion criteria. Due to methodological heterogeneity and lack of consistency defining the SI treatment, qualitative synthesis methods were applied. For seven included studies, however, an effect size of SI participation on final grades was calculated, ranging from $d = 0.29$ to $d = 0.60$. The findings of the review are consistent with claims validated by the U.S. Department of Education in the 1990s that participation in SI is correlated with higher mean grades, lower failure and withdrawal rates, and higher retention and graduation rates. Specifically, those three claim statements were: 1. Students participating in SI within the targeted high-risk courses earn higher mean final course grades than students who do not participate in SI. This finding is still true when analyses control for ethnicity and prior academic achievement. 2. Despite ethnicity and prior academic achievement, students participating in SI within targeted high-risk courses succeed at a higher rate (withdraw at a lower rate and receive a lower percentage of [fail] final course grades) than those who do not participate in SI. 3. Students participating in SI persist at the institution (reenroll and graduate) at higher rates than students who do not participate in SI.

Dawson, P. J. (2010). *Examining how an online mentoring model may support new Supplemental Instruction leaders*. (Ph.D. dissertation), University of Wollongong, Wollongong, Australia. Available online: <http://ro.uow.edu.au/theses/3208/>

This study investigated online mentoring as a method of supporting inexperienced, geographically-dispersed Supplemental Instruction Leaders (SILs). Supplemental Instruction (SI) is an academic support program that employs successful senior students as SILs to facilitate regular peer learning sessions. Over 250,000 tertiary students attend SI each year worldwide (Arendale, 2002). Students who attend SI are more likely to succeed in their studies, achieve higher grades, and be retained at their institutions (Martin & Arendale, 1993). The Australian higher education sector has a need for initiatives like SI that support the success of non-traditional students (Bradley, Noonan, Nugent, & Scales, 2008); however such programs can be difficult to implement in multi-campus institutions (Winchester & Sterk, 2006). In this study, online mentoring was examined as a method of addressing some of the difficulties in supporting inexperienced SILs who are geographically isolated. There is minimal research literature about the use of mentoring or community to support SILs, and none addressing the problem of supporting geographically dispersed SILs. Online mentoring and community models have been used successfully in other contexts to support novices that are geographically isolated from potential mentors and their peers. SILs are different from mentees in most mentoring literature; traditional mentees are either career employees or students being mentored for their academic success. In this study, SILs are being supported for a part-time,

fixed-term role that few intend to continue as a career. The following research questions were investigated: Research Question 1: What models are appropriate for mentoring geographically-dispersed Supplemental Instruction Leaders? Research Question 2: In what ways does participation in an online SIL support program impact on mentors, mentees and community members? The study consisted of two phases, each addressing the corresponding research question. In Phase 1, an exploratory qualitative study was conducted into the development of an online mentoring model for geographically-dispersed SILs. A new theoretical framework was developed from Social Learning Theory (Bandura, 1977) and Social Exchange Theory (Emerson, 1976; Homans, 1958) to inform the design of the model. This framework assisted in understanding how mentoring happens, and why mentors and mentees might participate in it. In Phase 2 the model was investigated twice using a qualitative, multiple-case study methodology. There were 30 participants from six campuses of five Australasian universities in the first study, and 67 participants from 27 campuses of 25 academic institutions from three continents in the second study. Data were analyzed using a deductive approach based on the theoretical framework. Key findings of this research were: A model for the mentoring of geographically-dispersed SILs. An understanding of the impacts of the model on participating SILs. Role modeling was found to be the component of mentoring most used for SIL development; this is interesting given Ensher, Heun and Blanchard's (2003) proposition that "role modeling may be the function of mentoring that is least efficiently done in a virtual setting" (p. 273). A set of design variables for the development and expression of mentoring models. These variables address an identified need in the literature for clarity in academic communications about mentoring. A set of design variables for the development and expression of mentoring models. These variables address an identified need in the literature for clarity in academic communications about mentoring. This research has significance for online mentoring and higher education in general, and more specifically, the support of geographically-dispersed, part time staff, such as SILs and university tutors or teaching assistants.

Dawson, P. J., Lockyer, L., & Ferry, B. (2007). *Supporting first year student supporters: An online mentoring model for Supplemental Instruction*. . Conference Proceedings of the Annual Pacific Rim First Year Conference, Australia. Available online:
https://www.academia.edu/attachments/42685842/download_file?st=MTU3ODY4NTU1NCw3M4zNy4yNTUuMjAxLDQwOTQ5MQ%3D%3D&s=email&ct=MTU3ODY4NTU1NCwxNTc4Njg1NTcwLDQwOTQ5MQ==

Supplemental Instruction (SI), or Peer Assisted Study Sessions (PASS) as it is commonly known in Australia, involves experienced senior student Peer Leaders who provide regularly scheduled peer learning sessions with students enrolled in university courses. Commonly implemented on first year subjects, the sessions integrate "how to learn" with "what to learn", helping students achieve better grades and helping raise student retention rates. This paper discusses the challenges of supporting SI Leaders who are geographically dispersed across multiple campuses and considers the theoretical and empirical literature that informs the development of an online mentoring model.

Dean, B. A., Harden-Thew, K., Austin, K., & Zaccagnini, M. (2015). *From the horses' mouths: Reflections on transition from peer leaders*. Unpublished manuscript. University of Wollongong, Australia. Available online: <http://www.unistars.org/papers/STARS2015/09B.pdf>
World-wide peer learning programs support students in their transition to university. Peer leader support is distinctive, being closer to the learning experience or transition encountered. This paper explores transition into the first year of university through the reflections of peer leaders. It outlines two synergetic programs at the University of Wollongong (UOW): one supporting high school students in the early stages of transition to university (In2Uni); and the second supporting enrolled university students (PASS). Focus groups were conducted to elicit the

voices of leaders reflecting on their own transition and experiences of mentoring peers through transition. The findings suggest peer leaders assist transitioning students to confront change; develop strong social networks; make connections within and across curriculum; and learn how to learn in the new academic context. It was found that peer leaders valued peer support in their own transition (or wished for it) and saw its ongoing significance for others in transition.

Deaton, C. C., & Deaton, B. (2012). Using mentoring to foster professional development among undergraduate instructional leaders. *Journal of College Science Teaching*, 42(1), 58-62.

This study examines the mentoring relationships of student instructors who provide Supplemental Instruction (SI) for undergraduate science courses. Specifically, the researchers examined the relationships negotiated between mentor and protege student instructors during the first year of the mentoring program. The undergraduate student instructors in this study are part of a Supplemental Instruction (SI) program that focuses on helping undergraduate students who are enrolled in science courses that are often labeled as traditionally hard courses. To support the new undergraduate student instructors in the SI program, a mentoring model was implemented to encourage collaborations with other undergraduate student instructors in the SI program. Findings of the study found that proteges developed session plans and different activities, found strategies to get students to participate more and be more active learners, proteges became more confident about their teaching abilities. The program also benefited the mentors by providing a professional experience in working with another person, received intrinsic rewards such as feeling good in helping another, having someone follow their advice, improved their own teaching skill. The article also provides an overview of the mentoring program.

DeCarbo, B. (2008, 2008, October 2). Keeping up at college, *Wall Street Journal*, p. B 9. This short newspaper article describes how Supplemental Instruction (SI) is being used at the University of North Carolina-Chapel Hill to improve academic success of students. Interviews from the program director and students attest to its usefulness.

Detchen, J. C., Hershberger, S. A. S., & Sarquis, J. L. (2004). *PLTL research explorations at Miami University*. Conference Proceedings of the 227th American Chemical Society National Meeting, Anaheim, CA. For more information, contact the authors at the Department of Chemistry and Biochemistry, Miami University, 501 E. High Street, Oxford, OH 45056, detchenc@muohio.edu

Peer-led Team Learning (PLTL) was used in a general chemistry course at Miami University (OH). PLTL was first used in 1998. A research study compared the impact of PLTL and Supplemental Instruction on different sections of the same course. All students in the different sections took the same ACS Examinations Institute exam as a final exam and each section was administered the Group Assessment of Logical Thinking instrument (GALT), and were surveyed using the Student Assessment of Learning Gains (SALG) instrument.

Diehl, N. D. (2012). *Using Supplemental Instruction to increase passing rates of developmental Algebra courses in community colleges*. (Masters of Science thesis), California State University, Channel Islands.

Developmental mathematics courses are historically difficult classes for community college students. The failure rate of these courses is alarmingly high. Supplemental Instruction (SI) was developed to assist students in mastering the concepts and as result increasing the passing rates of these difficult courses. SI is a program that uses small peer-assisted study sessions to improve the problem solving skills and the retention of students in historically high-risk courses. Study sessions are led by a student instructor that previously took the class and earned a good grade. This thesis is a study of the efficacy of Supplemental Instruction on Elementary and

Intermediate Algebra courses at a community college. While our results do not specifically show significant improvement in the passing rates, many students involved in Supplemental Instruction expressed a positive outlook on the program. SI is a way to reinforce topics presented in lecture without the students feeling the pressure of the instructor's presence. More study will need to be done to determine the efficacy of Supplemental Instruction in remedial math courses at community colleges. Supplemental Instruction, however, is recommended as another tool for students to use in high-risk courses, as our results show that SI students do as well as students in regular classes. Also, for many of them, the SI environment was very beneficial, as they had another source of instruction in a more relaxed atmosphere.

Dillard, M. S. (2017). *Perceptions of Supplemental Instruction by nontraditional developmental students in a community college setting*. (Ph.D. dissertation), Rowan University.

This qualitative study examined the perceptions of nontraditional developmental education students on the fidelity of a supplemental instruction program in a community college setting. This study was motivated by two research questions: What are nontraditional supplemental instruction (NTSI) students' perceptions of their experiences in the supplemental instruction program? What are NTSI students' perceptions of the supports provided to them at their community college? To examine these questions, a qualitative study was employed. Interview data were obtained from four students, a supplemental instruction leader, and a program manager. Participant responses offered insight into the experiences of the supplemental instruction program through descriptions of two major areas of interest: the conditions and challenges which nontraditional developmental students face, and the intentional engagement practices on the part of the college which students perceived to be most helpful and supportive to them. Students identified and reacted to particular strategies on the part of their instructors and program which were implemented to support diverse student populations. The data revealed a body of evidence which will likely continue dialogue between the program administrators and the targeted population, as well as among educators and students in similar programs in other colleges. Implications for policy, practice, and further research are also provided.

Donelan, M. (1994). Introducing Supplemental Instruction in mathematics, law, architecture, geography, and statistics. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 41-50). Birmingham, England: Staff and Educational Development Association

This chapter describes the introduction of Supplemental Instruction (SI) at University College London (UCL) in the United Kingdom. Goals for the SI program was to improve both students' personal skills alongside their academic abilities. SI was implemented to support cognitive skill development and provide them experience with group work. SI leaders are generally not paid as are other unpaid student facilitation programs elsewhere at UCL. SI was implemented in mathematics, law, architecture, geography, and statistics. Positive improvements were reported for both SI participants and the SI leaders.

Donelan, M. (1995). An enterprising start: Innovative teaching and learning at the University College London. *Universe: Innovation and Excellence at the University of Central Lancashire*, 7(1), 14-15.

This article describes a number of innovative learning practices being implemented at the University College London (the largest and oldest college in the federal University of London). Supplemental Instruction (SI) is one of the featured learning strategies at UCL. Paul Kohler, Sub-Dean in the Faculty of Laws cites benefits of the SI program that include: facilitates students' learning and understanding; prepares them for employment since they will have better skills for learning and applying new concepts.

Donelan, M. (1997). *Introducing Supplemental Instruction at University College London*. Unpublished manuscript. University College London. London, England.

This paper describes the introduction of Supplemental Instruction (SI) at University College London into the Department of Mathematics and subsequently into five other departments during 1993/4 at both undergraduate and postgraduate level. SI was seen to fit closely with the Enterprise in Higher Education program which aims to develop students' personal skills alongside their academic abilities.

Donelan, M. (1997). *Supplemental Instruction: Students helping students' learning at University College London and University of Central Lancaster*. Unpublished manuscript. University College London. London, England.

The Supplemental Instruction program aims to provide an untapped learning resource for academics interested in developing first year students' cognitive capabilities alongside their personal skills. This study examines whether the pilot SI program meets the needs of first year students within the Law faculties of UCL and UCLAN. Whereas the US model places prime emphasis on increasing grades, the UK model develops more holistically to include both cognitive and affective aspects of learning, in which the benefits to the 2nd year SI Leaders becomes an important outcome as the outcomes for 1st year students.

Donelan, M. (1999). *SI leaders: The real winners*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

While much has been written about the benefits of Supplemental Instruction (SI) to first-year students, significantly less has been written about the impact of this more holistic approach to learning and skills development as experienced by the SI leaders. Within the context of the major changes in higher education within the United Kingdom and the research into effective teaching and learning, this paper takes a qualitative view of the thoughts, perceptions, and feelings of undergraduate law students at University College London in 1997-98 as they developed from university entry to the end of their first year when they applied to become SI leaders for the following year. Common themes for SI participants included the following benefits of SI: valuable learning experience, consolidates knowledge through participation, cooperative and fun learning environment, social integration, and clarified difficult issues and improved understanding. Common themes for SI leaders: facilitate personal learning through discussions, received reciprocal support, improved communication skills, and improved understanding of the course material.

Donelan, M., & Kay, P. (1998). Supplemental Instruction: Students helping students' learning at University College London (UCL) and University of Central Lancashire (UCLAN). *The International Journal of Legal Education*, 32(3), 287-299.

The Supplemental Instruction (SI) program is used to meet the needs of first year students in their academic and personal development within the Law faculties of the University College London (UCL) and the University of Central Lancashire (UCLAN). The United Kingdom expansion of the SI model develops more holistically in cognitive and affective aspects of learning for both SI participants and SI leaders. The three law courses that had SI attached to them were English Legal System, Obligations 1, and Lawyers' Skills. There are several variations of SI within the UK use of the model: SI leaders are instructed to focus on facilitating the group discussion and not presenting course content material; SI leaders receive academic credit for their service through evaluation of a portfolio. Higher grades were recorded for SI participants and SI leaders when compared with non-participants. Interviews with SI participants revealed the following SI program benefits: enhanced academic understanding; enjoyed active learning;

opportunity to clarify concepts; enjoyed the social aspects of meeting students of other classes; and developed personal confidence and reassurance. Benefits cited by the SI leaders included: opportunity to help others; developed communication, presentation, and leadership skills; increased knowledge of the academic content of the course.

Donelan, M., & Wallace, J. (1997). *Peer assisted learning: A truly co-operative initiative*. Unpublished manuscript. University College London. London, England.

This paper sets out to examine the place of peer assisted learning within the context of higher education in the United Kingdom and to see how one model of co-operative peer learning, Supplemental Instruction, supports academic teaching, enhances the students' learning experience, reduces attrition, and most important of all in this context enables the students to develop confidence with the subject and practical development of those generic personal qualities and attributes most keenly sought by graduate employers: communication, teamwork, problem solving, negotiation, decision making, and management of self and others.

Dorian, J. A. (2016). *The effect of food as a positive reinforcer on attendance of Supplemental Instruction/tutoring session in community college students*. (Ph.D. dissertation), Northcentral University.

The general problem is a large majority of community college students do not attend SI/tutoring sessions (CCCSE, 2012; Dawson et al., 2014; Martin et al., 2014; White et al., 2011; White et al., 2008). The specific research problem was a lack of understanding about the effects of food as a positive reinforcement instrument on SI/tutoring session attendance rate in community college students. The purpose of this quantitative, two-group experimental study was to determine the effects of food as a positive reinforcement on SI/tutoring session attendance rate in community college students. The population of this study included community college students who had access to SI/tutoring sessions; the sample included 80 community college students. The independent variable was food as a positive reinforcement instrument for SI/tutoring session attendance, and participants were randomly assigned to either receive or not receive food as positive reinforcement for SI/tutoring session attendance. The dependent variable was SI/tutoring session attendance rate. Attendance rate data were analyzed using a one-way ANOVA to compare the attendance rates of both groups. The finding indicated participants in the experimental group (food group) attended SI/tutoring significantly more than the participants in the control group (no food group); $F(1, 78) = 32.98, p < 0.0001, \eta^2 > .30$. Multiple implications are indicated including the efficacy of food as a positive reinforcer for SI/tutoring session attendance rates. Recommendations for practice were offered and included the development a positive reinforcement implementation providing food during SI/tutoring sessions. Recommendations for future research included expanded study replication.

Doty, C. (2003). *Supplemental Instruction: National data summary, 1998-2003*. Unpublished manuscript. The University of Missouri-Kansas City, The International Center for Supplemental Instruction.

This report provides data supplied by 53 U.S. institutions between 1998 and 2003 concerning academic achievement for Supplemental Instruction (SI) participants and nonparticipants. The data is drawn from SI reports covering 745 courses with a total enrollment of 61,868 students. SI participants were defined as those who attended one or more sessions during the academic term. Outcomes displayed in the report included: SI participants received a D, F, or withdrew from the course at a rate between one-third and one-fourth that of non-participants, regardless of institutional type and mean final course grades were approximately half a letter grade higher for SI participants. These differences were statistically significant and were consistent across different types of institutions and academic content areas. The most prevalent use of SI is in the

Natural Sciences (46%), followed by Social Sciences (20%), Mathematics (15%), and Humanities (7%).

Doubleday, I. F., & Townsend, S. A. (2018). Supplemental Instruction as a resource for graduate student pedagogical development. *Yearbook of the Association of Pacific Coast Geographers*, 80, 134-156. doi: 10.1353/pcg.2018.0007.

Most literature on Supplemental Instruction (SI) programs focuses on the benefits to undergraduate students; this article addresses how such programs benefit the next generation of geography educators. We outline major differences between graduate teaching assistant (GTA) and SI work for graduate students, particularly those working with introductory-level geography classes. Pulling from our experiences working as SI instructors, GTAs, and instructors of record, we offer a more detailed description of an SI classroom and argue for its benefits in pedagogical training and preparation for academic careers in geography.

Douma, S. R. (1988). *Supplemental Instruction: An alternate approach*. (Master's of Science thesis), Mankato State University, , Mankato, MN.

This Master of Science thesis study from 1986 had two purposes. The first was to provide a descriptive review of the Supplemental Instruction (SI) program (e.g., program overview, SI leader training program). The second purpose of the study was to evaluate the effects of SI at Southwest State University (MN) during Fall 1986, Winter 1987 and Spring 1987. Between 36 to 42 percent of students participated in the SI program. Findings include the following: 1) SI participants earned a higher final course grade. F86, 2.34 vs. 2.01, W87, 2.31 vs. 2.01, S87, 2.55 vs. 2.04. 2) SI participants earned a higher rate of A and B final course grades. F86, 42% vs. 31%, W87, 41% vs. 35%, S87, 54% vs. 36%. 3) SI participants earned a lower rate of D and F final course grades or withdrawals: F86, 21% vs. 33%, W87, 21% vs. 35%, S87, 19% vs. 35%. Several data tables from an article by Blanc, DeBuhr, and Martin (1983) are reproduced in this report. Individual course reports from Southwest State University that were used to generate the previous summary research studies are included: Natural Science, Biology I, Food for Thought, Everyday Chemicals, Accounting I, Introductory Algebra, Business Statistics I, General Psychology I, A.C. Circuits, Critical Thinking, and General Biology II.

Drake, R. G. (2011). Why should faculty be involved in Supplemental Instruction? *College Teaching*, 59(4), 135-141.

Because instructor-led Supplemental Instruction (SI) offers additional benefits in student learning and engagement over the more traditional peer-led model, in this article the author argues that faculty should consider participating in SI sessions. Benefits to participating in instructor-led SI include: students spend more time on task in faculty-led sessions, earn higher grades on exams, meaningfully interact with their professor (even in a large enrollment class), appreciate working collaboratively with their peers, and report gains in their academic self-confidence. As such, while still a relatively understudied intervention strategy, faculty-led SI warrants greater study and attention.

Drake, R. G., & Foresman, G. (2012). The impact of faculty and peer-led Supplemental Instruction: Comparing two disparate courses. *The International Journal for the Scholarship of Teaching and Learning*, 7(2). Available online:

<http://mountainrise.wcu.edu/index.php/MtnRise/article/view/203/140>.

This 2009 study reports that faculty-led Supplemental Instruction (SI), a significant departure from the traditionally defined and implemented peer-led SI model, has a number of measurable advantages over the traditional peer-led model. The study was conducted at a doctoral-granting HBCU at North Carolina Agricultural and Technical State University. While it was observed that student grades on exams and in the course increased more for those who regularly attended

faculty-led SI, students also reported that they preferred it to the peer-led sessions. The researchers postulate that faculty-led SI sessions are more likely to attract less academically-prepared students than the peer-led SI sessions. The faculty-led SI sessions also attracted more student participants than the peer-led SI sessions since in both cases, attendance was voluntary. The researchers also speculate that faculty-led SI sessions encouraged more emotional engagement in addition to intellectual engagement with the course material and therefore reinforced higher academic achievement and satisfaction. The two courses were analytical reasoning (based on typical topics of a logic course) and a contemporary world course that uses an interdisciplinary approach to study the social, economic, political, and cultural roots of modern society.

Duah, F., Croft, T., & Inglis, M. (2013). Can peer assisted learning be effective in undergraduate mathematics? *International Journal of Mathematical Education in Science and Technology*. Our goal in this paper was to investigate whether peer assisted learning might be an appropriate tool to address the well-known “cooling off” phenomenon observed in the context of undergraduate mathematics courses. Earlier researchers have noted that the “cooling off” of students who were previously enthusiastic about mathematics is both serious and hard to solve. Solomon suggested that a fruitful method of addressing this issue would be to move away from traditional undergraduate teaching methods and develop a participatory pedagogic approach. In this paper we investigated whether PAL might be an appropriate way of implementing Solomon’s suggestion. Although PAL has been shown to be effective in non-mathematical domains, we are aware of no previous research which has investigated whether it can be successfully used in single honours mathematics courses, the context in which “cooling off” has been observed, and particularly in the second year. We asked two main questions. First, is it possible to successfully incorporate PAL into an undergraduate mathematics degree (with a traditional didactic contract)? Second, is PAL effective at increasing students’ attainment, and therefore reducing the “cooling off” phenomenon noticed by earlier researchers? With respect to the first question, we found that the PAL sessions appeared to run relatively smoothly. PAL sessions seemed to be informal and welcoming students, and involved discussion of mathematics topics which had previously been suggested by the PAL participants. Sessions typically involved paired, small or whole group discussions of a short opening activity followed by discussion of difficult parts of lecture notes, problem sheets, tests and examination items. With reference to our second question – whether PAL was effective at increasing students’ attainment – we found a positive relationship between students’ PAL attendance and their final module mark, even after controlling for prior attainment and lecture attendance (and this relationship was also found in a subsequent replication study). Although we cannot rule out the possibility of some unknown confounding factor accounting for this relationship (note that any such confound would have to be uncorrelated with both prior attainment and lecture attendance), we believe that this finding is sufficiently encouraging to call for further research into the effectiveness of PAL in undergraduate mathematics.

Dubetz, T. A., Barreto, J. C., Deiros, D., Kakareka, J., Brown, D. W., & Ewald, C. (2008). Multiple pedagogical reforms implemented in a university science class to address diverse learning styles. *Journal of College Science Teaching*, 38(2), 39-43. This study investigates a group of students enrolled in a General Chemistry I sections between fall 2001 and fall 2002. The control sections were taught without full implementation of all reforms. The sample group of students were enrolled in the same class between spring 2003 and spring 2004. The entire set of nine pedagogical reforms were used. Supplemental Instruction (SI) was one of those nine reforms implemented. Final course grades increased and rates of course withdrawal decreased at a statistically-significant rate. Student comments also confirmed these results with higher student satisfaction.

Duckett, J. (1996, 1996, April 28). Tutors offers more than last-minute fix, *The Morning Call Newspaper*, p. E1.

This newspaper article describes tutoring programs at colleges in the Allentown, PA area. Supplemental Instruction (SI) is used at Kutztown University.

Dvorak, J., & Tucker, K. (2017). The case for intentionally interwoven peer learning supports in gateway-course improvement efforts. *New Directions for Higher Education*(180), 43-52. doi: 10.1002/he.20260.

Tutoring has been a mainstay of college academic support for much of the history of U.S. higher education (Arendale, 2010). While tutoring began as a service for the elite, it took on a remedial connotation as a result of mass education. Beginning in the 1970s and 1980s, however, learning centers and writing centers began to reject the remedial label (Arendale, 2010; Harris, 1988/2006; North, 1984), and today there is high interest in normalizing the use of academic support as successful student behavior (Louis, 2015). To that end, more intentional academic-support services are being offered on college campuses. The programs may be designed by a learning center or developed as a collaboration of stakeholders. Advisors, instructors, and faculty can encourage, incentivize, or require participation in cooperation with the support service.

Dyett, J. M. (2010). *Determining physical therapy students' perceptions about faculty-led Supplemental Instruction at a selected community college*. (Ph.D. dissertation), Capella University, Minneapolis, MN.

The purpose of this research study was to examine the perceptions of students in faculty-led supplemental instructional (SI) sessions. A qualitative research design enabled the researcher to focus on insight and discovery based on the lived experiences and perceptions of the participants. The participants were 20 physical therapy students enrolled in the nursing and allied health department of an urban, east-coast community college between August 2009 and May 2010. Data were acquired from the transcriptions of personal interviews with 20 heterogeneous, multicultural students ranging from 22 to 53 years of age. Students shared that having a faculty member available in the tutorial and practice/open lab environment helped to build their confidence levels and to understand the need for repetition. Participants also noted that work schedules and children were barriers preventing them from consistently attending faculty-led SI sessions. Recommendations for participant support included encouraging students via synchronous and asynchronous motivation, more flexible SI schedules, and stipulations for implementing mandatory attendance to SI sessions. An additional recommendation was to establish structured guidelines for first year students. Further research is needed to develop a full understanding of the findings, relative to the statistical data of grade point averages, varied attendance practices, and the participants' perception of the faculty-led environment. Additional research is needed to understand the lived experiences of the participants who have families and/or employment obligations hindering their ability to consistently attend the scheduled faculty-led SI sessions. Further research is also needed to gather a comparative analysis between regional institutions.

Eastmond, J. N. (1997). Five academic development programs in the Eastern Cape Province: Reactions of an American academic in South Africa. *Educational Technology Research & Development*, 45(3), 129-134.

This article describes the academic development programs at four tertiary institutions in South Africa (University of Port Elizabeth, Port Elizabeth Technikon, Rhodes University, and the University of Ft. Hare) as well as the development of a fifth new program at Border Technikon. Topics include cross-cultural differences; interviews; Supplemental Instruction (SI) that

combined staff development and student academic development; integration of media support; and stages of program development. The author describes how a former SI student leader at the University of Port Elizabeth had been hired as an instructor at Border Technikon. Based on interviews, the previous experience as SI leader had a direct impact upon the new instructor's style of instructional delivery which utilized a high degree of academic inquiry and guided classroom discussion. The author commented about how the SI program was able to combine both staff development and student academic development. While this was a common pattern with South African institutions, the author commented that this was largely unknown in the U.S. The author subscribed to a four-stage model for faculty development previously articulated by DeBloois and Alder, 1974: 1). Awareness: through guest speakers, newsletters, and similar low impact activities; 2). Faculty support: small grants to faculty, seminars or workshops on aspects of tertiary teaching; 3). Faculty skills: larger investment in course development, more extensive involvement of individual faculty; and 4). Departmental curriculum: extensive development of a series of courses in the curriculum, organizational development efforts to change the prevailing reward structure.

Eastmond, J. N., Bartlett, G., & Terblanche, N. (1997). Planning for student involvement in a program of Supplemental Instruction. *Educational Technology Research and Development*, 45(3), 134-140.

Supplemental Instruction (SI) is used at Border Technikon (South Africa) to increase student achievement in the Accounting and Management academic departments. The article describes the ways student involvement has been maintained through enlisting support from the Student Representative Council (SRC). Article topics include: training, funding considerations, effectiveness, student response, and student achievement results. A grant provided through the United States Agency for International Development (USAID) Tertiary Education Linkages Project (TELP) was used to start the SI program. The grant's major goals are to enhance staff and student development, both of which were enhanced through the SI program. SI leaders reported the following benefits to them from participation in the SI program: gained confidence in public speaking; developed new teaching strategies; and enjoyed more interaction with the course lecturers. Surveys of SI participants identified the following suggestions to improve the SI program: assign the same place each week for SI sessions; SI leaders should prepare before SI sessions to provide structure in case the attending students do not have a full agenda of items; SI leaders should receive additional interpersonal discussion group skill training; and that times should be set aside in class scheduling to allow for SI sessions to be scheduled. Analysis of final course examinations revealed that the number and percent of students who passed the final examination had doubled after the introduction of the SI program. The author found stated that this was remarkable considering that the class size had increased significantly, straining the ability of the course instructor to deal with the additional workload of students.

Eaton, M. D. (2015). Bridging the experiential learning gap: An evaluation of the impacts of Ulster University's Senior Student Tutoring Scheme on first year students. *Journal of University Teaching & Learning Practice*, 12(2), article 6. Available online: <http://ro.uow.edu.au/jutlp/vol12/iss2/6/>.

Since 2004-05 first year students at the School of Environmental Sciences, Ulster University have engaged with senior student tutors (SSTs) in workshop activities aimed at preparations for their written examinations. Using a pedagogical action research methodology we evaluated the role of SSTs in bridging the experiential learning gap between practitioners and recipients. Analysis suggested positive associations between workshop participation, examination success and improved module marks. Surveys showed that first year students gained confidence, were less intimidated and empowered with revision and examination techniques. The SSTs gained valuable insights, tutoring experience and an evidence base useful to their career paths.

Discussion focused upon risk-averse first year students who grasped and then transformed the experiences of the SSTs into successful examination performance. It is argued that our SSTs have helped to bridge the experiential learning gap and made inter-collegiate connections that would have been less-likely in a formal, teaching staff-led situation. Faculty suffering from examination related student progression problems could, therefore, benefit from adopting this locally controlled, low cost, small-scale, tailor-made, peer assisted tutoring scheme.

Eberling, D. J. (1998). *A comparison of the effectiveness of study strategies instruction with community college students*. (Ph.D. dissertation), University of Houston, Houston, TX. College students who use study strategies effectively are more successful in school than are those who are unaware of study strategies, or who use such strategies infrequently. There is a relationship between poor performance in school and inadequate study strategies. Fortunately, study strategies can be taught. The purpose of this dissertation study was to investigate the relation between grade point average and study habits and attitudes. Also, to examine the effectiveness of a study strategies course and the Supplemental Instruction (SI) program with community college students' study habits and attitudes. Volunteers for the study completed a pre and post test of the Survey of Study Habits and Attitudes (SSHA). Small sample size (n=10) may have played a role in clouding results of the research. Most students refused to participate in the study by permitting access to course grades and other vital information variables. With this SI program, attendance in SI sessions was not tracked and therefore the quantity of SI attendance was not available as an independent variable which has been used with many other published studies. With the small remaining group of voluntary study participants, a comparison of the students' grade point average and scores on the SSHA did not reveal significance. The scores on the SSHA and the comparison between the study strategies course and the SI program revealed no significant difference between the treatment groups.

Eckard, S., & Hegeman, J. (2002). *Breaking the rules: Mandatory SI for developmental readers*. Conference Proceedings of the National Association for Developmental Education, Orlando, FL. This article describes the use of Supplemental Instruction (SI) for developmental readers at Frostburg State University (MD). The students enrolled for a block of three courses: Reading, a choice from several general education course that are reading-intensive (history, psychology, or sociology), and a section of Freshmen Orientation that emphasized the development of study strategies. These students participated in a mandatory SI laboratory session each week to develop successful reading and study skills. Final course grades favored the SI participants in the history and sociology courses, but not in psychology.

Eddy, S. L., & Hogan, K. A. (2014). Getting under the hood: How and for whom does increasing course structure work? *CBE-Life Sciences Education*, 13(3), 453-468. Available online: <http://www.lifescied.org/content/13/3/453.full.pdf+html>.

At the college level, the effectiveness of active-learning interventions is typically measured at the broadest scales: the achievement or retention of all students in a course. Coarse-grained measures like these cannot inform instructors about an intervention's relative effectiveness for the different student populations in their classrooms or about the proximate factors responsible for the observed changes in student achievement. In this study, we disaggregate student data by racial/ethnic groups and first generation status to identify whether a particular intervention—increased course structure—works better for particular populations of students. We also explore possible factors that may mediate the observed changes in student achievement. We found that a “moderate-structure” intervention increased course performance for all student populations, but worked disproportionately well for black students — halving the black–white achievement gap—and first-generation students — closing the achievement gap with continuing-generation students. We also found that students consistently reported completing the assigned readings

more frequently, spending more time studying for class, and feeling an increased sense of community in the moderate-structure course. These changes imply that increased course structure improves student achievement at least partially through increasing student use of distributed learning and creating a more interdependent classroom community

Edelnant, V. (1999). Supplemental Instruction program helps students succeed. *Recruitment and Retention in Higher Education*, 13(5), 3.

This short article describes the use of Supplemental Instruction (SI) at Wartburg College in Waverly, IA. The SI program is four years old at the 1,500 student undergraduate Wartburg College. Benefits for the SI leaders reported by the author include developing empathy for the faculty members, experimenting with a possible career as a teacher, and development of their leadership skills.

Edelson, M. (1996). *A student's experience of the Supplemental Instruction programme and the first year of university: A case study*. (Ph.D. dissertation), University of Port Elizabeth, Port Elizabeth, Republic of South Africa.

Ehly, S. W., & Topping, K. (1998). Summary and conclusions. In K. Topping & S. Ehly (Eds.), *Peer-assisted learning* (pp. 313-327). London: Lawrence Erlbaum Associates, Publishers
This book chapter discusses the potential future impact of peer-assisted learning (PAL) programs in the United Kingdom higher education system. PAL is based upon Supplemental Instruction.

Eig, J. (1997). Supplemental Instruction programs: An effective way to increase student academic success? *Journal of The Indiana University Student Personnel Association*, 11-15.
Supplemental Instruction (SI) is used at Indiana University (Bloomington) to increase academic achievement and retention. This article provides a basic overview of the SI program and data concerning its effectiveness at the institution. Challenges for implementing SI include: administratively SI programs require considerable coordination; SI leaders must be carefully selected for their academic and interpersonal skills; SI leaders must be trained prior to the academic term and receive supervision throughout the term; students must make a time commitment to attend SI sessions; and the institution must have sufficient professional staff to supervise the SI program.

Eisenhauer, L. (2002). *Closing the gap: Can attendance to Supplemental Instruction classes remove the academic gap between target and non-target students?* (Ph.D. dissertation), Cornell University, Ithaca, NY.

Elder, B. L., & Jacobs, P. (2015). Identification and support of at-risk students using a case management model. *Journal of Professional Nursing*, 31(3), 247-253. doi: 10.1016/j.profnurs.2014.10.003.

This study evaluated a program to identify and support students at risk for failure in nursing courses or NCLEX-RN. A case management model (CMM) was implemented to provide assessment of and support for 183 Bachelor of Science in nursing students; 83 were identified as at risk by the CMM criteria. The CMM involved student self-evaluation and grade assessment of prerequisite and nursing courses. Science course grades were all found to be significantly higher for those students who passed NCLEX-RN on the first attempt than those who did not. Admission GPA was significant ($t = 2.443$, $P = .018$). Using a Motivated Strategies for Learning Questionnaire for self-evaluation, at-risk students rated their performance in nursing courses higher in every area than the non-at-risk student group, significantly higher for self-efficacy ($t = 2.829$, $P = .005$) and metacognition ($t = 2.426$, $P = .016$). Neither task value nor critical thinking

scores were significant. Graduation rate was 100% with 158 students passing NCLEX-RN on the first attempt (64 of 83 at risk and 94 of 100 non-at risk). The CMM was effective in identification and support of at-risk students.

Eller, J. L. (2016). *Investigating the Supplemental Instruction leader experience: A phenomenological study of undergraduate peer educators*. (Ph.D.), Liberty University, Lynchburg, VA. Available online:

<http://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=2345&context=doctoral>

The purpose of this transcendental phenomenological study was to describe the experiences of undergraduate students who serve as Supplemental Instruction (SI) leaders at a mid-sized, private research university in the Midwestern United States. Using Schlossberg's transition theory as a theoretical framework, this study attempted to answer the central research question: What is the experience of students who serve as SI leaders at a mid-sized, private research university located in the Midwestern United States? Sub-questions sought to address student expectations moving into the experience, how expectations were met or not met as they moved through the SI leader experience, the expected and unexpected outcomes as they moved out of the experience, and what students perceive to be the value of their experience beyond their tenure as an SI leader. Criterion, intensity, and maximum variation sampling were used to secure 12 co-researchers who experienced the phenomenon of serving as an SI leader at the research site. Data collected through questionnaires, interviews, archival records, and focus groups revealed four themes: (a) importance of relationships, (b) engagement for self and others, (c) valuing teaching and learning, and (d) developing intrapersonal skills for life, learning, and work. The study findings and limitations, implications for practitioners, and recommendations for future research are discussed.

Eller, J. L., & Milacci, F. A. (2017). Moving in, through, and out of the Supplemental Instruction (SI) leader experience. *Supplemental Instruction Journal*, 3(1), 38-63. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

Using a phenomenological research method and Schlossberg's transition theory as a theoretical framework, this study addressed the central research question: How do students move in, through, and out of the Supplemental Instruction (SI) Leader experience at a mid-sized, private research university located in the Midwestern United States? Through questionnaires, interviews, archival records, and focus groups, data analyses revealed themes that were used to describe the participants' perceptions of their SI Leader experience in the context of their transition from students to peer educators and the lasting impact of their experience beyond their SI Leader tenure. Themes are organized within Schlossberg's stages of transition and the factors of situation, self, supports and strategies that influence how a person copes with transition. Study limitations and recommendations for future research are discussed. Appendices including data collection instruments are included.

Emal, C., Johnson, T., & Kelter, P. B. (1997). *Supplemental Instruction: A model program that goes against the grain*. Unpublished manuscript. University of Nebraska at Lincoln. Lincoln, Nebraska.

This report examines the use of Supplemental Instruction (SI) at the University of Nebraska (Lincoln, NE). After an initial overview of the SI model, the paper reports on a study of the use of SI in multiple sections of Chemistry 109 (1,100 to 1,300 students total) over a period of five academic terms (Fall 1994 through Fall 1996). The SI participants earned a mean final course grade of 2.70 vs. 2.12 for the nonparticipants. The SI participants received a much lower rate of D, F and withdrawal grades (17.2 percent) when compared with the nonparticipants (42.9 percent). There was a positive correlation between increased attendance at SI sessions with

higher mean final course grades. A further analysis of students was accomplished by dividing them into quartile groups on the basis of their standardized college entrance scores (ACT). Whether it was the top (3.18 vs. 2.53), bottom (1.97 vs. 1.68) or middle quartile groups (2.60 vs. 2.04) the SI participants received approximately a mean final course grade that was half a letter grade higher. It appears that SI was equally attractive to all students since approximately the same percent of students attended SI from each of the quartile groups (18 to 20 percent).

Englert, A. (2016). *Addressing student performance in the classroom: A case study of the University of Alaska Fairbanks Supplemental Instruction program*. (Ph.D. dissertation), University of Alaska Fairbanks.

The Supplemental Instruction (SI) program, developed and headquartered at the University of Missouri Kansas City, is a peer-to-peer mentorship program that seeks to aid post-secondary education students in passing historically difficult courses. The University of Alaska Fairbanks Supplemental Instruction program was established in 2003, and to date no external study has been completed as to its effectiveness despite the university's unique student population. To empirically evaluate the program's main user groups and impact on final course grade, three models were created: a probit model identified the demographic factors that led to a student self-selecting to participate; a negative binomial regression model was used to predict the number of SI sessions students attended; and an ordered probit model quantified the effect of SI attendance on final course grades. The results suggest that the program had a positive impact on final grades, with SI attendees being approximately 92% more likely to receive an A, and 94% less likely to receive a D or an F, than non-attendees. Older and married students were consistently found to be more likely to participate, as were students with large high school grade point averages. However, minority males were found to be almost 9% less likely to participate in SI than their white male counterparts.

English, B. J. (1999). *Effects of social integration on the academic performance of international students*. Unpublished manuscript. The University of Southern California. Los Angeles, CA. This manuscript describes the use of Supplemental Instruction (SI) with postsecondary international students. A comparison is made between SI and the English Language Fellows Program at the University of Rhode Island which has similar purposes. The focus of the sessions is placed more on the use of language as the means for communicating and understanding the course material. The pairing of the native and nonnative speakers of English provides a rich atmosphere for language acquisition and fostering higher comprehension of the course content. The author then explores adapted use of Video-based Supplemental Instruction (VSI) for nonnative speakers as a supplement to challenging courses to aid in language development and mastery.

Erasmus, M. (2017). From inky pinky pony to improving student understanding in assessment: Exploring the value of Supplemental Instruction in a large first-year class. *Journal of Student Affairs in Africa*, 5(3), 33-53. doi: 10.24085/jsaa.v5i2.2701 Available online: <http://jsaa.ac.za/index.php/jsaa/article/viewFile/33-53/1665>.

Large classes are a reality in many tertiary programmes in the South African context and this involves several challenges. One of these is the assessment process, including the provision of meaningful feedback and implementing strategies to support struggling students. Due to large student numbers, multiple choice questions (MCQs) are often used in tests, even though researchers have found possible negative consequences of using MCQs. Giving appropriate feedback has been identified as a strategy to remedy some of these negative consequences. This paper reports on action research in which an intervention strategy was implemented in a large first year Psychology class where Supplemental Instructors (SIs) were used to give detailed feedback to students after assessments. The lecturer first modelled how to give

feedback by discussing the MCQs in detail with the SIs and identifying possible errors in their reasoning and meta-cognitive processes. The SIs subsequently repeated this feedback process in their small-group sessions. After each assessment, students who performed poorly were advised to attend a certain number of SI sessions before the next test, and their attendance, even though voluntary, was monitored to determine the effectiveness of the intervention. Students' performance in subsequent tests was compared and the results seem to indicate that attending SI sessions was mostly associated with improved test results. This strategy also appears to encourage attendance of SI sessions. In addition, students' responses in a feedback survey indicate an overall positive perception of this practice. These results can inform other lecturers teaching large classes and contribute to quality enhancement in assessment and better support for students

Eroy-Reveles, A. A., Hsu, E., Rath, K. A., Peterfreund, A. R., & Bayliss, F. (2019). History and Evolution of STEM Supplemental Instruction at San Francisco State University: A Large, Urban, Minority-serving Institution. In Z. S. Wilson-Kennedy, G. S. Byrd, E. Kennedy & H. T. Frierson (Eds.), *Diversity in Higher Education* (Vol. 22): Emerald Publishing Available online: <https://www.emerald.com/insight/content/doi/10.1108/S1479-364420190000022010/full/html>. Supplemental Instructions (SIs) were introduced into the San Francisco State University College of Science & Engineering curriculum in 1999. The goal was to improve student performance and retention and to decrease the time to degree in STEM majors. While for the most part we followed the structure and activities as developed by the International Center for Supplemental Instruction at the University of Missouri, Kansas City, we discovered several variations that significantly improved our outcomes. First and foremost, we created SI courses that require attendance, which results in higher students' performance outcomes compared to drop-in options. Second, at SFSU the SI courses are led by pairs of undergraduate student facilitators (who are all STEM majors) trained in active learning strategies. Each year, more than half of our facilitators return to teach for another year. Thus, each section has a returning "experienced" facilitator who works with a new "novice" facilitator. Third, the SI courses were created with a distinct course prefix and listed as courses that generate revenue and make data access available for comparison studies. Results are presented that compare SI impact by gender and with groups underrepresented in STEM disciplines.

Etter, E. R., Burmeister, S. L., & Elder, R. J. (2000). Improving student performance and retention via Supplemental Instruction. *Journal of Accounting Education*, 18, 355-368. This study reports on student performance, and failure and withdrawal rates for 9,053 students enrolled in 132 Principles of Accounting classes from 21 four-year colleges and universities that have adopted the Supplemental Instruction (SI) program. The overall SI participation rate was 26.8 percent. After providing an overview of the SI model, the data study concerning accounting occupies the rest of the paper. SI participants were found to have statistically significant higher average course grades (2.44 vs. 2.12), lower failure rates (5.9% vs. 15.3%) and lower withdrawal rates (10.6% vs. 19.8%) than non-participants enrolled in the target courses.

Evenbeck, S., & Williams, G. (1998). Learning communities: An instructional team approach. *Metropolitan Universities: An international Forum*, 9(1), 35-46.

At the Indiana University-Purdue University Indianapolis (IUPUI) a commitment was made to widely implement learning communities throughout the curriculum. This chapter provides a narrative overview of the implementation of this approach throughout the campus. The freshmen seminar is taught by a team that includes faculty, an academic advisor, librarian, and a Supplemental Instruction (SI) leader. This team approach provided for a rich learning environment for first-year students. Freshmen students were enrolled in a similar cohort of classes which provided high interaction among them and the team that taught the freshmen

seminar. The SI leaders facilitated study review sessions for one of the common courses that all students in the cohort had enrolled for that academic term.

Fallon, D. M. (2005). *An analysis of academic assistance programs on at-risk students at the United States Naval Academy*. (Master's of Science thesis), Naval Postgraduate School, Monterey, CA. Available online: <http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=ADA435690&Location=U2&doc=GetTRDoc.pdf>

The purpose of this research is to examine the impact of academic assistance programs on at-risk students at the United States Naval Academy. Each year, students determined to be at-risk are enrolled in an academic assistance program known as the Plebe Intervention Program. In addition, other academic assistance programs are available to these students. In particular, the Naval Academy administers a program known as the Midshipmen Group Study Program, which is based on the Supplemental Instruction model. This study examines the impact of participation in each of these programs as a determinant to persistence beyond the freshman year. Other determinants examined included demographics (ethnicity and gender), course grades, athletic status, and preadmittance data (SAT scores).

Faqrrell, H., Pastore, C., Handa, N., Dearlove, J., & Spalding, E. . (2004). *Initiating the new battlers*. Unpublished manuscript. Available online: http://www.proceedings.com.au/isana/docs/2004/paper_handa2.pdf

The cognitive benefits of peer mentoring for all students, and in particular for international students are closely linked to the socio-cultural context in which the learning takes place. As a supportive program, it is especially beneficial for international students who have opportunities to develop and practice additional skills such as group participation, negotiation and leadership qualities. This supportive context in turn, encourages appropriate socio-cultural, affective adjustments to the university. The experience of mentoring and of being mentored develops a sense of collegiality among students who consequently feel more positive about their learning. They also feel a sense of 'connection' to the university community. For the program to run successfully there is a need for cooperation between academic and training staff as well as cooperation between groups of students. This cooperative and collaborative ethos of the program positively affects the climate of the overall university (Shores & Tiernan, 1996)

Farmer, B. (1991). Helping learners to help themselves. *Teaching and Learning Bulletin*, 7, 2-3. This article describes the use of Supplemental Instruction (SI) at several institutions in England. The author, a member of the Learning Methods Unit at Birmingham Polytechnic, describes research that was shared at a SI workshop coordinated by Kingston Polytechnic and the World Wild Life Fund for Nature.

Fayowski, V. (2006). *An evaluation of the Supplemental Instruction program implemented in a first-year calculus course*. (Master's of Science thesis), University of Northern British Columbia, Prince George, British Columbia, Canada.

Supplemental Instruction (SI) is a voluntary program that incorporates collaborative learning in peer-led, small group settings in order to integrate instruction in learning and reasoning skills with the content of the course with which the SI is paired. Calculus for Non-Majors is the course that forms the basis of this three year study. This study addresses two related questions. First, does SI participation improve student achievement, as measured by course final letter grades? Second, does SI participation improve the pass/fail rate in the course? Prior student success, a combination of ability and motivation, was statistically controlled for in both analyses through the use of incoming grade point average. Gender was also chosen as an independent variable both for increased statistical sensitivity and generalizability. The effect of SI participation in Analysis of Covariance, after prior GPA and gender were controlled for, was statistically significant ($p <$

.0005) and practically significant ($d = .48$) or the equivalent of a two letter grade improvement. Pass/fall analysis was determined through binary logistic regression with observed statistically significant differences between the first model containing both prior GPA and gender and the second (full) model which also contained SI (chi-square = 41.19, $p < .0005$). In the full model gender did not contribute significantly ($p = .24$). The odds of succeeding were 2.7 times greater for SI participants. Overall, SI participants succeeded at a higher rate than non-participants (73% vs. 51%). These findings are consistent for both genders. Supplemental Instruction is an effective method for boosting success rates in a difficult undergraduate course with concentrated mathematical content.

Fayowski, V., & MacMillan, P. D. (2008). An evaluation of the Supplemental Instruction programme in a first year calculus course. *International Journal of Mathematical Education in Science and Technology*, 39(7), 843-855.

The Supplemental Instruction (SI) approach was used in a first year calculus for non-majors course at the University of Northern British Columbia in Canada. An ANCOVA indicated that ability/motivation, as measured by prior grade point average, was a useful predictor of course letter grade; and SI participation was statistically significant. The odds of success were 2.7 times greater for SI participants than nonparticipants.

Feinn, R. (2004). Effectiveness of Supplemental Instruction for developmental math in a university setting. *Dissertation Abstracts International*, 65(02), 410.

This dissertation explored the utility of Supplemental Instruction (SI) at a public university in New England with an elementary algebra course. The study sample consisted of all students enrolled in MATH099 during the fall of 2001, when SI was used, and all students enrolled in the same course during the fall of 2002, when instructors led the study sessions. Combined the sample was nearly 1,700 students, with no statistical difference in gender, race, or placement test scores between years. Using multilevel modeling to capture the within class covariance, it was found that students who had study sessions led by instructors had higher final exam scores and better course letter grades than students who experienced typical SI. However, the withdrawal rates were similar between students who experienced instructor led tabs with students who had peer-assisted lab sessions. Having instructors lead supplemental lab sessions is more effective than traditional SI, where a peer leads the study session. In addition, the cost for having instructors lead the sessions is less than half the cost for implementing SI.

Ferrell, D. K., Decrane, S. K., Edwards, N. E., Foli, K. J., & Tennant, K. F. (2016). Minority undergraduate nursing student success. *Journal of Cultural Diversity*, 23(1), 3-11.

Minority providers are more likely to practice in underserved areas with minority populations. Currently the representation of minorities in healthcare professions is less than that of the United States population. More research is needed to examine specific variables associated with educational success of minority students. Purpose: The purpose of this study is to examine, and increase the understanding of, current factors that influence success among ethnic and minority nursing students. Methods: The revised Minority Student Nurse Questionnaire (MSNQ) was utilized for this study with a sample of 31 students from 2 entry-level nursing programs in the Midwest. Results: Minority students were slightly older than traditional college students and consisted of African-American/Black, Native (American) Indian, Asian, Hispanic/Latino, and Hawaiian. Students reported multiple factors that influenced their higher education experience. Academic services and cultural organizations were available, free, but were used by less than half of the students. Several sources of financial assistance are important, including scholarships, federal subsidized and unsubsidized loans, and grants. Students most strongly disagreed with the statement that 'the number of minorities in this program is representative of the number of minorities overall.' Students felt that several services were supportive and helpful

strategies for success. Conclusion: Although progress has been made to improve success of minority students, numbers continue to lag between demographic population overall.

Fest, B., Beauchamp, L., Holladay, J., & Sparks, S. (1999). *The use of graduate students/experienced Supplemental Instruction (SI) leaders as SI supervisors*. Unpublished manuscript. The University of Texas at Austin. Austin, TX.

This manuscript describes the use of graduate students and experienced Supplemental Instruction (SI) leaders to serve as SI supervisors with the SI program at the University of Texas at Austin. An established SI program has a natural set of experienced SI leaders who can assume additional responsibilities within the program, thereby allowing the program to expand with the appropriate level of supervision. Extensive information is presented on how the SI program is supervised by both the professional as well as student paraprofessional staff.

Fest, B. J. R. (2000). The effects of Supplemental Instruction (SI) on student performance in a college-level biology course [Dissertation, The University of Texas at Austin, 1999]. *Dissertation Abstracts International*, 80(09), 3311.

This experimental study examined the effects of participation in a Supplemental Instruction (SI) program on student performance in a college level biology course. SI is an academic support program which incorporates study techniques into the framework of an academic course through discussion sessions. According to Blanc, DeBuhr, and Martin (1983) and Kenney (1988), students who experienced Supplemental Instruction had higher course grades, semester grade point averages, and rates of re-enrollment than did non-participants. The present study was conducted within the scheduled discussion sections of a large lecture class of biology for science majors ($n = 135$). The researcher and another graduate student conducted these discussion sessions in which half of the sections served as the SI treatment group and half of the sections served as the non-SI (traditional) control group. This design eliminated both time on task and motivation as potential contaminating variables. This posttest only, quasi-experimental design study uses a modified nonequivalent control group design. The academic performance of students who participated in SI discussion sessions was compared to the academic performance of students who participated in traditional review-type discussion sessions. Other research questions examined the interactive effect of SI on student performance with respect to SI leader experience, student ability level as measured by total SAT scores, previous academic success as measured by previous college GPA, and different cognitive level of examination questions. t-test and ANOVA statistical methods were used to analyze the data. The results of the t-tests to compare the means of the SI group to the non-SI group ($p < .458$) do not indicate any significant difference in the semester course scores between the two groups. Thus, the data did not show an overall effect of SI on student performance. The most important results obtained from this study are those with respect to the interactive effect of SI and student ability groups as measured by SAT total scores and prior college GPA. In this study the students in middle ability groups seemed to benefit more from SI than did the lower and higher ability students.

Finlay, K., & Mitchell, M. Z. (2017). *Evaluating the effectiveness of online vs. face-to-face Supplemental Instruction in introductory biology courses*. University of Regina. Canada. Available online: <https://www.uregina.ca/ctl/assets/docs/pdf/ptls-2015-2016/Finlay,%20Kerri%20-%20PTLS%20Final%20Report.pdf>

Our study found very little difference in the real and perceived differences when SI was offered live face-to-face, live online, and recorded online. Quantitative data: We found a significant positive correlation between students' final grades and their attendance at SI sessions of all types. In BIOL111, final grades were 5-6% higher for those students who attended more than 3 SI sessions (averaged 73% at both Regina and Saskatoon sites) compared to those who did not

attend any SI sessions (67% in Saskatoon and 68% in Regina). Similarly, in BIOL110, students who attended more than 3 online SI sessions received an average of 6% higher final grades (73% at both sites) compared to students who did not attend any SI sessions (67% at both sites). Surprisingly, even those students who only accessed recorded SI sessions received 4% higher final grades than those students who did not, at all sites. Qualitative data: overall, students were very positive about the benefits of SI, in any format. In the survey data, where “strongly agree” is coded as a 5, and “strongly disagree” is coded as a 1, the average responses to all of the questions ranged from 4.2 to 4.5 indicating high agreement with all statements provided. We did not find any difference in agreement with the statements when the SI was offered online vs. face-to-face, and students found many benefits even from accessing the previously recorded sessions.

Finney, J. E., & Stoel, C. F. (2010). Fostering student success: An interview with Julie Phelps, Virginia B. Smith Award Recipient for 2010. *Change*, 42(4), 38-43. At Valencia Community College, an overview of how SI operates at the college is provided.

Finney, K., Musil, O., Tram, A.-L., & Trescott, S. (2018). *Standard Operating Protocol Virtual Supplemental Instruction*. San Diego State University. San Diego, CA. Retrieved from <https://docs.google.com/document/d/1wqqrdsLTVRCStwutoLMWYCH2Xz8vznjU1OLm11Sx8/edit?ts=5c7fff6b#>

This document provides the procedures for conducting an online SI session and making it available for students to watch in the future. The Zoom software is used to record the online session. Extensive editing occurs afterwards of the video by breaking it into modules.

Fisher, J. E. (1997). Effects of Supplemental Instruction on undergraduate academic achievement, motivational orientation, and learning strategies [Dissertation, Auburn University, 1997]. *Dissertation Abstracts International*, 58(10), 3831A.

Examined in this dissertation study were the effects of participation in a Supplemental Instruction (SI) program on student academic achievement, motivational orientation, and learning strategies in a core psychology course at Auburn University. Participants in this study were 381 undergraduate students divided into one treatment and two comparison groups. Students in the treatment group participated in SI outside of regular class time once a week for 9 weeks. Both the treatment and comparison groups were administered four items: a course content knowledge pretest, the Halpin and Halpin Demographic Survey (1996), the Motivated Strategies for Learning Questionnaire (1994), and a course content knowledge posttest. Both the pretest and posttest were teacher-made tests assessing knowledge of course content. An initial cross-tabulation frequency distribution followed by a chi-square supported the assumption that the two groups were equal on course entry demographic variables. An analysis of variance (ANOVA) conducted with pretest scores revealed that there were no significant differences across groups in pre-entry content knowledge prior to the treatment. Once the study was completed, a multivariate analysis of variance (MANOVA) was conducted revealing that there were differences between the groups. On two variables, peer learning and help seeking, significant differences were found in favor of the SI treatment group. The groups did not differ on the other motivation and learning strategies subscales or on the posttest measuring academic achievement. Several research design features were unusual with this study. Most SI studies limit possible variables that might influence student achievement. Therefore, most research designs limit analysis to a single course, one course instructor, one SI leader, analysis of actual course grades, and provide no additional academic enrichment activities in the class. Numerous limitations were listed by the researcher in the dissertation. 1) The actual final course grades of the students were not used, but rather a teacher-made posttest that was one part of the final course grade. 2) To increase sample size, additional sections of the same course were added to

the study even though SI was not available to them and the course sections were taught by other professors who may employ different approaches to the curriculum, grading, and instructional delivery. 3) Ten SI leaders were employed in one course section. 4) All students in the course also participated in mandatory discussion sessions conducted each week. Fifteen graduate teaching assistants conducted these sessions in the three course sections. 5) All students who scored high on the course pretest were given an "A" final course grade and were dismissed from the course. This excluded their potential involvement in SI sessions and providing additional successful student modeling other than the SI leader. 6) Students were not allowed to attend SI sessions more than once a week. Students who needed additional help were denied the assistance. 7) Since the pre/post test was teacher-made, there is no way to judge its validity as an instrument. 8) The final exam was optional for students. If students already had an "A" average, they could skip the exam, therefore they were then excluded from the study. Students who needed a few points to earn a "B" only needed to correctly answer enough questions on the posttest exam to earn a "B" final grade, even though they might have earned a "D" or "F" on the final exam.

Fisher, M. (1988, 1988, September 23). UD "ringers" succeeding academically, *Dayton Daily News*, p. 3.

This newspaper article describes the use of Supplemental Instruction (SI) at the University of Dayton (OH)

Fitzgerald, N. (1997). The dropout dilemma. *Careers and Colleges Magazine*, 18(2), 14-17, 26. This article reviews the causes and cures for the high rate of college drop outs. The author interviewed a number of people for the article. One of those interviewed and quoted in the article is David Arendale, National Project Director for Supplemental Instruction (SI). Arendale describes how SI and its newest variation, Video-based Supplemental Instruction help students to integrate "what to learn" with "how to learn it"

Fjortoft, N., Bentley, R., Crawford, D., & Russell, J. C. (1993). Evaluation of a Supplemental Instruction program at a college of pharmacy. *American Journal of Pharmaceutical Education*, 57(3), 247-251.

The purpose of this study was to evaluate, in terms of improved final grades, the effectiveness of the Supplemental Instruction program with students enrolled in a required first year pharmacy course at the University of Illinois at Chicago College of Pharmacy. Regular SI attendance was found to be significantly and positively related to final course grades for minority students. The authors postulate that the SI program might have been more effective if the SI program had been started the first week of class rather than being delayed until the third week. An additional factor that may have diminished the statistical impact of the SI program was that funds were not available to hire additional SI leaders since the average SI attendance at every session through the academic term was 52. The authors speculate that smaller groups might have been more helpful than these large groups since students could have been more active and be able to vocally participate with others.

Fleet, T. (2017). *The relationship of locus of control and social learning on academic achievement in a Supplemental Instruction program*. (Ph.D. dissertation), Abilene Christian University, Abilene, TX. Available online:

<http://digitalcommons.acu.edu/cgi/viewcontent.cgi?article=1055&context=etd>

A large number of high school students entering college are arriving academically unprepared. Abilene Christian University's newly founded Bridge Scholars Program seeks to help and support academically at-risk students based upon low ACT/SAT scores and low high school GPA averages. This research utilizes the Supplemental Instruction program, (based upon

Bandura's social learning theory), as its academic intervention. The research questions are 1) How does Supplemental Instruction contribute to an at-risk student's college readiness (knowledge, skills, attitudes, behaviors and strategies)? And, 2) Does a student's internal or external locus of control predict academic performance? A pretest and posttest using Rotter's (1966) Internal-External Locus of Control Scale measured students' overall academic confidence. Class test scores, class final grades, and semester GPA were used to measure Supplemental Instruction program effectiveness. Although Locus of Control proved insignificant, test scores, final class grade, and overall semester GPA indicate that the Bridge Scholars program and Supplemental Instruction are highly effective interventions in better preparing at-risk students for the rigors of college level academia.

Flores, K. (2018). *Effect of Supplemental Instruction in a community college*. Paper presented at the 2019 Southern California Conference for Undergraduate Research. Available online: https://www.sccur.org/sccur/FALL_2018_CONFERENCE/MULTIDISC_TALKS/7/. Community colleges provide an accessible pathway to complete higher education for many students. Researchers found that within a cohort of nationally representative students who enrolled in postsecondary educational institutes, only 12% of those who first enrolled in public two-year institutions obtained a bachelor's degree within six years; however, 54% of students who were enrolled at four-year institutions had received their bachelor's degree within six years. This is troublesome, as within the California Community College System the majority of incoming students express interest in transferring but only 4% transfer within 2 years, 25% within 3 years, and 38% within six years. Some of the strongest positive predictors of transfer from a community college to a four-year institution include cumulative grade-point-average (GPA) and cumulative credits. Among community college students, remediation in math courses have a negative effect on bachelor's attainment. This may be a result of different academic and financial resources across community college campuses compared to four-year institutions. Supplemental Instruction (SI), created by the University of Missouri-Kansas, is a peer-led academic support program in which students participate in discussion groups outside of the class. SI has been consistently correlated with academic success across multiple disciplines including but not limited to Science Technology Engineering and Math (STEM), humanities, and social science courses. The current study examines the effect of SI in one community college. The effect of SI will be examined across different groups of students including disproportionately impacted students and first-generation college students. The effect of SI will also be examined across different courses, including remedial courses as well as STEM and non-STEM courses. Existing SI data is currently being analyzed.

Ford, N., Thackeray, C., Barnes, P., & Hendricks, K. (2015). Peer learning leaders: Developing employability through facilitating the learning of others. *Journal of Learning Development in Higher Education*, November. Available online: [http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path\[\]=373](http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path[]=373). Employability is a key theme in higher education and attitudes towards its development have shifted from a focus on technical skills development to a broader focus on values, intellect, social engagement and performance contributing to graduate identity (Hager and Hodkinson, 2009). Peer Assisted Learning (PAL) and Language Conversation Clubs are both examples of student-led peer learning schemes at Bournemouth University (BU), and are reviewed to explore the development of students employed to lead and facilitate group learning sessions. Data from four annual evaluation surveys (n=239) is reviewed in addition to qualitative comments and reflective writing. Peer leaders were found to have developed employability attributes including: leadership, time management and organisation, communication, and cultural awareness. Above all, peer leaders identified with developing confidence in their roles. Comments provided examples of student leaders who had actively selected peer learning as an

opportunity to develop their confidence and were able to transfer this to other academic and employment contexts.

Forester, J. P., Thomas, P. P., & McWhorter, D. L. (2004). Effects of four Supplemental programs on students' learning of gross anatomy. *Clinical Anatomy*, 17(4), 322-327. This article evaluated the effectiveness of Supplemental Instruction (SI) when adapted for use through four interventions: second-year medical student teaching assistant program, directed study program, weekly instructor laboratory reviews, and a web-based anatomy program. In each case participants in the adapted SI programs earned higher grades and self-reported higher levels of satisfaction when compared with nonparticipants.

Forson, L. (2000). *Supplemental Instruction: Can it work in outcomes-based education?* Vista University, Republic of South Africa. Available from the author at Vista University, Welkom Campus, PO Box 1881, Welkom 9460, FRSON-LF@weasel.vista.ac.za
The paper compares the basic tenets of Supplemental Instruction and Outcomes-based Education. Using the SI program at the Welkom campus of Vista University in the Republic of South Africa has been used for both raising student academic achievement as well as fulfilling outcomes-based institutional objectives. SI sessions can be intentionally designed to carefully augment and support instruction in the traditional classroom. The SI leader can ensure that students engage in meaningful work during SI sessions that relate to institutional mission.

Frans, P. (1997). *The development of Supplemental Instruction facilitators as skilled and confident leaders*. Unpublished manuscript. South African Association for Academic Development Conference. Broederstroom, Republic of South Africa.
This paper describes the use of Supplemental Instruction (SI) at Vista University-Mamelodi Campus (South Africa). In addition to fulfilling traditional SI program objectives, additional ones were a focus of this contextualization: providing feedback to the lecturer concerning student comprehension, thereby providing an opportunity to revise content delivery; give opportunity for students to use their first language rather than having all conversation occur in English; providing another venue for faculty development; and ensuring that all stakeholders -- students, course lecturer, SI Supervisor, and SI leaders -- work together to evaluate the SI program.

Frans, P. (1998). *Evaluation of the Supplemental Instruction (SI) programme implemented at a historically disadvantaged university*. Conference Proceedings of the South African Association for Academic Development Conference, Bloemfontein, Republic of South Africa.

Fredricksson, J., Malm, J., Holmer, A., & Ouattara, L. (2019). Does size matter? Attendance numbers at SI-sessions and how it affects learning conditions. *Journal of Peer Learning*. Available online: <http://lup.lub.lu.se/record/2e98ec4b-2093-49d8-965b-15de29afcd09>.
Supplemental Instruction (SI) is today a well-known academic support model to address retention and student performance in higher education. However, in studies reporting the effect of SI, the number of attendees at SI-sessions are seldom mentioned or reflected upon. This study investigates if there is a lower, optimal, and upper number of SI-attendees for SI-sessions with viable learning conditions. A literature review of 135 publications on studies of SI-programmes was conducted combined with a survey of 44 SI-leaders and 176 SI-attendees at Lund University in Sweden. The literature review shows that there is no consensus regarding minimum, optimum or maximum numbers for SI-session attendance size for viable learning conditions. In the survey, the number of attendees for optimal learning conditions was estimated to 11-12 by both leaders and attendees. These respondents also estimated that if the number of attendees is below 5 or above 16 students the learning conditions are likely to suffer. In the former case this is attributed to too little collective knowledge, too few viewpoints and a risk of

the SI-leader being too prominent (less active participants). In the latter case, attendees are likely to find the conditions noisy and feel that they do not get seen, while the SI-leader may have difficulties in obtaining a good structure in the session as well as getting an overview of the different group discussions. The results hint to the importance of reporting attendance numbers at an SI-session. Otherwise it is impossible for an outsider to determine if the conditions were favourable for small group learning and thus makes it hard to judge SI's effectiveness.

Fredriksson, J., & Lindberg, E. (2014). Does SI belong in lower secondary school? An exploratory pre-study in a Swedish socially challenged area. *Supplemental Instruction Journal*, 1(1), 54-71. Available online: <http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf>.

Supplemental Instruction has worked very well in various settings all over the world. It should be of interest to see if SI works at earlier stages than tertiary education. There are examples of successful SI programs at upper secondary schools, but no reports from lower secondary schools. This study evaluates a pilot SI program in a 7th and a 9th grade class in a socially challenged area with regards to the general impression of SI, development of study strategies and general skills, motivation for further studies, and whether lower secondary school students would be interested to be SI Leaders themselves and, if so, why. Overall, questionnaires and student interviews indicate that SI seems to work in all evaluation areas. However, further extensive research is needed, and the authors suggest future areas to focus on.

Frericks, K. (2006). *The relationship between Supplemental Instruction, course grade, and retention of freshman students*. (Master's of Science thesis), Minnesota State University Moorhead, Moorhead, MN.

Gaddis, B. A. (1994). The science learning center. *Education*, 115(2), 195-201.

This article describes the services provided by the Science Learning Center at the University of Colorado in Colorado Springs. The Center had three primary objectives: (1) to identify the mathematical, computational, and conceptual skills needed by science students; (2) to assist students to master basic conceptual, mathematical, and computational skills that are common to most science disciplines; and (3) to develop skills in the use of basic and specific laboratory instrumentation required in most science disciplines. To help meet the second goal, Supplemental Instruction (SI) was offered in connection with historically-difficult science courses (e.g., physics or organic chemistry). Research studies suggested that SI participants received higher mean final course grades. Since the Center's creation in 1992: the number of students enrolled in basic science classes increased by 12 percent; the number of declared science majors increased by 37 percent; 72.1 percent of students who used services from the Center received a grade of B- or better; cum GPA of students who used the Center's services had an average of 3.03 vs. 2.49 for those who did not; the rate of attrition of science classes dramatically dropped (e.g., Chemistry I, the rate decreased from 39.7 percent to 5.7 percent; Physics III, 16.5 percent decreased to 4.8 percent; Biology I, 16.7 percent decreased to 3.2 percent. SI was one component of a comprehensive Center that contributed to these positive outcomes.

Garcia, E. (2006). *Supplemental Instruction, study habits, and the community college student*. (Master's of Science thesis), Florida International University, Miami, FL.

The purpose of this study was to demonstrate if the academic assistance program Supplemental Instruction (SI) facilitates the acquisition of effective study behaviors through strategies that transcend simple double-exposure to the course material. Its advocates claim it increases academic achievement using learner-centered knowledge and acquisition of effective study behaviors. SI sessions are specifically related to particular courses that students are

taking. Sessions are facilitated by the SI leader who has taken the subject matter course in the past. Students review the content of the previous subject matter class using collaborative learning strategies coordinated by a SI leader. In addition, the SI leader models appropriate study behaviors in his or her interactions with the students. An instructor at a large Florida community college who taught five classes of an Anatomy & Physiology I course (traditionally supported by SI) was identified. Two of the classes were randomly selected to participate in SI activities, and two classes were random chosen to participate in alternate, computer-based activities that dealt with the course content, but did not include work in developing students' study behaviors. These treatments were carried out over the course of an entire semester. Participation was mandatory. Data were collected on two variables. Academic achievement in anatomy and physiology content was measured both pre- and post-treatment using an instructor developed examination. Student study behaviors were measured using pre- and post-treatment administration of the *Study Behavior Inventory*, a valid and reliable instrument that provides scores on three categories of study behaviors: (a) Academic self-efficacy, (b) Preparation for routine academic tasks, and (c) Preparation for long range academic tasks. Measures obtained at the end of the semester of treatment revealed no significant differences between the SI and alternative treatment groups in post-treatment achievement test score and the post-treatment scores on the three study behaviors categories when adjusted for pre-treatment scores. These results suggest that the development of appropriate study behaviors requires more time than SI, as it is now implemented, can provide. In addition, results indicate that improved academic achievement may be attained through any number of means that include repeated exposure to course material.

Gardiner, P., Corbett, B., & Palmer, P. (1994). Increasing student participation in the education of civil engineers. In J. Wallace (Ed.), *Kingston University HEFCE Supplemental Instruction Project: 1993-94* (pp. 237-241). London, England: Kingston University
Through use of Supplemental Instruction in the civil engineering courses at the University of Brighton (East Sussex, United Kingdom), improvement occurred in: student learning, self-motivation, and team work skills.

Gardiner, R. (1996). *Supplemental Instruction: A cost-effective, student-centered collaborative learning program*. Conference Proceedings of the Second International Open Learning Conference, Brisbane, Queensland, Australia.
This paper presented by Emeritus Professor Ron Gardiner of Queensland University of Technology describes the use of Supplemental Instruction (SI) in Australia. After an extensive description of the SI model, program benefits for the SI Leaders and the course instructors are described. Benefits to the SI Leaders include: deeper understanding of the course content; development of leadership and group facilitation skills; increased self-confidence; improved job marketability and admission to advanced graduate work due to service as SI Leader; development of professional relationship with course professor; membership in an effective peer support network; and modest financial reward. Benefits for the course professors that have SI attached to their lectures: timely feedback concerning the comprehension level of the students regarding course material; opportunity to repeat previous lecture material in a modified fashion to increase comprehension; an option to modify future teaching strategies based on feedback from students; a basis for accessing additional funds through grants (e.g., teaching and learning development grants); increased rapport with students and SI Leaders; membership in local, national and international SI network; increased recognition from their colleagues; and increased satisfaction with their teaching role. The institution benefits in several ways: deployment of a cost-effective, student-centered learning enhancement program; membership in national and international SI networks; and effective means of managing the collective learning power of its students.

Gardiner, R. (1997). *Comparison of costs and financial benefits of a Supplemental Instruction program*. Unpublished manuscript. Queensland University of Technology, . Brisbane, Queensland, Australia. Available from the author: Emeritus Professor R B Gardiner, Ph.D., SI/PASS Program Coordinator, Queensland University of Technology, GPO Box 2434 , Brisbane 4001, Australia, Tel: +61 (0)7 3864 2927, E-mail: rb.gardiner@qut.edu.au
This paper describes the benefits of the Supplemental Instruction (SI) program in terms of educational outcomes and financial benefits. The costs and benefits are based on implementation at higher educational institutions in Australia. Based on higher reenrollment rates of SI participants, the SI program increases revenue through savings from lost student fees and tuition. Preliminary data from Queensland University of Technology in Civil Engineering suggest an increase in 15 percentage points for reenrollment of SI participants. However, the financial equation model described in this paper is very conservative and only estimates a difference of 5 percentage points.

Gardner, J. F., Moll, A. J., & Pyke, P. A. (2005). *Active learning in mathematics: Using the Supplemental Instruction model to improve student success*. Conference Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition, Portland, Oregon.

Boise State University (Boise, ID) adapted the Supplemental Instruction (SI) program for use in mathematics called Active Learning in Mathematics (ALM). ALM was used to support courses in pre-calculus and Calculus II that serve as foundations for engineering programs. After starting as a program similar to the traditional SI model, ALM has added some new features: interact with students via Internet discussion rooms in addition to face-to-face group sessions; extensive training throughout the academic term; and interactions between ALM session facilitators and students via e-mails and phone calls. The results have been positive. While the academic preparation level of the entering students are lower than average, the academic achievement of the students is among the highest in the U.S. for engineering programs.

Garland, M. (Writer). (1992). *Supplemental Instruction: Interview with Deanna Martin and Robert Blanc [Videotape]*. In J. Connett (Producer). Kansas City, MO: National Diffusion Network, United States Department of Education

This videotape interview provides a historic overview of the Supplemental Instruction (SI) program. The creator of the SI program -- Deanna Martin -- and her husband Robert Blanc who customized the use of SI with medical students are interviewed in this program. Topics included: overview of the SI program; historical background of SI; typical activities in SI sessions; training of SI leaders; and suggested methods of evaluating the SI program.

Garland, M., & Anderson, J. (Writers). (1985). *Supplemental Instruction: The review session [Videotape]*. In M. Garland (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape provides a simulation of a Supplemental Instruction (SI) session in an economics class. A narrator guides the viewer regarding the activities of the SI leader and provides a debriefing of the SI session.

Garland, M., & Gordy, K. (1987). *Supplemental Instruction in the context of critical thinking*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO.

This manuscript describes how the Supplemental Instruction program can be used to promote critical thinking skills of students. This goal is supported through SI session activities. Independent thought is fostered through session strategies that require students to work privately before group discussions are facilitated. Creating a learning environment in SI

sessions where students feel comfortable to talk promotes active learning and vocalizing of ideas. A third component needed by critical thinking proponents is "reflection" when students begin to understand their own thinking processes. SI sessions focus not only on the course content, but also on the process of learning and thinking about it. The SI leader vocalizes when they are thinking about as they consider the material and solving the problems. SI participants are also encouraged to vocalize their thinking process and their uncertainties as well.

Garland, M., & Gordy, K. (Writers). (1989). National teleconference on Supplemental Instruction [Videotape]. In J. Connett & C. B. J. (Producer). Kansas City, MO: United States Department of Education, National Diffusion Network

This live national teleconference featured an overview of the Supplemental Instruction (SI) model. Also included were interviews with SI leaders and faculty members who had SI attached to their classes. A live call-in portion of the teleconference permitted members of a national audience to call in with questions.

Garland, M., & Jamerson, L. (Writers). (1988). Supplemental Instruction: A validated model of student academic support [Audio cassette], *The 1988 National Conference on Higher Education, Washington, D.C.* Glendale, CA: Mobiltape Co.

Taped at the 1988 National Conference on Higher Education in Washington, D.C., two experts from the Supplemental Instruction (SI) program at the University of Missouri-Kansas City discuss their experience with SI, a nonremedial model of student academic assistance that targets historically-difficult courses rather than high-risk students. They provide an overview of the model and its use with a variety of student subpopulations.

Garland, M., Minkoff, D., & Zerger, S. (Writers). (1995). The use of Supplemental Instruction in small classes and small colleges [Videotape]. In D. Arendale (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape records a panel discussion regarding the advantages and challenges of Supplemental Instruction (SI) in small classes and colleges. Some of the issues included: locating SI leaders; cost effectiveness in small classes; networking with faculty members; and the use of SI in quarter and semester terms. The panelists are campus SI supervisors as well as Certified Trainers with the SI program.

Garvin, A., & Snyder, D. (2001). MASH (Math and Science Help): Supplemental Instruction at a technical university. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student-assisted teaching: A guide to faculty-student teamwork* (pp. 82-86). Bolton, MA: Anker Publishing Company. Available online: ERIC database. (ED449713).

This chapter describes the use of Supplemental Instruction (SI) at Worcester Polytechnic Institute (WPI) located in Worcester, Pennsylvania. WPI is the nation's third oldest private engineering college. The name given to the Supplemental Instruction (SI) program is MASH (Math and Science Help) for purposes of marketing to students and faculty members. The focus of MASH was with students enrolled in Calculus I and II, Physics I and II, and Chemistry I and II. Data from a Fall 1999 study suggested higher final grades for the MASH attendees in comparison to nonattendees. Based on student utilization, the program appears to be cost effective since the unit cost of offering MASH to a student is approximately \$24 annually.

Gattis, K. W. (2000). Long-term knowledge gains due to Supplemental Instruction in college chemistry courses. *Journal of Research and Development in Education*, 33(2), 118-126.

This article examined the effectiveness of a Supplemental Instruction (SI) program for undergraduate chemistry courses at North Carolina State University (Raleigh, NC). The SI program was evaluated through the effects of academic preparation, fall SI attendance, and

spring SI attendance on spring chemistry grades. In Experiment #1, 437 undergraduate students were enrolled in Chemistry I in the fall semester and Chemistry II in the spring; results show that SI exerted a significant positive effect on spring course grade. Following changes made to the Chemistry I course, 148 students in Experiment #2 proceeded from fall Chemistry I to Chemistry II or Organic Chemistry I in the spring. Results show that those attending SI in both fall and spring semesters obtained the highest grade scores in the spring term. Findings suggest both short-term and long-term benefits of SI attendance. SI sessions can enhance long-term retention of concepts, improve problem-solving skills, and build conceptual frameworks for future learning.

Gattis, K. W. (2002). Responding to self-selection bias in assessments of academic support programs: A motivational control study of Supplemental Instruction. *The Learning Assistance Review*, 7(2), 26-36.

A motivational control study of students participating in Supplemental Instruction (SI) sessions in college chemistry at North Carolina State University showed that participants benefit from SI sessions to an extent that cannot be explained by their higher levels of motivation. Motivation is shown to be an important factor in grade performance whether students use SI or not. Actual SI attendance is shown to provide additional grade benefits. Students who had initially indicated high motivation to attend SI and attended SI four or more times during the academic term earned statistically significantly higher final course grades than similar students who attended SI between one and three times or students who were highly motivated but did not attend SI. The highly motivated students who attended SI four or more times earned dramatically higher grades than students who were not highly motivated and did not attend SI. The effectiveness of SI is thought to be due to enhanced interactivity. SI provides students with a productive hour of learning, featuring a psychologically safe environment for asking questions and opportunities for guided practice.

Geerlings, P. M., Cole, H., Batt, S., & Martin-Lynch, P. (2016). Peer Assisted Study Sessions (PASS): Does gender matter? *Journal of Peer Learning*, 9(1), article 3. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1108&context=ajpl>.

Peer-learning is an effective way to assist students to acquire study skills and content knowledge, especially in university courses that students find difficult, and it is an effective adjunct to improve student retention. In 2014, Murdoch University in Perth, Western Australia, commenced Peer Assisted Study Sessions (PASS) in two first-year undergraduate subjects: a mathematics (statistics) unit and a business unit. The key finding in this evaluation was that while female mathematics students improved their final marks in response to attending a greater number of sessions per semester, male students achieved lower final marks on average. Although several studies have shown that in PASS-like programs gender tends to not be a significant factor relating to achievement, our results suggest otherwise. In this article we posit the observed differences in achievement attributed to gender arise from complex gender-related issues, including gender stereotypes, student gender ratios in class, the gender of the teacher relative to the gender of the student, and gender-related motivation, engagement, and subject choice.

Geller, L. K. (2004). *A description, comparison, and contrast of postsecondary developmental mathematics programs in North Dakota*. (Ph.D. dissertation), Montana State University.

Postsecondary developmental education is prevalent in higher education. In North Dakota and the rest of the nation, mathematics required remediation more often than any other subject. The literature has identified practices that contribute to successful developmental education, but it was not known if postsecondary developmental educators used these practices. In response to the above issues, this study did three things: (1) described developmental mathematics

education at six of the eleven public postsecondary institutions in North Dakota; (2) compared each institution's policies, organizational and instructional characteristics to "best practice" in developmental education; and (3) contrasted the practices of the programs across institutional types. Data were collected from interviews with instructors and directors of the developmental mathematics programs, observations of developmental mathematics classes, developmental mathematics grade distribution data, and course syllabi. Findings from the study include the use of mandatory assessment at all institutions but a lack of mandatory placement except at one institution. None of the programs had clearly defined and stated program goals, but most course syllabi included course goals or objectives. None of the programs were regularly and systematically assessed and evaluated. Developmental mathematics instructors were usually adjuncts or lecturers with bachelor's or master's degrees. They had few faculty development opportunities, and some were not included in their department's planning and decision-making activities. All programs used some form of technology but to differing degrees, and most programs intended to align developmental math courses with future courses. Tutoring was the main support service available to students, except at one institution. This institution had a successful cohort program for underprepared students that included Supplemental Instruction.

Gentner, N. (1997, 1997, April 22). Queensland University of Technology to push Supplemental Instruction in local units, *Inside QUT (Queensland University of Technology Newspaper)*, p. 11. This newspaper article contains an interview with Kathy Phillips, Supplemental Instruction campus coordinator from The University of Missouri-Kansas City who was spending an academic term at the Queensland University of Technology (Australia). The SI program was started at QUT by Professor Ron Gardiner, then Associate Pro-Vice-Chancellor (Academic) in 1992. At present SI is offered to 1,000 students in 12 course units in four faculties.

Ghazali, R., & Ali, M. C. (2015). Peer-assisted learning program: A creative and effective learning approach at higher education. *Journal of Applied Environmental Biological Science*, 4(10), 39-44.

The primary purpose of this article is to review the effect of Peer-Assisted Learning (PAL) program on higher education. Thus, this paper tries to explain the educational theories and concepts which support the effectiveness of the program. It also to identify the benefits and shortcomings of the program to the students who participated in the program based on the existing researches and experiences of some universities which had undertaken the schemes. The review is expected to highlight the best practices of PAL program adopted by universities. Lastly, recommendations from previous researches for a successful implementation of PAL were taken that to be used in the implementation of the program in the university, particularly for the accounting faculty.

Gibbon, M., & Saunders, D. (1998). Peer tutoring and Peer-Assisted Student Support: Five models with a new university. *Mentoring & Tutoring*, 4(3), 165-176. Peer-Assisted Student Support (PASS) is based upon Supplemental Instruction (SI) and is the predominate name used in the United Kingdom. This article provides an overview of PASS.

Gilinsky, R. (1985, 1985, October 20). Extra effort, *New York Times Newspaper*, p. 3. This newspaper article provides an overview of the Supplemental Instruction (SI) program at the State University of New York at Purchase. The SI program is funded through a grant from the Xerox Corporation.

Gill, D., Parker, C., Spooner, M., Thomas, M., Ambrose, K., & Richardson, J. (2006). Tomorrow's doctors and nurses: Peer assisted learning. *The Clinical Teacher*, 3(1), 13-18. Available online: <http://www.theclinicalteacher.com>.

This article describes the use of Peer Assisted Learning (PAL) in the United Kingdom to improve achievement for health science students at the Royal Free and University College London Medical School and the School of Health and Social Sciences at Middlesex University. PAL is based upon the Supplemental Instruction (SI) model. Senior nurses served as the PAL leaders for the first-year students. Outcomes for the PAL leaders included gains in confidence, knowledge of the subject material, gains in teaching and clinical examination skills, and an opportunity to enhance interprofessional relationships.

Gill, M., & McConnell, C. (2016). "What's in it for me?" - An investigation into the motivations, challenges and benefits of peer leadership in a School of Education. *Student Engagement and Experience Journal*, 5(1). doi: 10.7190/seej.v4i1.117. Available online: <http://research.shu.ac.uk/SEEJ/index.php/seej/article/view/117/pdf>.

This case study of practice provides an account of an academic peer-learning scheme in a university School of Education in the South of England. The significance of this case study is to provide insights specifically into the experiences of undergraduate peer leaders. The scheme is called PASS (Peer Assisted Study Sessions), and is a nationally recognized student-led mentoring scheme involving trained student volunteers from levels five and six (second and third year) facilitating weekly study sessions for level four (first year) students. Through the voices of seven student PASS leaders, this small-scale study employed a qualitative approach using a focus group to explore leaders' motivations, and to enable a discussion of the benefits and challenges they experience through leadership. The findings also reveal the leaders' awareness of their growing confidence, communication and employability skills development, particularly pertinent for Education students in relation to their future career paths in teaching and learning settings.

Ginns, I. S., & Watters, J. J. (1995). *Final Report of Peer Assisted Study Sessions in Science Foundations MDB303*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This report describes the use of Peer Assisted Study Sessions (PASS) with students at Queensland University of Technology (Brisbane, Queensland, Australia). PASS is the term used at the institution for Supplemental Instruction (SI). Students enrolled in the Primary and Early Childhood strands of the preservice Bachelor of Education program are required to undertake basic studies of science in their first year. This core unit (Science Foundations - MDB303) was the course proposed for PASS. The performance of the students were examined on a 1 to 7 scale (1 to 3=fail, 4=pass, 5=credit, 6=distinction, 7=high distinction). The PASS group earned a statistically significant ($p < .01$) higher mean final course grade of 4.88 as compared with 4.15 for the non-participants. No PASS participants earned a failing grade while 8 of the non-participants did so. The PASS group earned grades of distinction or high distinction 66 percent of the time compared with 28 percent for the non-participants. Interviews with PASS participants identified the following changes: more thorough understanding of scientific concepts; identified ways of engaging the course content; study methods improved; established more consistent study times; attitudes towards science improved; and overall confidence increased. PASS leaders mentioned the following changes for themselves: increased confidence in teaching skills; enjoyed working in groups.

Ginty, C., & M, H. N. (2014). The first year experience of a peer assisted learning program in two institutes of technology in Ireland. *Journal of Peer Learning*, 7(1), 36-56. Available online: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1062&context=ajpl>.

This paper describes a collaborative action research study in which peer assisted learning was deployed simultaneously across a range of disciplines in two institutes of technology in Ireland. The aim of the research was to determine if peer assisted learning enhances the learning

experience of first year participants. An action research approach was selected and involved three phases between 2009 and 2011. The implementation of each phase was informed by a review of the previous phase. The third phase also incorporated the rollout and evaluation of a new peer assisted learning student leadership module (an elective 5 ECTS European Credit and Accumulation Transfer System) in both institutes. This paper focuses on both quantitative and qualitative data from the first year experience student survey, which was designed and deployed in phase one and repeated in phase two. The survey is supplemented by data from focus groups with student leaders and session reviews. Qualitative data was analysed using both the constant comparison method and text analysis. Our findings illustrate the challenges associated with implementing and embedding a long-term peer assisted learning program as part of the first year student experience. In addition, we found wide ranging benefits for the two institutes of technology that collaborated on the development, rollout, and evaluation of the program. An evidence based model emerged, which involved a partnership between management, academic staff, student services, and learning and teaching advocates. These partners continue to work together to sustain the program.

Glesner Fines, B. (2003). *Structured Study Groups at the University of Missouri-Kansas City School of Law*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.law.umkc.edu/faculty/profiles/glesnerfines/SSG.html>

This short abstract describes the adaptation of the Supplemental Instruction (SI) program for use at the School of Law at the University of Missouri-Kansas City. The SI program is called the Structured Study Groups.

Goldstein, J., Sauer, P., & O'Donnell, J. (2014). Understanding factors leading to participation in Supplemental Instruction programs in introductory accounting courses. *Accounting Education: An International Journal*, 23(6), 507-526. doi: doi:10.1080/09639284.2014.963132.

Although studies have shown that supplemental instruction (SI) programs can have positive effects in introductory accounting courses, these programs experience low participation rates. Thus, our study is the first to examine the factors leading to student participation in SI programs. We do this through a survey instrument based on the Theory of Planned Behavior. Our study shows that students' attitudes toward the sessions affect their intent to participate in them. This attitude is influenced by students' perceptions that the sessions can help them in various ways. Results also show that influential others can influence student intent to participate in SI sessions. We also note that students' perceptions of the amount of personal control that they have over going to SI sessions have no effect on their participation in the sessions. We discuss how these findings can be leveraged to increase SI participation rates.

Goomas, D. T. (2014). The impact of Supplemental Instruction: Results from an urban community college. *Community College Journal of Research and Practice*, 38(12), 1180-1184. doi: 10.1080/10668926.2013.854182.

Supplemental Instruction (SI) is an academic support program consisting of a series of free, voluntary based weekly study sessions for students taking historically difficult courses. SI is designed to increase student retention and academic performance. Whereas Hensen and Shelley (2003) examined SI impact at a large public midwestern university, this study examined a newly implemented SI at an urban community college in downtown Dallas, Texas. General psychology students who regularly attended SI study sessions had an 83% success (final letter grade of A, B, or C) rate compared to 64% for students who did not participate. To further increase overall success, an early alert warning system within the Blackboard™ learning management system was set up to track each student's performance in the event students started to fall behind in assignment completion. In that case, the student was placed in the SI

study group. Additionally, this study examined the SI leaders themselves by tracking their academic and professional activities.

Goomas, D. T., & Isbell, T. (2014). The challenges of institutional research in building a culture of evidence: A case study. *Community College Journal of Research and Practice*, 39(5), 489-494.

The process of building a culture of evidence involves using data to understand where students are experiencing problems, designing strategies for remedying those problems, implementing them, and then evaluating the effectiveness of those implemented strategies. This case study is about two programs that were implemented within the last two years at El Centro College of the Dallas County Community College District—in-class instructor-guided service learning and supplemental instruction—and the challenges in institutional research in building a culture of evidence. Both programs showed significant improvement in their respective measurements for general and developmental psychology classes. However, without an easy-to-use data collection, central repository, and analysis system, conducting the kind of institutional research that could inform improvements to program and institutional performance can be quite difficult. Across the institution, data entered at different times by multiple departments and the difficulties in extracting data from multiple systems were the major impediments to collecting standardized data.

Gordy, Z. K. (1987). *Supplemental Instruction in the context of critical thinking*. Conference Proceedings of the Intellectual Skills Development Association Conference, San Diego, CA. This paper describes the use of Supplemental Instruction (SI) to increase the level of critical thinking by students enrolled in historically difficult college courses.

Gordy, Z. K., & Garland, M. (1987). *Improving college-level thinking through Supplemental Instruction*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO. The authors describe the use of Supplemental Instruction (SI) to increase the level of thinking by college students. Since SI sessions incorporate a reflective approach to learning, the SI leader creates an environment for students to increase their level of critical thinking. Not only do the SI sessions focus on review of course content, but also through active discussions, students become more aware of their own thinking process.

Gravina, M. (1990). *Supplemental Instruction: A continuation of the goals of the Freshman Year Experience*. Conference Proceedings of the Freshman Year Experience Conference, Austin, TX.

This article provides an overview of the Supplemental Instruction program.

Gravina, M. (1990). *Supplemental Instruction and enhanced performance in social science classes*. Paper presented at the National Social Science Association, Louisville, KY.

This article provides an overview of the Supplemental Instruction (SI) program.

Gravina, M. (1990). *Supplemental Instruction: A collaborative experience*. Paper presented at the Southeastern Conference on At-Risk Students, Savannah, GA.

This article provides an overview of the Supplemental Instruction (SI) program.

Gravina, M. (1990, 1990). *Supplemental Instruction: Success with diverse student populations*. Conference Proceedings of the Conference Proceedings of the Minority Student Today Conference, San Antonio, TX.

This article provides an overview of the Supplemental Instruction (SI) program. Data suggests that the SI program is helpful for all students, regardless of their ethnic background or previous levels of academic preparation.

Gravina, M. (1991). Supplemental Instruction: SI for "at-risk" courses. *Freshman Year Experience Newsletter*, 3(4), 8.

This newsletter article provides an overview of the Supplemental Instruction (SI) program.

Gravina, M. (1991, 1991). *Supplemental Instruction: A continuation of the goals of the Freshman Year Experience*. Conference Proceedings of the Proceedings of the Freshman Year Experience Conference in Kansas City, MO, Kansas City, MO.

This article provides an overview of the Supplemental Instruction program.

Gravina, M. (1991, 1991). *Supplemental Instruction: A continuation of the goals of the Freshman Year Experience*. Conference Proceedings of the Proceedings of the Freshman Year Experience Conference in Long Beach, CA, Long Beach, CA.

This article provides an overview of the Supplemental Instruction program.

Gravina, M. (1991). *Supplemental Instruction: A continuation of the goals of the Freshman Year Experience*. Conference Proceedings of the Freshman Year Experience Conference, Tampa, FL.

This article provides an overview of the Supplemental Instruction program.

Gravina, M., & Adams, B. (1991). Supplemental Instruction: Integration of approaches to help high-risk students *Youth at-risk: A resource guide* (pp. 67-74). Lancaster, PA: Technomic Publishing Company, Inc.

The book chapter describes the use of Supplemental Instruction (SI) to assist students who have been predicted to be of academic risk at the institution.

Green, D. (1990). Student mentors fight departmental attrition. *Academic Leader: The Newsletter for Academic Deans and Department Chairs*, 6(3), 2.

This newsletter article provides an overview of the Supplemental Instruction (SI) program. In addition to comments from SI's creator, Deanna Martin, it also provides a quotation from Professor Lowell Orr at Kent State University who is using SI in his two biology courses. Orr supports the SI program since the SI leaders help participants to develop their own problem-solving skills.

Green, J. L. (2017). Peer support systems and professional identity of student nurses undertaking a UK learning disability nursing programme. *Nurse Education in Practice*. doi: 10.1016/j.nepr.2017.11.009.

This practitioner based action research examines the implementation of the peer assisted study scheme (PASS) and individual peer mentoring in a cohort of first year undergraduate nursing students. It arose out of the desire of a small number of students in one UK university to transfer from the learning (intellectual) disabilities nursing field to other fields. The number of learning disabilities nurses is falling in England, and nursing shortages and student nurse retention generally is an international concern. The peer support was evaluated by 21 completed questionnaires. All the students had found the sessions they attended useful. Four themes emerged from the study. Students reported gains in knowledge around academic skills, placements and their chosen field of nursing; students felt more confident as a result of attending the sessions; students felt supported, and the importance of the peer mentor's

interpersonal skills was highlighted; and finally students had valued meeting other students in their chosen field. These findings are discussed with reference to relevant literature.

Grier, T. (2004). Supplemental Instruction and noncognitive factors: Self-efficacy, outcome expectations, and effort regulation. *The Learning Assistance Review*, 9(2), 17-28.

The study reported in this articles examined the relationship between Supplemental Instruction (SI) and noncognitive factors such as self-efficacy, effort regulation, and outcome expectations. The student population studied were first-year TRiO students who participated in SI for two semesters, those who participated for one semester, and those that did not participate in any SI. The MSLQ instrument was used to gather data from the students. The results of the study did not reach statistical significance. The researcher speculated that it may have been due to a lack of sensitivity by the MSLQ instrument for the study, the other variables at work within the lives of the students, or other causes. Since other studies have reported some impact of SI with noncognitive variables (see Visor publications), this area warrants further review and research.

Grillo, M. C., & Leist, C. (2014). Academic support as a predictor of retention to graduation: new insights on the role of tutoring, learning assistance, and Supplemental Instruction. *Journal of College Student Retention: Research, Theory and Practice*, 15(3), 387-408.

This study examined the relationship between the long-term use of academic support services such as tutoring, learning assistance, and Supplemental Instruction and retention to graduation. Little research has been devoted to the relationship between academic support and retention to graduation in both the literatures on retention and academic support. The authors use 6 years of data from the University of Louisville's Resources for Academic Achievement unit (REACH) to test the hypotheses that a larger quantity of time spent engaged in academic support services is associated with a higher likelihood of graduation and that cumulative GPA mediates the relationship between hours spent using academic support and graduation. The findings support these hypotheses, suggesting a relationship between academic support and retention to graduation that should be given serious consideration by scholars and administrators. Students' active engagement in academically focused sessions with their peers serving as tutors, LA and SI leaders may have provided multiple benefits. For example, not only did these interactions help students understand or clarify difficult concepts in a content course, but additionally, these interactions may have improved the motivation to learn, the understanding of the process of learning, and the development of study strategies. Each of these factors could be future avenues of additional research focused on the relationship of academic support and retention. Regardless of which benefit may have most assisted students who used academic support services, this engagement outside of the classroom seems to have contributed to their academic or social integration to the extent that these students were more successful in their courses as evidenced by earned GPA which then contributed to their retention at the university. The results of this study suggest that the positive impact of this engagement with academic support services was long-term and associated with graduation. This study also found the quantity of hours spent in academic support was related to students' mean GPA, where more tutoring hours led to higher GPAs which then led to a higher likelihood of graduating. This evidence supports the pragmatic advice frequently given by academic support professionals who emphasize, especially to first-year students, the benefits of engaging in academic support services early and often during the semester. Higher GPA has been associated with college graduation in previous research studies and is commonly acknowledged (Harackiewicz, Barron, Tauer, & Elliot, 2002; Ishitani, 2003). The data analysis for this study offers additional evidence for this claim. The higher students' earned GPA, the more likely the students were to graduate. As mean GPA increased, the likelihood of graduating increased. For this study, students who maintained higher GPAs engaging in academic support services may have improved their confidence in their own ability to learn or contributed to developing a sense of empowerment or

self-efficacy necessary for college success. A last finding of this study suggests that traditional predictors of college readiness (high school GPA and standardized test scores, e.g., ACT or SAT scores) did not have a statistically significant relationship to the likelihood of students' graduating. This finding supports other retention research which suggests the complexity of identifying the components necessary to predict college success beyond those academic skills measured by high school grades and standardized test scores at the time of admission (Geiser & Santelices, 2007; Pascarella et al., 2006).

Grimm, J. L. (2019). *Supplemental Instruction, calibration, and self-efficacy: A path model analysis*. (Ph.D. dissertation), Old Dominion University. Available online:

https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1203&context=efl_etds

Many students preparing for careers in the fields of science, technology, engineering, and mathematics (STEM) are unable to persist past entry-level courses to complete their college degrees. As a result, many higher education institutions have implemented intervention programs, like Supplemental Instruction (SI), to help students master course content and gain the self-regulated learning (SRL) behaviors necessary for success in challenging STEM courses. Numerous studies have demonstrated that SI attendance is correlated with improved course grades; however, few studies have examined the effect of SI attendance on students' SRL behaviors, like self-efficacy and calibration, which may explain students' academic achievement throughout college. The present study examined if students' pre-existing self-efficacy beliefs and calibration accuracy predicted their decisions to attend SI. In addition, the study explored if SI attendance had a direct effect on students' final self-efficacy, calibration, and course grades. Students in a fall semester general biology course for science majors were invited to participate in the study, and 320 students completed the pre- and post-test survey. The surveys measured beginning and final self-efficacy using the Academic Efficacy Scale from the Patterns of Adaptive Learning Scale, and calibration was measured by asking them to predict their first and final exam scores. A path model was analyzed in Mplus via robust maximum likelihood estimations using pre- and post-test results and students' total SAT scores, SI attendance, and final course grades. The results indicated that participants with lower self-efficacy were more likely to attend SI; however, students' beginning calibration accuracy did not predict their SI attendance. Findings also indicated that SI attendance did not predict final self-efficacy or calibration accuracy, but attending SI had a modest, direct effect on participants' final course grades. Final self-efficacy and calibration accuracy also predicted final course grades. The results of this study demonstrate a need to explore additional SRL variables that may be influenced by SI. In addition, the present study validates the value of SI as an academic support program to raise course grades. Finally, potential course-level instructional strategies are offered for improving students' self-efficacy and calibration accuracy to support STEM degree persistence.

Grise, D. J., & Kenney, A. M. (2003). Supplemental Instruction in biology. *Journal of College Science Teaching*, 33(2), 18-21.

This article examines the use of Supplemental Instruction (SI) at Southwest Texas State University in a three-credit nonmajors biology course without a lab during 2000 BS 2001. Data were analyzed by ANCOVA with their grade point average used as the covariate. The researchers noticed differences in student performance based on the size of the class lecture with less participation in the larger class. It was noted that SI attendance was quite low for the participants with a common attendance pattern of only once during the academic term. The class instructor chooses to make SI attendance voluntary, but shares data studies on the effectiveness of SI with the students with the hope of motivating their participation.

Grizzard, J. R. (2019). *The impact of Supplemental Instruction in higher education*. (Master of Science), California State Polytechnic University, Pomona, CA. Available online: https://broncoscholar.library.cpp.edu/bitstream/handle/10211.3/211235/GrizzardJasmine_Thesis2019.pdf?sequence=3

The purpose of this Applied Public Administration Project is to evaluate the need of student support in courses most commonly failed by students at California State Polytechnic University, Pomona. The Learning Resource Center (LRC) at CPP is currently piloting a Supplemental Instruction program. Using the CSU Dashboard to determine which classes have the highest D, F, W rates. The LRC has reached out to the departments of those particular courses and offer extra support for students enrolled in that class. This program is designed to create independent learning by using learning strategies that require students to think for themselves and look to their classmates for help. This project consists of analyzing data of current student grades that attend SI sessions versus students that do not attend SI sessions to determine the outcome of whether or not the program is successful. The data were analyzed by the following measurements: 0 sessions attended, 1-4 sessions, 5-9, and 10 +. This will allow the LRC and CPP to determine if the students of highly difficult courses at CPP need Supplemental Instruction. The purpose of this project is to perform an evaluation of the Supplemental Instruction pilot for trigonometry (MAT 1060) courses at CPP. A proposal composed of data and research of the benefits SI has in influencing the decrease in D, F, W rates. This document will be used to help improve the SI program at Cal Poly Pomona. Although the results were not conclusive in proving how affective the SI program was. The GPA of those that attended SI sessions gradually increased the more sessions that were attended beginning from 1 -10. There were several factors that needed to be taken into consideration in proving if the program was successful. As mentioned in the "Findings" portion, the measure of success is dependent on the individual student. It can be proposed that the type of students attending our pilot program were on the verge of failing but instead passed the course with a letter grade of "C" or higher.

Guarcello, M. A., Levine, R. A., Beemer, J., Frazee, J. P., Laumakis, M. A., & Schellenberg, S. A. (2017). Balancing student success: Assessing Supplemental Instruction through coarsened exact matching. *Technology, Knowledge, and Learning*.

Supplemental Instruction (SI) is a voluntary, non-remedial, peer-facilitated, course-specific intervention that has been widely demonstrated to increase student success, yet concerns persist regarding the biasing effects of disproportionate participation by already higher-performing students. With a focus on maintaining access for all students, a large, public university in the Western United States used student demographic, performance, and SI participation data to evaluate the intervention's efficacy while reducing selection bias. This analysis was conducted in the first year of SI implementation within a traditionally high-challenge introductory psychology course. Findings indicate a statistically significant relationship between student participation in SI and increased odds of successful course completion. Furthermore, the application of Coarsened Exact Matching reduced concerns that increased course performance was attributed to an over-representation of higher performing students who elected to attend SI Sessions.

Guinane, J. M. (1991). *The impact of Supplemental Instruction on the academic performance of "at-risk" students*. (Master's of Arts in Education thesis), Gratz College, , Melrose Park, PA.

Gunning, F. (1993). Supplemental Instruction is not teaching. *The Lecturer (The University & College Lecturers' Union)*, 2.

This article describes how Supplemental Instruction (SI) is not used as a replacement for teaching by course instructors. The author is a professional tutor at Kingston University in England and is a member of the teacher's union. The author describes the unique benefits that

SI provides for students: peer support; modeling of study strategies; focuses on learning, not teaching. Faculty and tutors that have SI attached to their courses are supportive of the SI program since it provides different services to students than what they provide. They see no conflict in the roles.

Guyon, A., Butterfint, Z., Lacy, A., Sanosi, A., Sheridan, K., & Unwin, J. (2015). Speech and language therapy students' experience of Peer Assisted Learning: Undergraduates investigate PAL as a means of enhancing academic and professional development. *Journal of Learning*. Available online: https://ueaeprints.uea.ac.uk/55820/1/PAL_Project_FINAL.pdf.

The implementation of Peer Assisted Learning (PAL) on healthcare courses in Higher Education Institutions has been explored in a number of studies. This paper presents research into the experience of PAL on a BSc Speech & Language Therapy (SLT) programme. The research was conducted by final year undergraduate SLT students to form the basis for their final dissertations. The focus for their research was on the effects of PAL on academic and professional development for both mentees and mentors on the same course. Data were generated from standard PAL evaluations and focus groups. Findings indicate that mentees benefit from PAL in terms of their university experience and learning. Mentors benefited from opportunities to develop and practice skills for their future employment. Engagement with PAL is attributed to its structured yet informal nature and the enthusiasm of the mentors. However, the collaborative nature of PAL take time to develop, impacting on the behaviours of both mentees and mentors. Overall PAL offers mentees and mentors opportunities which enhance their academic learning and professional development.

Habley, W. R., & McClanahan, R. (2004). *What works in student retention?* American College Testing, Inc. Iowa City, IA. Available online:

<http://www.act.org/path/postsec/droptables/pdf/AllColleges.pdf>

This followup to the classic 1980 and 1987 reports is a comprehensive national study of college student retention practices. Eighty-two academic intervention strategies were analyzed for their potential impact on student persistence. The top five strategies were: freshman seminar, tutoring programs, advising interventions, mandated course placement testing program, and comprehensive learning assistance center. Among learning support activities, Supplemental Instruction was a significant factor.

Hafer, G. R. (2001). Supplemental Instruction in freshman composition. *Journal of Developmental Education*, 24(3), 30-32, 34, 36-37.

In the past, Supplemental Instruction (SI) has been underutilized in freshman composition courses particularly because of misperceptions regarding the nature of composition and the notion that the writing laboratory provides the only needed assistance programs. This article examines those assumptions and explores how success is measured in the composition classroom. It argues that the goals and method of freshman composition and SI are complementary. The conclusion outlines a pilot SI program, modified for a freshman composition classroom, that supports writing strategies and appropriate behaviors for students.

Hakizimana, S., & Jurgens, A. (2013). The Peer Teaching/Learning Experience Programme: An analysis of students' feedback. *Alternation Special Edition* 9, 99-127.

Freire's views on the dialectical nature of teaching and learning inspired a group of postgraduate students who had previously been involved in facilitating Supplemental Instruction (SI) but observed low student participation. After reflecting on their own experiences the group initiated a discussion forum for first year biology students with the aim of transforming student learning from a relatively passive experience to an active, engaging process. In contrast to the SI programme Peer Teaching/Learning Experience Programme (PTLEP) sessions were

characterized by large student numbers per session (100 to 300), a much longer duration (up to 3 hours), and they were conducted at weekends or after hours. Furthermore sessions were offered only close to exams and tests with two sessions per test and three sessions per exam. In the PTLEP tutorials, facilitators guide the process and make comments, but only after the students themselves have made suggestions on how to answer questions correctly. Records from the attendance registers, evaluation questionnaires given to a sample of students attending the programme, and video recordings of sessions revealed that PTLEP increased attendance and active participation of the attending students. These multi-layered peer interactions mitigated the effects of the high student-lecturer ratios observed at the University of KwaZulu-Natal and offered pedagogical benefits as competition was decreased among students and cooperation, motivation, self-confidence and self-esteem were increased. Contrary to the belief that peer teaching should be limited to peer discussion in small groups, the students' responses to a set of questionnaires and their participation in academic workshops indicate that, in an African context, peer education involving large numbers of students creates a motivating learning environment

Hall, P. T. (1992). Use of Supplemental Instruction at the University of Missouri-Kansas City School of Law. In D. C. Martin & D. R. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 38-39). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED 354839).

The author describes the use of Supplemental Instruction with first-year "special-admit" law students at the University of Missouri-Kansas City. SI sessions were offered in Introduction to Law, Contracts I, Property I, and Criminal Law. While special admit students were directed to participate in the SI sessions, the program was open to all students enrolled in the four courses. Research suggests that the SI program assisted students to earn higher grades. Reenrollment rates for the special admit students was higher than before the introduction of the SI program.

Hamilton, S., Blakeley, R., Critchley, C., Playford, J., Kelly, B. A., McNamara, E., & Robertson, R. (1994). *Supplemental Instruction at the University of Queensland: A pilot program*. Unpublished manuscript. University of Queensland. Brisbane, Queensland, Australia. The project at the University of Queensland (Australia) investigated the effectiveness of incorporating Supplemental Instruction (SI) with two large first-level biological science subjects (Introductory Biochemistry and Plant Biology). Research studies suggest that the SI program contributed to higher final course grades for SI participants (63.2 percentile vs. 52.7 percentile). The following factors were cited as important for program success: financial commitment by the academic department; availability of an experienced SI coordinator; selection and training of appropriate SI leaders; and full support of the program and the leaders by academic staff associated with the subject.

Hammill, J., Best, G., & Anderson, J. (2015). Developing student mentor self-regulation skills through formative feedback: Rubric development phase. *Journal of Peer Learning*, 8(1), 48-58. Available online: <http://ro.uow.edu.au/ajpl/vol8/iss1/6/>.

Research into Peer Assisted Study Sessions (PASS) in Higher Education has largely focused on the positive effects of PASS on student motivation, retention and engagement. Less attention has been given to the cognitive, affective and professional development of the PASS Student Mentors through their engagement with students and academic staff. At Victoria University learning and development for Student Mentors begins at training and continues during the semester, supported by several methods of formative feedback: weekly reflective posts through an online platform, weekly development workshops, observations, progress interviews, and evaluations. Despite ongoing training and development throughout the semester, PASS

supervisors have observed that some Student Mentors do not have a clear understanding of the role expectations. This paper describes the processes undertaken to develop a rubric that clarifies PASS facilitation objectives for Student Mentors and their PASS supervisors.

Hand, J. (2003). *Framework fidelity in an entry level biology Supplemental Instruction program*. Unpublished manuscript. Southwest Texas State University.

The research question "do the experiences of students participating in the first year Supplemental Instruction (SI) program in the entry-level biology program at Southwest Texas State University resonate with the frameworks in which the SI model is grounded?" was investigated using qualitative inquiry within a phenomenological epistemology. The purpose of the study was to determine if the experiences of five students, participating full time in a SI program for an entry-level biology curriculum, resonated with the frameworks underlying the SI model. Analysis of transcriptions of open-ended interviews with the study participants revealed that students participating in the entry-level SI sessions were experiencing phenomena reflective of the frameworks undergirding the SI model. This tentative, theoretical construct of "framework fidelity" emerged as grounded theory from the qualitative study. These findings suggest that if the SI model is implemented with fidelity, the educational and developmental theories that underpin the model will resonate in a way that produce predictive, desired and expected results in student cognitive and affective domains.

Hardee, T. (2013). *Exploring student experiences in developmental education at a four year higher education institution*. (Ph.D. dissertation), California State University.

In the United States, the most commonly used method for developing an incoming freshman's math and English skills is through remedial education courses. Depending on the 4 year institution and the student's level of need, these remedial courses will be taught in conjunction with varying other forms of support programs, such as supplemental instruction, mandatory tutoring, and advising sessions. Once a student has taken a placement test to assess that level of need, he or she will then enter into college participating in developmental education. The purpose of this study was to explore student experiences participating in developmental education during their first year in college. This study gives voice to developmental education students' perceptions of their experiences in the first year, provides insight into how non-cognitive variables may aid in student persistence through their developmental education coursework, and examines the importance of students experiencing validation during their developmental education program. In this basic qualitative inquiry, interviews were used as a way to gain understanding into how students experience developmental education. The constant comparative method was employed as a way to gain deeper insight and meaning into each participant's shared experiences. The study sample contained 14 (12 female and two male) students who had participated in three developmental education courses in their first year at Barkley University (pseudonym), a large 4-year public university in Southern California. Additional criteria for participants were that they must have completed all of the developmental education courses with a C or better, and enrolled in courses at Barkley University for their second year. Since participants required three developmental education courses in their first year, they were subsequently part of the Sun Learning Community (SLC; pseudonym), a mandatory community that required participants to take their courses in a cohort model, participate in advising, supplemental instruction, and were provided with extra tutoring services. Five themes emerged from the data regarding how students experience their first year participating in developmental education coursework: (a) Reflection, (b) Connection, (c) Before, (d) During, and (e) After. These themes were influenced by Laura Rendón's validation theory, along with William Sedlacek's concept of non-cognitive variables. Implications for developing a conceptual understanding of the relationship between validation and specific non-cognitive variables and what this relationship may mean for students who participate in several

developmental education courses are also highlighted. Recommendations are given to faculty members, advisors, and higher education administration with the goal of encouraging these stakeholders to understand the complexities of being a first year college student who participates in several developmental education courses and to understand how students may feel about membership to a learning community. This understanding would lead to an awareness of how various constituencies' behavior could influence a student's ability to successfully pass all coursework and persist to the next year.

Harding, A., Engelbrecht, J., & Vervvey, A. (2011). Implementing Supplemental Instruction for a large group in mathematics. *International Journal of Mathematical Education in Science and Technology*, 42(7), 847-856.

The Supplemental Instruction (SI) programme has been well-established worldwide and the resulting success of the programme is indisputable. The University of Pretoria has decided on SI as the model to be used for addressing the underpreparedness of students entering the university, largely brought about by the changes in the curricula at secondary school level. The SI model was piloted in two courses, one in mathematics and another in chemistry, each consisting of more than a thousand students. This article addresses implementation issues of SI for such a large group of students in mathematics. It cautions would-be implementers to pitfalls and shortcomings of the SI model and suggests how the model could be adapted to answer the current needs. This article also shows that despite problems in strictly adhering to SI principles in the implementation of the programme, participants showed increased performance.

Harrell, G., & Lazari, A. (2015). Extended sections for at risk students in college algebra. *Georgia Journal of Science*, 73(2), Article 4. Available from

<http://digitalcommons.gaacademy.org/cgi/viewcontent.cgi?article=1167&context=gjs>.

VSU is identifying students at-risk of failing College Algebra based on admissions data, including SAT/ACT-Math scores and high school GPA's. Fall 2014, the Department of Mathematics and Computer Science taught College Algebra to at-risk students via Extended Sections. In this study, we compared the common departmental final exam scores for the treatment group, Extended Sections, and the control group, Traditional Method Sections, in order to compare the students' performance. The mean SAT-Math and ACT-Math scores for the treatment group were significantly lower than the mean SAT-Math and ACT-Math scores for the control group. However, the students' performance on the departmental final exam for the treatment group and control group showed no significant difference. The at-risk mathematics students that take the Extended Sections can perform on average on the final exam just as well as the students in the traditional courses.

Harrington, J., & Moore, D. (1986). *Say "Si" to supplementals*. Paper presented at the 7th Annual Meeting of the Rocky Mountain Regional Conference of the International Reading Association, Colorado Spring, CO. Available online: ERIC database. (ED270739).

This paper provides an overview of the Supplemental Instruction (SI) program. The authors describe a pilot test of the SI program with a Spanish class at the University of Nebraska-Omaha. Lessons learned from the pilot test of SI included: tie SI sessions to one course taught by one instructor; hire staff leaders for sessions; provide adequate feedback and constructive criticism for session leaders; and inform students that SI session attendance is not a substitute for independent studying.

Harrison, D., Lentz, J., Schmatz, N., Escovedo, C., & Stark, E. (2017). Peer-based anatomy tutoring for first-year medical students: An analysis of peer-tutoring from the tutors' perspective. *Medical Science Educator*, 27(1), 57-61.

In response to student demand for additional anatomy lab instructional time outside of typical teaching hours, a peer-based anatomy tutoring program was implemented at the David Geffen School of Medicine at UCLA. Peer tutoring is a well-studied form of supplemental instruction, and is known to benefit students and tutors alike. This study aims to address the effect of tutoring on the tutors themselves, specifically in the context of the gross anatomy laboratory. A one-time 12-question survey was distributed to all students who acted as tutors over a three-year period (n = 57), asking them to reflect on their experiences as tutors. Specifically, we aimed to address their thoughts on their career plans and academic achievement as they relate to their experience as tutors, as well as their opinions on effective tutoring techniques. Based on a 100% response rate, 85.7% of tutors reported being “very interested” in incorporating a teaching component to their career, and 73.7% of respondents reported that their experience tutoring influenced this plan. In contrast to an expectation that tutors would skew their residency choices toward anatomy-focused specialties, the distribution of tutors’ anticipated specialty choices actually reflected the overall distribution of the class. The tutors believed their experience tutoring improved their academic and clinical performance. The overwhelming majority reported believing that their experience as a tutor improved their USMLE Step 1 score (90.2%, n = 46). Sixty-one percent (n = 31) reported feeling that the experience as a tutor helped with their clerkship evaluations. Finally, the most effective tutoring techniques were quizzing the students directly and using the tutors’ own notes and study materials from the prior year. This study supports the finding that tutoring provides a significant beneficial effect on the tutors based on their own perceptions, and further studies obtaining quantitative data on academic achievement and clinical performance of the tutors will be beneficial.

Haskell, D. H., & Champion, T. D. (2008). Instructional strategies and learning preferences at a historically Black university. *Journal of Negro Education, 77*(3), 271-279.

Through the Minority Biomedical Research Support-Research Initiative for Scientific Enhancement program, the natural sciences faculty at Johnson C. Smith University, a historically Black university, works to support their students' learning. The heterogeneity of learning preferences among students challenges the faculty to provide a variety of instructional methods. Supplemental Instruction was a particularly popular and effective strategy. Results include an increasing trend in number of JCSU Natural Sciences graduates.

Haunwitz, R. K. M., & Heinauer, L. (2005, 2005, February 6). Colleges left behind, *American-Stateman Staff Newspaper*, p. A1.

This newspaper article describes the use of Supplemental Instruction (SI) at the University of Texas-San Antonio.

Hawthorne, J., & Hawthorne, J. W. (1987). *Separating the wheat from the chaff: Finding the unique effect of Supplemental Course Instruction*. Unpublished manuscript. Olivet Nazarene University. California. Available online: ERIC database. (ED328201).

Supplemental Instruction (SI) at Olivet Nazarene University (CA) was examined through a study utilizing path analysis. Confounding factors such as the voluntary nature of the study sessions and the open admission policy of the college were controlled through path analysis/structural equation modeling. The analysis studied: 1) the effect of factors affecting SI participation, such as high school rank, marital status, semester load, and expected grade; and 2) the effects of SI participation on course grade, semester grade point average, and re-enrollment. Overall, path analysis explained 12.5 percent of the total variance of SI participation. Three of the exogenous variables have a direct, statistically significant, impact on SI participation: 1) The study found that the more a student is "at-risk" the more likely he or she is to use SI. 2) There is a direct positive effect between reported high school grades and SI participation. 3) The longer the student has been out of high school, the less likely he is to use SI. Two endogenous variables

also have direct impacts on SI participation: 1) The more a student works, the less likely he is to attend SI sessions. 2) Students who expect to do well in the course are significantly more likely to attend SI sessions. SI participation had significant direct effects on course grade, semester GPA, and reenrollment. Since there was direct effects of SI on grade point average and semester grade point average, the authors suggest the transfer of study skills learned to other courses.

Hayes, C., & Fulton, J. A. (2019). A participatory action research study on the impact of Peer Assisted Student Support (PASS) and Supplemental Instruction (SI) by international PhD students. *Journal of Learning Development in Higher Education*(14). Available online: <http://journal.aldinhe.ac.uk/index.php/jldhe/article/view/477>.

Using a Participatory Action Research (PAR) approach, this evaluative research study gives an insight into the implementation of a pilot study of a newly implemented Peer Assisted Student Support (PASS) and Supplemental Instruction (SI) Programme. The focus of the study involved six postgraduate PhD students delivering a PASS/SI scheme to cohorts of MSc Public Health, MSc Nursing and MSc Psychosis and Complex Mental Health Interventions students, all undertaking their final dissertations. The study was used to illuminate the degree to which PASS and SI were perceived to impact on the overall student experience as part of a quality enhancement initiative. Findings of the study revealed that the programme had positively impacted on both PASS/SI leaders and participants of the scheme, who reported increased confidence and an increased sense of social inclusion and belonging to the institution respectively. Being facilitated by students who had experienced the same academic pathway was perceived to have widened networking opportunities and to have positively impacted on the capacity of the participants and leaders to build relationships and prepare skills of direct relevance to the requirements of an employer such as teamwork and initiative.

Haynes, A., Christiansen, B., Bjork, T., & Hessevaagbakke, E. (2016). Peer learning in higher education: Patterns of talk and interaction in skills centre simulation. *Learning, Culture, and Social Interaction*, 8, 75-87. doi: 10.1016/j.lcsi.2015.12.004.

This study conceptualises patterns of peer talk and interaction and the potentials for learning inherent in a peer tutoring setting in an undergraduate nursing education skill centre. Third-year students are responsible for training first-year students in performing nursing procedures. The paper identifies patterns of peer interaction as they occur in a pre-training reflection setting where students prepare for practising the procedures. Three interaction patterns are identified: a tutor-led question-and-answer pattern and two exploratory patterns: cumulative-exploratory and dispute-exploratory. The analysis additionally uncovered three ways of dealing with the object of learning: recitation, re-contextualisation and thematic errors and sloppiness. The researchers suggest that analyses of peer learning needs to go beyond the level of interaction and address its content. Furthermore, interaction patterns might afford an expansive or more restrictive way of framing and dealing with the object of learning.

Healey, M., Flint, A., & Harrington, K. (2016). Students as partners: Reflections on a conceptual model. *Teaching & Learning Inquiry*, 4(2). doi: 10.20343/10.20343/teachlearning.4.2.3

Available online: <http://tljournal.com/tli/index.php/TLI/article/view/105/97>.

This article reflects on a conceptual model for mapping the work that fits under the broad heading of students as partners in learning and teaching in higher education (Healey, Flint, & Harrington, 2014). We examine the nature and purpose of the model with reference to specific examples, and reflect on the potential and actual uses of the model in the development of practice and policy, focusing particularly on students as co-inquirers in SoTL. The article also provides a framework for the other articles in a special section of *Teaching & Learning Inquiry* on students as co-inquirers.

Healy, C. E. (1994). Supplemental Instruction: A model for supporting student learning. In J. Wallace (Ed.), *Kingston University HEFCE Supplemental Instruction Project: 1993-94* (pp. 231-236). London, England: Kingston University

The study investigates the effectiveness of Supplemental Instruction at the Glasgow Caledonian University. Preliminary results indicate: a) improved performance in the students' annual examinations (e.g., Electrical Engineering Principles: 61 percentile vs. 46 percentile for non-SI participants); b) reduction in students' drop-out rates; c) enhanced communication and other transferable skills and d) deeper understanding of engineering principles.

Healy, C. E. (1994). Introducing Supplemental Instruction in engineering. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 25-30). Birmingham, England: Staff and Educational Development Association
This chapter describes the implementation of Supplemental Instruction in engineering courses at Glasgow Caledonia University in Scotland. The University is seeking to initiate cultural change through partnership events involving students, staff and employees. Research studies suggested improvements by both the SI participants (64.8 percentile vs. 54.4 percentile for non-SI participants) and the SI leaders. Some SI leaders reported that they had now considered pursuing a teaching career based on the positive experience with the SI program.

Healy, C. E. (1994). Supplemental Instruction: A model for supporting student learning. In H. C. Foot, C. J. Howe, A. Anderson, A. K. Tolmie & D. A. Warden (Eds.), *Group and interactive learning*. Southampton, England: Computational Mechanics Publications

The authors reported improved performance in annual examination results of Supplemental Instruction (SI) students as well as reductions in dropout rates, coupled with enhanced communication and other transferable skills and a deeper understanding of the principles of engineering at the British higher education institution.

Healy, C. E. (1994). *Supplemental Instruction: A model for supporting student learning*. Conference Proceedings of the International Conference on Group and Interactive Learning, Glasgow, Scotland.

This article describes the implementation of Supplemental Instruction in engineering courses at Glasgow Caledonia University in Scotland. The University is seeking to initiate cultural change through partnership events involving students, staff and employees. Research studies suggested improvements by both the SI participants (64.8 percentile vs. 54.4 percentile for non-SI participants) and the SI leaders. Some SI leaders reported that they had now considered pursuing a teaching career based on the positive experience with the SI program.

Heerspink, J. B. (1997). *The use of spatial representation in history courses and in courses with historical content*. Unpublished manuscript. Calvin College. Grand Rapids, MI.

Students who learn to represent historical information spatially will find their learning to be both more complete and more efficient. The Supplemental Instruction (SI) leader has a significant role to play in bringing experience in learning history and in the use of learning strategies in the SI sessions. Five typical spatial representation patterns of learning in history courses include: sequence, parts/types/lists, compare/contrast, cause and effect, PERSIA (political, economic, religious, social, intellectual, and/or artistic factors). The author is the tutor coordinator at Calvin College (Grand Rapids, MI).

Heil, A. (2009). *Impact of Supplemental Instruction on achievement of technical college students in college algebra*. (Ph.D. dissertation), Georgia State University. Available online: https://getd.libs.uga.edu/pdfs/heil_alysen_s_200912_edd.pdf

Increasingly, students are enrolling in college who are less prepared for college academics, and require remedial courses. The Supplemental Instruction (SI) program is one remedial program that may aid in student success in college level courses. Supplemental Instruction is an academic assistance program, which employs instructor specific peer tutoring. An experimental study, as designed at a 2-year technical college in Georgia, was used to examine the usefulness of SI in supporting student achievement in college algebra. Supplemental Instruction was conducted for a randomly assigned group of students for the first 5 weeks of a 10-week quarter. Upon completion, students completed a midterm achievement assessment between those who participated in SI and those who did not. The results were not statistically significant, meaning that statistically there was no difference between those students who participated in Supplemental Instruction and those who did not participate.

Henry, M. (1998, 1998, February 27). Faculty senate applauds recommendations, *Lubbock Avalanche-Journal*, p. 7c.

This newspaper article discusses the steps that Texas Tech Chancellor John Montford outlined to enhance academic performance of student-athletes. Supplemental Instruction (SI) was among the suggested activities. Four classes with high concentrations of student-athletes have SI provided as a service with an expansion to 10 to 12 classes for the following fall 1998 academic term.

Hensen, K. A. (2005). *Examining the relationship between Supplemental Instructors (SI) and student retention at a doctoral extensive institution*. (Ph.D. dissertation), Iowa State University, Ames, IA.

This study tracked 3,286 students over a five-year period who were enrolled in entry-level biology, chemistry, mathematics, and physics courses offering SI in the fall 1999 to see if they were retained or graduated at a Midwestern doctoral extensive institution and identified which predictor variables (demographic, achievement, and level of SI participation) most significantly predicted student retention or graduation. Chi-square analysis, based on two-way contingency tables indicated that SI participants are retained at higher rates than non-SI participants while having lower mean ACT composite scores and fewer semesters of high school preparation in calculus, chemistry, and physics. Backward stepwise multiple logistic regression analysis was used to determine that the most significant predictor of student retention/graduation was high school rank. Positive predictors for the various disciplines across the five year period included the number of SI sessions attended the number of transfer credits earned, and the number of semesters of high school calculus, chemistry, or physics. Negative predictors of student retention or graduation included Pell Grant eligibility and being a member of ethnic minority group. The results of this study, in addition to making a significant contribution to literature on retention and SI, also have implications for institutional practice. Specifically, this study provides a model for evaluating SI programs or other academic support programs to demonstrate how the program helps retain students. The findings also may be used to inform institutional leaders, policymakers, and the public about how SI is a useful tool to retain students and encourage the expansion of SI programs to meet the needs of additional learners.

Hensen, K. A., & Shelley, M. C. (2003). The impact of Supplemental Instruction: Results from a large, public, Midwestern university. *Journal of College Student Development*, 44(2), 250-259. This article describes the use of Supplemental Instruction (SI) at Iowa State University. The SI program was established in 1992 and serves 60 sections of biology, chemistry, math, and physics courses with a combined enrollment of approximately 7,500. About 22% of students in these courses attend SI sessions one or more times during the academic term. There was statistically significant differences favoring the SI participants regarding higher rates of A & B final course grades (9% higher), lower rates of D, F, and withdrawals (8% lower), and higher

mean final course grades (one-third of a letter grade higher). Regarding preentry attributes (e.g., ACT scores), the SI participants in biology, chemistry, and math had statistically lower scores and were less academically prepared than their non-SI participants. In physics, there was no statistical difference. This suggests that preentry attributes do not explain the reasons for higher academic performance by SI participants, especially since most SI participants were less academically prepared.

Hensley, D. (1997, 1997, February 27). Montford vows to set new pace for Texas Tech University athletes, *Lubbock Avalanche-Journal*, p. 7c.

The Chancellor of Texas Tech University (Lubbock, TX) announces that the Supplemental Instruction (SI) program will be expanded at the institution as part of a comprehensive increase in academic support services for student-athletes. Due to several highly-publicized cases of poor academic performance by several athletes, the institution will provide: closely monitored study table; SI provided in more classes; tutors to students when they are out-of-town for athletic contests; and more closely monitored class attendance.

Hibbert, T. D. (1996). *Taking study skills to the classroom: Supplemental Instruction as an integral part of college courses*. (Master's of Arts thesis), University of Texas at El Paso, El Paso, TX.

This paper studied the impact of Supplemental Instruction (SI) at the University of Texas at El Paso during Fall 1994 and 1995 in three Sociology Statistics classes and three Sociology Methods of Research classes with a total student enrollment of 269 students. These sections were chosen since the same instructor taught the three sections in each subject -- controlling for the possibility of different teaching styles. The three dependent variables studied were final course grade, semester grade point average, and re-enrollment at the university the following academic term. The classes included in this study had D, F or withdrawal rates of 32 to 38 percent before providing the SI program. During Fall 1994 the researcher conducted a mandatory study session connected with each section of the sociology classes. These mandatory sessions occurred during one class period each week. In one course section the researcher conducted a traditional SI session. In the other section of the same course the researcher allowed the enrolled students to guide the session. The researcher served as a discussion facilitator. The results were mixed regarding the improvement of semester grade point averages. In the statistics course the SI group had a higher subsequent semester GPA (2.86 vs. 2.57). In the methods course the results slightly favored the non-SI group (1.98 vs. 1.90). The same pattern emerged regarding final course grades. In the statistics course the SI group had higher academic performance (percent A & B, 41.3% vs. 32.6%; D, F & W, 32.0% vs. 30.4%; mean final grade, 73.66 vs. 72.2). In the methods class the non-SI group had higher achievement (percent A & B, 55.0% vs. 48.9%; D, F, & W, 20.0% vs. 26.5%; mean final grade, 76.4 vs. 73.8). An abbreviated version of the Whimbey Analytical Skills Inventory (8 items rather than 38) and a math assessment test was administered to all students at the beginning and the end of the academic term. No significant differences were found. Analysis of student journals suggested increased confidence and enjoyment of the course content due to the experience of the supplemental study review sessions provided through both the traditional SI and the informal student-led sessions. The researcher postulated several possible reasons for no significant difference between the SI group and the informal student study groups: (1) since the same person facilitated the SI sessions and the informal student study group (non-SI) some SI activities may have been utilized during the non-SI group sessions; (2) the SI facilitator also provided additional tutorial help to the non-SI group throughout the academic term.

Hill, D. (1992). Supplemental Instruction in the social sciences at Weber State University in Ogden, UT. *Collaborative Learning Exchange Newsletter*, 10-11.

The author reports on the implementation of Supplemental Instruction at Weber State University in Ogden, Utah. In the 1991-92 year SI was offered in US History 170, American National Government 110, Introduction to Criminal Justice 106, Introduction to Philosophy 101, and Introduction to Economics 101. In the Introduction to Criminal Justice 106 course the SI participants earned a higher percent of A and B final course grades (80% vs. 53%). The article described some of the SI session activities for the social science courses: cause and effect; comparison and contrast; short writing activities; review of elements of research reports; review lecture note taking strategies; integration of outside reading assignments with lecture notes; and interpretations of reading assignments.

Hill, S., Gay, B., & Topping, K. J. (1998). Peer-assisted learning beyond school. In K. Topping & S. Ehly (Eds.), *Peer-assisted learning* (pp. 291-311). London: Lawrence Erlbaum Associates, Publishers

This book chapter provides a wide overview of peer-assisted learning (PAL) programs. The first part deals with cross-age tutoring programs. This most often involve college students working with young people. It is common for student tutors to report growth in improved communication skills, self-confidence, and cognitive gains. The studies have had mixed results concerning cognitive gains by the tutees. More common improvements are reported with the social and affective domains. The authors report substantial and persuasive evidence of impact on dropout rates, course grades, and graduation outcomes.

Hillman, J. C. (1996, 1996). *The value of Supplemental Instruction in conceptual learning*. Conference Proceedings of the 4th AFRICON Conference, Piscataway, NJ.

Undergraduates have difficulty with courses that are conceptual in nature. The internalization of concepts and the development of problem solving skills is achieved by individuals in a variety of ways, relatively few of which are known by lecturers or actively sought. Supplemental Instruction (SI) can overcome these problems by encouraging students to learn from the experiences of others by participating in structured group discussions which are facilitated by senior students. This paper describes the development of an SI program with a first year electrical engineering course and concludes that it is both an efficient and cost effective methods of improving student learning, particularly for those from an educationally disadvantaged background.

Hilsdon, J. (2014). Peer learning for change in higher education. *Innovations in Education & Teaching International*, 51(3), 244-254. doi: 10.1080/14703297.2013.796709. Available online: <http://srhe.tandfonline.com/doi/pdf/10.1080/14703297.2013.796709?needAccess=true>.

This paper draws upon small scale, qualitative research at a UK university to present a Learning Development (LD) perspective on peer learning. This approach is offered as a lens for exploring social aspects of learning, cultural change in higher education and implications for pedagogy and policy. Views of a small group of peer learning leaders are considered in relation to notions of learning and identity, within disciplinary or broader student communities.

Hinckley, A. (1991, 1991, April). Students get paid to help others pass, *The National College Newspaper*, p. 23.

This newspaper article describes the use of Supplemental Instruction (SI) program at Utah State University. Currently SI is offered in connection with two courses: economics and nutrition/food science. The SI program is administered through the Learning Assistance Center.

Hizer, S. E. (2010). *The Supplemental Instruction program: Student perceptions of the learning environment and impact on student academic achievement in college science at California State University, San Marcos*. (Ed.D. dissertation), San Diego State University and California State University, San Marcos, California United States.

Higher education in science has been criticized and calls to increase student learning and persistence to degree has been recognized as a national problem by the Department of Education, the National Science Foundation, the National Research Council, and the National Academy of Sciences. One mode of academic assistance that may directly address this issue is the implementation of Supplemental Instruction (SI) in science courses. SI is a specific model of academic assistance designed to help students in historically difficult science classes master course content, thus increasing their academic achievement and retention. This study assessed the SI program at California State University, San Marcos, in supported science courses. Specifically, academic achievement based on final course grades were compared between SI participating and nonparticipating students, multiple affective factors were measured at the beginning and end of the semester, and students' perceptions of the classroom and SI session learning environments recorded. Overall, students who attended five or more SI sessions achieved higher final course grades. Students who chose to participate in SI had higher initial levels of responsibility and anxiety. Additionally, SI participants experienced a reduction in anxiety over the semester whereas nonparticipants experienced an increase in anxiety from beginning to the end of the semester. The learning environment of SI embodies higher levels of constructivist principles of active learning such as cooperation, cohesiveness, innovation, and personalization -- with one exception for the physics course, which is based on problem-based learning. Structural equation modeling of variables indicates that high self-efficacy at the end of the semester is directly related to high final course grades; this is mediated by cohesion in the classroom and the cooperation evidenced in SI sessions. These findings are elaborated by student descriptions of what happened in SI sessions and discussed given the theoretical frameworks of Bandura's concept of self-efficacy and learning environment activities that embody constructivist principles.

Hizer, S. E., Schultz, P. W., & Bray, R. (2017). Supplemental Instruction online: As effective as the traditional face-to-face model? *Journal of Science Education and Technology, 26*(1), 100-115.

Supplemental Instruction (SI) is a well-recognized model of academic assistance with a history of empirical evidence demonstrating increases in student grades and decreases in failure rates across many higher education institutions. However, as college students become more accustomed to learning in online venues, what is not known is whether an SI program offered online could benefit students similarly to SI sessions that occur in face-to-face settings. The in-person (traditional) SI program at California State University San Marcos has demonstrated increases in grades and lower fail rates for courses being supported in science and math. Students enrolled in four biology courses who participated in online SI received increases in academic performance similar to the students in the courses who attended traditional SI. Both the online and traditional SI participating students had higher course grades and lower fail rates as compared to students who did not participate in either form of SI. Self-selection, as measured by past cumulative college grade point average, did not differ between students who attended either form of SI or who did not attend. Student perceptions of online SI were generally positive and appeared to offer an alternative path to receive this valuable academic assistance for some students. Overall, results are promising that the highly effective traditional model can be translated to an online environment.

Hodges, R., Dochen, C. W., & Joy, D. (2001). Increasing students' success: When Supplemental Instruction becomes mandatory. *Journal of College Reading and Learning, 31*(2), 143-156.

The study found that students in both mandated and voluntary Supplemental Instruction groups in a high-risk, required, freshmen-level, writing-intensive United States history course earned significantly higher course grades and semester grade point averages than students in the non-

SI group. The study found no significant differences between voluntary and mandatory SI participants.

Hodges, R., & White, W. G. (2001). Encouraging high-risk student participation in tutoring and Supplemental Instruction. *Journal of Developmental Education*, 24(3), 2-4, 6, 8, 10, 43. The study investigated the effect of high-risk students' use of self-monitoring strategies and instructors' use of verbal prompts on high-risk students' participation in tutoring and Supplemental Instruction (SI) and on their academic achievement. Subjects consisted of 103 conditionally admitted contract students at a large state university in the southern United States enrolling approximately 21,000 students during Fall 1996. The study employed an experimental posttest-only control-group design. Results indicated no significant group differences in mean semester GPA between attendees and non-attendees in tutoring but did find a statistically significant difference between mean semester GPA of attendees and non-attendees in SI. One of the challenges with high risk students is that they may not accurately perceive their own need for academic assistance. Possible solutions to this challenge is to make SI attendance mandatory.

Hodges, R. B. (1997). The effect of self-monitoring strategies and verbal prompts on high-risk students' attendance in tutoring and Supplemental Instruction and their academic achievement (Ph.D. dissertation, Grambling State University, 1997). *Dissertation Abstracts International*, 59(02), 0429A.

The study investigated the effect of high-risk students' self-monitoring (SM) strategies and instructors' use of verbal prompts on high-risk students' attendance in tutoring and Supplemental Instruction (SI) and on their academic achievement. Subjects consisted of 103 conditionally admitted contract students at Southwest Texas State University during fall 1996. Using an experimental posttest-only control-group design, instructors in four freshman seminar classes implemented different combinations of treatment. In Treatment 1, subjects were required to self-monitor their attendance in tutoring and SI, and they received verbal prompts from their instructors to attend free tutoring and SI. In Treatment 2, subjects were required to self-monitor their attendance in tutoring and SI but were not given verbal prompts. In Treatment 3, subjects received verbal prompts to attend tutoring and SI but were not required to self-monitor their attendance. In the control group, subjects were not required to self-monitor their attendance in tutoring and SI and were not exposed to verbal prompts. A validation analysis of the effectiveness of tutoring and SI compared subjects attending one or more tutoring sessions and one or more SI sessions to those not attending. Using independent t-tests, the results indicated no significant group differences occurred in semester GPA between attendees and non-attendees in tutoring but did find statistically significant group difference in semester GPA for attendees in SI. Three hypotheses examined the relationship between subjects' use of SM strategies and instructors' use of verbal prompts on subjects' attendance in tutoring and SI. Two ANOVAs failed to reject the three null hypotheses which indicated that there was no increased in subjects' attendance in tutoring and SI between groups. SI attendance for this subpopulation of students was low (mean=2.27 with S.D.=3.37) when compared with national SI data studies. The researcher suggested the following reasons for low SI attendance based on student surveys and interviews: SI sessions scheduled at time in conflict with other student commitments; high-risk students have unrealistic positive perceptions regarding their own academic skills and may not seek help; and high-risk students need stronger external influences to change their behavior including the requirement of mandatory SI attendance. The researcher suggests increased attention to the affective domain and its possible impact upon student learning and the use of mandatory attendance in academic enrichment programs such as SI and tutoring.

Hodges, R. B., Sellers, D. E., & White, W. G. (1994). Peer teaching: The use of facilitators in college classes. *Journal of College Reading and Learning*, 26(2), 23-29.

This article discusses the use of peer students as facilitators in the learning process. Supplemental Instruction (SI) is cited as another example of these student-led peer groups. The authors cite Maxwell (1992) when stating that SI is the best known and has the widest acceptance of any course-related learning program. A facilitator is defined as a facilitator as an undergraduate teaching assistant engaged in collaboratively teaching a college course alongside the instructor. While facilitators may perform some clerical duties, the focus of their work is to foster student learning. Common activities for facilitators include: through hosting smaller outside-of-class sessions make large classes more personable; turn lecture material by asking questions; share from a student's perspective another way to think about the lecture material; provide individual feedback to students; supervise small student work groups; provide role models of active learning; give encouragement; and change the classroom climate. Critical elements for a successful facilitator: be carefully selected by the instructor and perhaps a team of other student facilitators; training both before and during the academic term; evaluation by student and self-administered surveys.

Hoi, K. N., & Dowing, K. (2010). The impact of Supplemental Instruction on learning competence and academic performance. *Studies in Higher Education*, 35(8), 921-939. This study investigated the effects of Supplemental Instruction, a peer-assisted learning approach, on students, learning competence and academic performance. The Supplemental Instruction intervention facilitated by senior students focused on developing students' use of study skills and enhancing their motivation and academic performance. Pre- and post-intervention learning competence measures (the 10 scales of the Learning and Study Strategies Inventory) were available for 430 first year undergraduate business students (Supplemental Instruction, n = 109; Non-Supplemental Instruction, n = 321) from a university in Hong Kong. Structural equation modeling demonstrated that Supplemental Instruction had a significant effect on academic performance, both directly and indirectly via enhancement of student learning competence, after controlling for pre-intervention learning strategy scores and previous academic achievement. This study provides evidence that Supplemental Instruction can be a very effective instructional strategy for promoting undergraduate student learning.

Holek, D. D. (2008). *The impact of Supplemental Instruction on the retention and graduation of students of color at "Mid-Western University"*. (Ph.D. dissertation), Central Michigan University, Mount Pleasant, MI.

Understanding how students of color become socially and academically integrated into college is critical to improving their retention. Although a variety of retention programs exist, programs such as Supplemental Instruction (SI) focus on lowering the rate of attrition by promoting academic success through peer instruction, teaching effective learning methods, and study skills training. A recent study demonstrated that SI significantly improved the GPA for students of color that attended SI sessions at MWU. It was important to determine if the SI program also had an impact on the retention and persistence to graduation of students of color at MWU attending SI. The study site was unique since MWU has the only SI program, nation-wide, administered in an institutional diversity office. This unique location provided in-depth data on students of color that will contribute significantly to current research. Although much research has been conducted in the areas of SI and academic achievement, there has been minimal research performed analyzing the effect SI has on the retention and graduation rates on the population of students of color. Given this paucity of research, the purpose of this quantitative investigation was to fill this research gap by measuring the extent to which there was a difference between the retention and graduation rates of students of color at MWU who attend SI to students of color at MWU who do not attend SI. The null hypotheses was that there would

be no significant increase in the retention rate and graduation rate within each group of students of color who attend SI in comparison to student of color who do not attend SI. This quantitative investigation involved a causal-comparative, ex post facto method of research, using the Cochran-Mantel-Haenszel chi-square technique. The population of this investigation included MWU undergraduate students of color. Archival data for the time period beginning in the Fall semester of 2001 through the Fall semester of 2002 was utilized in this investigation. The students' reenrollment and graduation status at the end of the Spring semester of 2007 was analyzed in the comparison, and collected from the MWU Minority Student Services (MSS) records and MWU Office of Institutional Research. The F tests were performed on the main effects for the two factors and the interaction between the two factors. In the post hoc analysis, three summary Cochran-Mantel-Haenszel (CMH) correlation statistics were used to test for the hypothesis of no association. Differences were determined to be significant at the associated p - value of $<.0005$. This study concluded that SI had a significant impact on the retention and persistence to graduation for African-American, Hispanic/Latino, and Native American students at MWU. However, this study concluded that SI did not have a significant impact on the retention and persistence to graduation for Asian students at MWU. To decipher the reasons for differences by ethnicity, factors relating to ethnic identity development, learning styles and academic achievement, self-concept of academic ability, and specific social and cultural experiences and needs were reviewed to explain how and why these factors play a role in the academic achievement and retention of students of color. The literature supports that African-American, Hispanic/Latino, and Native American students often develop networks and support systems when entering college (i.e., cultural organizations), and having strong and active ties to the campus community may play a role in increased SI attendance and the impact on retention and persistence to graduation. Previous research indicated that Asian students are influenced by three key factors that may contribute to SI attendance not having a significant impact on their retention and persistence to graduation: experiences with reverse stereotype threat (i.e., living up to the stereotype that Asian's are academically superior, making it more difficulty to ask for assistance, therefore, not attending SI); being influenced by relationships and external forces; and the reaction and focus on social political consciousness identity development in the college years. It is important to note that the Asian students graduated at the same rate as the students from other ethnic groups, indicating they achieved academically through other methods. This study demonstrated the significance intervention programs such as SI have on retention, and persistence to graduation of students of color. Measurable data attained from studies such as this support the acquisition of funding, institutional understanding and buy-in, and continuation of diversity initiatives and retention programs, such as SI.

Hollenkamp, J. (1992, 1992, April 1). Supplemental Instructors help fellow students understand lectures, homework, *Louisville Cardinal Newspaper*, p. 10.

This newspaper describes the use of Supplemental Instruction (SI) with students at the University of Louisville (KY) since 1984. Each academic term SI is offered in a dozen courses for the following academic departments: accounting, biology, chemistry, EMCS, geography, HED, history, ISDP, math, physics, political science, and sociology.

Holm, A., & Pelger, S. (2016). *Mathematics communication within the frame of Supplemental Instruction – SOLO and ATD analysis*. Conference Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education, Prague, Czech Republic. Available online: <https://hal.archives-ouvertes.fr/hal-01289441/document>

Teaching at Swedish primary and secondary schools is often combined with collaborative exercises in a variety of subjects. One such method for learning together is Supplemental instruction (SI). Several studies have been made to evaluate SI in universities throughout the world, while at lower levels hardly any study has been made until now. This study aimed at

identifying learning conditions in SI-sessions at two Swedish upper secondary schools. Within this study, a combination of ATD (Anthropological theory of the didactic) and the SOLO-taxonomy (Structure of the Observed Learning Outcome) was successfully tried as an analysis strategy.

Holmer, A. (2017). Quantifying the soft power of SI. *Supplemental Instruction Journal*, 3(1), 80-93. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

Supplemental Instruction is one of the most successful programmes of peer-assisted study in existence. Numerous studies show that SI attendance correlates with student achievement, regardless of the level of knowledge of the student prior to commencing their studies. The present study, from Humanities at Lund University, Sweden, outlines a method for gauging the effect of SI on soft values such as study attitudes, confidence, and self-reported study skills. To eliminate the effect of different backgrounds, the study is based on 388 pairs of two questionnaires (before and after the semester) and SI attendance is correlated with the change in the self-reported values, rather than with the final absolute value. It is shown that issues dealing with study skills and strategies correlate more closely with SI-attendance than do psychological issues such as ambition and confidence.

Horsley, L. (1991, 1991, September 19). UMKC pioneers a 'survival course': Study skills program gives students the help they need to succeed, *The Kansas City Star Newspaper*, pp. 1, 6.

This newspaper article provides an overview of the Supplemental Instruction (SI) program at the University of Missouri-Kansas City. The article provides an interview with Deanna Martin -- SI's creator -- as well as several other SI supervisors and SI leaders. Dr. Gary Widmar, UMKC Vice Chancellor for Student Affairs, estimates that for every dollar invested in the SI program for staff salaries, the university receives back six dollars due to higher reenrollment and graduation rates of SI participants. Martin shares that the SI program is expanding to the United Kingdom and the Arctic Circle.

Hoskins, T. D., Gantz, J. D., Chaffee, B. R., Arlinghaus, K., Wiebler, J., Hughes, M., & Fernandes, J. J. (2017). Effectiveness of a low-cost, graduate student-led intervention on study habits and performance in introductory biology. *CBE-Life Education*, 16(3). doi: 10.1187/cbe.17-01-0004. Available online: <http://www.lifescied.org/content/16/3/ar43.full.pdf+html>.

Institutions have developed diverse approaches that vary in effectiveness and cost to improve student performance in introductory science, technology, engineering, and mathematics courses. We developed a low-cost, graduate student-led, metacognition-based study skills course taught in conjunction with the introductory biology series at Miami University. Our approach aimed to improve performance for underachieving students by combining an existing framework for the process of learning (the study cycle) with concrete tools (outlines and concept maps) that have been shown to encourage deep understanding. To assess the effectiveness of our efforts, we asked 1) how effective our voluntary recruitment model was at enrolling the target cohort, 2) how the course impacted performance on lecture exams, 3) how the course impacted study habits and techniques, and 4) whether there are particular study habits or techniques that are associated with large improvements on exam scores. Voluntary recruitment attracted only 11–17% of our target cohort. While focal students improved on lecture exams relative to their peers who did not enroll, gains were relatively modest, and not all students improved. Further, although students across both semesters of our study reported improved study habits (based on pre and post surveys) and on outlines and concept maps (based on retrospectively scored assignments), gains were more dramatic in the Fall semester. Multivariate models revealed that, while changes in study habits and in the quality of outlines

and concept maps were weakly associated with change in performance on lecture exams, relationships were only significant in the Fall semester and were sometimes counterintuitive. Although benefits of the course were offset somewhat by the inefficiency of voluntary recruitment, we demonstrate the effectiveness of our course, which is inexpensive to implement and has the advantage of providing pedagogical experience to future educators.

Hostetter, S. (1994). Improving college student retention: Interview with David Arendale. *National Tutoring Association Newsletter*(3), 2-3.

The interview of David Arendale provided an overview of the Supplemental Instruction (SI) program. Tinto's Model of Student Retention was discussed and its relationship to explaining the effectiveness of the SI model was discussed. Data from a study of students at the University of Missouri-Kansas City suggested that SI participation was positively correlated with increased levels of reenrollment at the institution when compared with non-SI participants. It is estimated that through increased reenrollment rates, the SI program generates over \$200,000 in annual savings.

Hrabovsky, P. (1998). *Math Supplemental Instruction at Indiana University of Pennsylvania: A short and sweet first report*. Conference Proceedings of the Annual Conference of the Pennsylvania Association of Developmental Educators, Hershey, PA. Available online: ERIC database. (ED428632).

Math Supplemental Instruction (SI) was initiated at Indiana University of Pennsylvania (IUP) during the summer session of 1996 through the developmental math course, LC 095: Introduction to College Math II. Improved grades and scores were noted and SI was integrated into all LC 095 sections beginning with the summer session of 1996. With the cooperation of the Mathematics Department and support from administrators, SI was piloted in select sections of developmental math courses. The pilot program was continued and expanded in the spring semester of 1998.

Huang, T. K., Pepper, M. P. J., Cortese, C. L., & Rogan, S. (2013). Faculty and academic staff perceptions, experiences and expectations of the PASS Program. *Journal of Peer Learning*, 6(1), 118-132. Available online: <http://ro.uow.edu.au/ajpl/vol6/iss1/10>.

Current research largely explores the evaluation and perceptions of Peer Assisted Study Sessions (PASS) from the student perspective. PASS is a common name used to describe Supplemental Instruction (SI) in Australia. The purpose of this study was to identify and evaluate institutional, faculty, and academic staff perceptions, experiences, and expectations of an established PASS program in the Faculty of Business in an Australian University. A survey and semi structured interviews were used to collect responses from participants from each level of the university, including the PASS program coordinators, Dean of Faculty, Head of School, and subject coordinators. Results highlight the importance of "closing the communication loop" between PASS leaders and academics to maintain the efficacy of such programs and aid in their continuous improvement. This research contributes to the literature concerning peer learning. The findings may be used in the future development of programs such as PASS to further inform the engagement of academic staff to enhance the student learning experience in such programs.

Hughes, A., Watson, R. & Boggs, C. (2008). *The Online Dilemma: Student Perceptions of Online Supplemental Instruction for General Microbiology*. Conference Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education. Supplemental Instruction (SI) is a model that has been used to enhance instruction for several decades and has seen a significant increase in popularity. Prior to the spring semester of 2008, the University of Wyoming only conducted SI in face-to-face settings. In the spring of 2008, the

General Microbiology course at the university held online SI sessions. For these sessions, students were asked to read a popular non-fiction novel and discuss it online with the other students. At the end of the semester, students were given a survey. Data at the end of the study indicated that the students perceived the exercise as beneficial, enhanced their understanding of course material, and were able to relate the information to real-world applications.

Huijser, H., & Kimmins, L. (2005). *PALS online and community building: A contradiction in terms?* Conference Proceedings of the 22nd annual ASCILITE Conference, Brisbane, Australia. At the University of Southern Queensland (USQ), Peer-Assisted Learning (PAL) is a modified version of the Supplemental Instruction (SI) model. PAL is used to build community for the online learners. The paper reviews examples of implementing online mentoring and suggestions for improved service to the students. Some of the suggestions included periodic face-to-face PAL sessions to offset the social isolation of the online learning activities and also to provide online photographs and short background narratives about the PAL facilitators to help acquaint them with the students participating online.

Huijser, H., & Kimmins, L. (2006). *Developing a peer-assisted learning community through MSN Messenger: A pilot program of PALS online.* Unpublished manuscript. University of Southern Queensland. Southern Queensland, Australia.

At the University of Southern Queensland (USQ), Peer-Assisted Learning (PAL) is a modified version of the Supplemental Instruction (SI) model. PAL is used to build community for the online learners. The paper reviews examples of implementing online mentoring and suggestions for improved service to the students. MSN Messenger is used as the venue for communication between the PAL facilitator and the students in the class. An economics and a data analysis class were selected for the study. The pilot program was evaluated using qualitative measures. While the online component helped to build community among the students, the initial academic outcomes appeared to be limited. The researchers encourage others to reproduce the experiment and seek to find more effective uses of the technology.

Huijser, H., Kimmins, L., & Evans, P. (2008). Peer assisted learning in fleximode: Developing an online learning community. *Australasian Journal of Peer Learning*, 1, 51-60. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/7>

At the University of Southern Queensland in Australia use an adaptation of Peer Assisted Learning Strategy (PALS) to support online learners. This version of PAL is named Meet-Up. Since 2006 MSN Messenger has been used to serve these distance learning students. This paper describes the use of Wimba software within an institution-wide Moodle learning management system. Use of these enhancements provides a chat function, sharing of PowerPoint slides, and document sharing. This more comprehensive suite of learning tools provides more interactivity and more content sharing than the earlier use of instant messaging alone.

Hull, H., Broome, H., Brown, D., & Portlock, J. (2017). A quantitative survey of the MPharm peer assisted learning programme at the University of Portsmouth. *International Journal of Pharmacy Practice*, 23, 59. Available online: <http://pharmacyresearchuk.org/wp-content/uploads/2017/04/73-A-quantitative-survey-of-the-MPharm-peer-assisted-learning-programme-at-the-University-of-Portsmouth.pdf>.

Peer assisted learning (PAL) involves Year 2 student volunteers called PAL leaders, trained in leadership and facilitation skills, who run study sessions for Year 1 students. PAL was developed to aid transition into university for Year 1 pharmacy students and the course. PAL leaders were Year 2 pharmacy students. The aim of this study was to determine the perceived impact of peer assisted learning (PAL) upon Year 1 MPharm undergraduates' transition to

university and their perceived preparedness for assessment. Eight PAL sessions were timetabled during the academic year and two PAL leaders facilitated 20 pharmacy students. Topics were student-led, meaning Year 1 students had control of the subjects to study and discuss in sessions. PAL leaders encouraged collaborative learning and consolidation of knowledge between students. Feedback from 182 pharmacy students, collected by means of a questionnaire, indicated that those students attending more than 4 PAL sessions (good attenders) during the academic year, benefited more than those attending fewer sessions (poor attenders). Students perceived an “enhanced knowledge and understanding of course topics” (60% good attenders compared to 34% poor attenders); “better understanding of how to meet course expectations” (51% compared to 22%) and an overall “confidence with the course” (42% compared to 11%). Attending PAL increased students’ perceived “preparedness for assessments” (86% compared to 59%). Students found PAL sessions useful and regular attendance impacts upon pharmacy students’ perceived knowledge, understanding and confidence with their course. As PAL becomes embedded into institutions’ cultures and the benefits further evidenced by impact-evaluation research, it should become a valued priority for resourcing.

Hurley, K. F., McKay, D. W., Scot, T. M., & James, B. M. (2003). The Supplemental Instruction Project: Peer-devised and delivered tutorials. *Medical Teacher*, 25(4), 404-407.

The study examined the effectiveness of Supplemental Instruction Program (SIP) with undergraduate first-year medical students at Memorial University of Newfoundland in the Integrated Study of Disease I course during 1888 and 2000. The SIP program is based on the Medical Scholars Program developed at the University of Southern California which is an adaptation of Supplemental Instruction. Both qualitative and quantitative data collection methods were employed to evaluate the program. Benefits were stated for both the student participants as well as the student group facilitators who were second year medical students. The purpose of this study was to determine whether student devised and delivered supplemental instruction is beneficial and acceptable to first-year medical students. A student-run Supplemental Instruction Project (SIP) was developed and delivered by second-year medical students and offered free of charge to all first-year medical students at Memorial University of Newfoundland taking the Integrated Study of Disease I course in 1999 and again in 2000. Small-group tutorials focused on subject material that second-year medical students identified as 'difficult'. Five 60- to 90-minute sessions covering topics in cardiology, nephrology and respiratory were offered. Student and tutor perceptions about the project were collected using anonymous questionnaires. Students were quizzed before and after each tutorial session. Post-tutorial quiz scores were significantly greater than pre-tutorial scores. Student and tutor perceptions of SIP were positive. It is concluded that the SIP is an acceptable, practical and effective method to supplement delivery of challenging material to first-year medical students.

Hurley, M., & Gilbert, M. (2008). Basic Supplemental Instruction model. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 1-9). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition this chapter provides a basic overview of the Supplemental Instruction (SI) model. Topics explored within the chapter include: early history of SI at the University of Missouri-Kansas City where it was created; characteristics of the students served by SI; essential individuals needed for an effective SI program (SI leaders, SI supervisor, faculty members, participating students); and learning strategies employed during SI sessions.

Hurley, M., & Gilbert, M. (2008). Research on the effectiveness of Supplemental Instruction. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success*

in high-risk courses (Monograph No. 7, 3rd ed., pp. 11-19). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

This chapter explores some of the research studies that evaluate the effectiveness of Supplemental Instruction (SI). The cited studies are those conducted by the staff at the University of Missouri-Kansas City, institutions at other U.S. institutions, and institutions outside of the U.S. Some of the cited studies focused on immediate outcomes of the SI program regarding improved final course grades and reduction of course withdrawals. Other studies examined longer-term impacts regarding increased persistence towards graduation. Other studies investigated changes in student affective domain such as self-confidence, personal communication skills, and other areas. Regardless of institutional type, academic discipline, or student population, participation with SI increased student outcomes.

Hurley, M., Jacobs, G., & Gilbert, M. (2006). The basic SI model. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 11-22). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This general overview of the SI model looks at the SI philosophy, essential program components, program structures, key roles, outcomes, and evaluation. The chapter also reviews what has been learned about the importance of planning SI sessions, providing ongoing training for leaders, conducting regular SI program assessments, and implementing effective and essential learning strategies.

Hurley, M., Patterson, K. L., & Wilcox, F. K. (2006). Video-based Supplemental Instruction: Serving underprepared students. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 43-54). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter discusses Video-based Supplemental Instruction (VSI), a variation of the SI model that presents options for students who, barring a serious academic intervention, will not be successful in college. Rather than enrollment in developmental-level courses, students enroll in a traditional introductory college course such as Western Civilization or General Chemistry. SI sessions are embedded inside of the lectures rather than waiting until after the lecture periods. Concurrent development of learning strategies along with mastery of rigorous academic content reduces the need for enrollment in prerequisite developmental-level courses.

Ilserver, J., & Leung, R. (2014). Measurement of the impact of supporting and Supplemental Learning Intervention Strategies (SSI) in introductory accounting classes at the University of Fraser Valley. *Business Studies Journal*, 6(1), 59-71. Available online: <http://www.alliedacademies.org/articles/bsjvol6si12014.pdf#page=67>.

This study highlights the importance of such tutorial services as Student-Learning-Group (SLG) for elementary accounting students in university education. In their first year of the bachelor program, fundamental concepts of various accounting topics such as accrual accounting are the corner-stones for students who move up to higher and more challenging accounting courses. With some help and guidance from senior students in the SLG program, freshmen students who are willing to receive help will receive the benefits of learning better and getting higher grades. Such experience will help those students who are well equipped with the fundamental concepts, able to study better in the intermediate and advanced accounting courses, and ultimately go back to become the tutor and leader in the SLG program and help other junior accounting students. Consequently, this on-going, reciprocal cycle of helping each other will become a positive culture that promotes better tutors and learners in the university.

Illesley, G. (1994). Introducing college-wide Supplemental Instruction. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 65-70). Birmingham, England: Staff and Educational Development Association
Supplemental Instruction is being used at Nene College (Northampton, United Kingdom). SI was used in five courses drawn from engineering, building studies, human biological studies and information systems. Research studies suggest improvement with SI participants.

Im, S. W. T., Chiu, P. H. P., & Ng, M. (2019). Comparative study between traditional and peer assisted learning of business management students on accounting Module *IAFOR Journal of Education*. Available online: <http://iafor.org/archives/journals/iafor-journal-of-education/10.22492.ije.7.2.pdf#page=97>.

Candidates who study business disciplines are trained to be all-round administrative staff to handle business-related issues. Knowledge of a basic accounting principle for supporting financial decisions is vital in business operations, and is especially crucial for managerial workers of a listed company. Indeed, the accounting module is one of the core modules for higher education students who are studying in business disciplines. With the College Heads' endorsement when departments joined the Peer-Assisted-Learning using Supplemental Instruction (PALSI) scheme, the academic results of two accounting modules were collected anonymously for research purposes. The subject registration information shows that each cohort had at least 300 enrolments and, at most, over 800 enrolments. A review of academic results throughout four academic years was performed, the sample size of the study consisting of a total of 1,815 PALSI students and 5,869 non-PALSI students. This article focuses on the quantitative analysis in comparing the performance of PALSI students and non-PALSI students by monitoring their academic results consecutively in different cohorts. In this study, a t-test is implemented to evaluate the effectiveness of the peer-assisted learning scheme by identifying the academic results of each cohort to ascertain if there is a significant difference between the two groups. Similar investigation on the effectiveness of the PALSI scheme with different accounting knowledge background before joining the undergraduate programmes is implemented in the latter part. The findings of the analysis provide remarkable academic enhancement for students with PALSI support, and it is concluded that the scheme is worth extending to different subjects in the business discipline in the future.

Indiana Commission for Higher Education. (1997). *Campus retention programs at Indiana public institutions: Working paper*. Unpublished manuscript. Indiana Commission for Higher Education. Indianapolis, IN. Available online: ERIC database. (ED431480).

This paper examines what Indiana public colleges are doing to improve the retention of students, and provides a synopsis of 12 examples of "best practices" in the state and three from other states. The commission also presents 11 observations, each accompanied by one or more possible strategies that might improve student retention. Half a dozen of the institutions provide achievement and persistence data about the impact of Supplemental Instruction with higher student outcomes.

Ingram, T. N., & Marcellus, E. (2018). Engaging foreign-black males through Supplemental Instruction. In T. N. Ingram & J. Coaxum (Eds.), *Engaging African American males in community college* (pp. 121-144): Information Age Published

Irwin, D., & Risser, B. (1988). *Supplemental Instruction-Plus: Levels of academic support at the community college*. Unpublished manuscript. Onondaga Community College. Syracuse, NY. Traditional support programs at community colleges focus a great deal of attention on meeting the needs of developmental students. Supplemental Instruction PLUS (SI+) builds on that model to provide several levels of academic support all students as they are challenged. SI+ was

developed at Onondaga Community College in Syracuse, NY and is a variation of the traditional SI program. However, SI+ groups have a slightly different focus since SI+ is meant to help students adjust to the demands of college courses after they have completed a sequence of developmental courses. The courses targeted by SI+ are not historically difficult and requiring the intensity of a full SI program. While the study sessions appear similar to traditional SI, SI+ leaders do not attend the course professors lectures. The SI+ leader still models effective study behavior. To keep pace with the course, the SI+ leader meets weekly with the course professor. It is anticipated that students will participate in traditional SI program when they encounter historically difficult courses in succeeding academic terms. The final stage for the SI+ program is for students to create independent study groups in other courses where SI+ and traditional SI sessions are not offered.

Ishmael, A. (2017). *The impact of Supplemental Instruction on student achievement and retention at a minority-serving, private, not-for-profit university in southeastern Florida*. (Ph.D. dissertation), Nova Southeastern University.

Student academic success and retention are primary concerns for colleges and universities. This researcher used a mixed method study to explore the impact of Supplemental Instruction (SI) on student success and persistence in two introductory, college-level algebra courses, Math 1030 Intermediate Algebra, and, Math 1040 Algebra for College Students, at a minority-serving, private not-for-profit university in Southeastern Florida. In response to greater accountability to increase students' achievement and retention, SI, in conjunction with other academic support programs, was developed to assist students to progress successfully through high-risk courses, for example, mathematics. Developed by Deanna Martin at the University of Missouri-Kansas City, SI is an academic support tool that incorporates collaborative learning study sessions to improve student academic success and persistence. This study allowed the researcher to understand if students are more successful academically because of participating in SI sessions. More specifically, the researcher's goals were to find out if student achievement and long-term retention is gained when students participate in SI, and, if additional benefits outside of course grades and retention are achieved because of SI participation. Using a convenience sample, the researcher sought to answer five research questions: (a) To what extent are students who participated in SI Mathematics more successful than students who did not participate in SI Mathematics, as measured by final course grades? (b) What is the persistence of students who participated in two or more SI sessions as measured by fall-to-fall semester retention? (c) Does the level of persistence differ by gender? (d) What additional benefits occur with SI student participation outside of course grades and retention as measured by focus groups? (e) To what extent does the quantitative and qualitative data converge? This study required the use of archival data of students who participated in SI Math 1030 Intermediate Algebra and SI Math 1040 Algebra for College Students in the 2015-2016 academic year. In addition, the researcher conducted a focus group and two one-on-one interviews to investigate if additional benefits were gained when students participate in SI Math. Analysis of the quantitative data revealed that student academic success is achieved, based on final course grades, and fall-to-fall retention is statistically significant when students participate in two or more SI sessions. However, a Mann-Whitney U test showed that persistence level did not differ by gender. Results from the qualitative data indicated that additional benefits such as increased student engagement and integration, enhanced learning, and communication is gained by attending SI.

Jacobs, G., Hurley, M., & Unite, C. (2008). How learning theory creates a foundation for SI leader training. *Australasian Journal of Peer Learning*, 1, 6-12. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/3>

This article explores the theories that inform the Supplemental Instruction (SI) approach and how they link to training of SI leaders. Three elements are identified as critical for effective SI leader training: a conducive environment needs to be established to enable the SI leaders to construct their own meaning and practice their newly acquired skills in a safe place; training should promote a social process in which students talk in order to learn through peer-to-peer interaction; and active learning is encouraged by simulating the experience of serving as a SI leader with a group of students.

Jacobs, G., Stone, M. E., & Stout, M. L. (2006). The new vision for SI: Where are we heading? In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 95-100). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This final chapter in this monograph focuses on future uses of SI outside of its historic role of improving academic achievement for students in historically-challenging courses. Areas for new and extended uses for SI include industry, online education, and use in enhancing learning in remote learning environments throughout the world.

Jacobs, G., Stout, M. L., & Stone, M. E. (2008). Supplemental Instruction: International adaptations and future directions. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 81-90). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

The Supplemental Instruction (SI) model has been adopted and adapted by more than 1,500 colleges and universities in more than 30 countries. Five international institutions are highlighted in this chapter: University of Manchester, United Kingdom; University of Wollongong, Australia; St. George's University, School of Medicine, Grenada, West Indies; Nelson Mandela Metropolitan University, South Africa; and Lund University, Sweden.

Jacquez, R., Gude, V. G., Hanson, A., Auzenne, M., & Williamson, S. (2007). *Enhancing critical thinking skills of civil engineering students through Supplemental Instruction*. Conference Proceedings of the ASEE.

This conference proceeding describes the use of Supplemental Instruction (SI) at New Mexico State University with civil engineering students. SI has been offered for these students since 2003. In addition to focusing on enhancement of final course grades, the SI program requires the students to exercise critical thinking skills as it involves design-oriented open-ended problem solving. SI participants outperformed the nonparticipants through both their work examples as well as exam scores. There was a dramatic reduction of grades of C-D with a corresponding increase of final grades of A or B for the SI participants. Surveys of students indicated high satisfaction with the SI program. Special attention was paid during the evaluation process for the potential impact of SI with Hispanic and female students. This was important since the institution serves a high percentage of Hispanic students due to its location in New Mexico. Attention was paid for female students since they are historically underrepresented in the engineering degree programs. On both accounts, the Hispanic and female students participated at similar rates in the SI program in comparison with students from other demographic backgrounds.

James, A. M. (2014). *Experiential learning theory, transformational leadership, and the Supplemental Instruction Leader: An exploration of their relationship and influence on recurring attendance to Supplemental Instruction sessions*. (Ph.D. dissertation), Texas A & M University, College Station, TX. Available online: <http://oaktrust.library.tamu.edu/handle/1969.1/153476>

The purpose of this study was to explore the learning preferences and leadership behaviors of Supplemental Instruction (SI) leaders at Texas A&M University, and the impact of those preferences on recurring attendance to their sessions. The Learning Style Inventory (LSI) 3.1, the Multifactor Leadership Questionnaire (MLQ), and a demographic instrument were administered to 34 SI leaders employed in the fall 2013 semester. A majority of participants preferred a diverging or accommodating learning style and perceived themselves to display transformational leadership behaviors the most. Analysis of variance and Pearson product-moment correlations revealed that learning preferences and leadership behaviors did not have a significant relationship with recurring attendance. Significant relationships for variables on the LSI and MLQ were found for transformational and transactional leadership behaviors and learning preferences. Most of these relationships were found for preference for transforming information. Literature concerning the SI leader is narrow. Supplementary studies exploring their characteristics, preferences, and personality are needed. The relationship between leadership and learning is an area that can benefit from further research.

James, A. M., & Moore, L. (2018). Understanding the Supplemental Instruction leader. *The Learning Assistance Review*, 23(1), 9-29. Available online: <https://files.eric.ed.gov/fulltext/EJ1170156.pdf>.

This article explored the learning styles and leadership styles of Supplemental Instruction (SI) leaders at Texas A&M University, and the impact of those preferences on recurring attendance to their sessions. The Learning Styles Inventory, the Multifactor Leadership Questionnaire, and a demographic instrument were administered to SI leaders employed in the fall 2013 semester. This study is of significance to practitioners and researchers by identifying characteristics of SI leaders, one of the key personnel of a higher education learning program. The majority of participants in this study preferred a diverging or accommodating learning style. On the MLQ participants had a higher mean score for transformational leadership. The highest mean score reported was for inspirational motivation.

James, C., & Templeman, E. (2015). Exploring the emotional intelligence of student leaders in the SI context. *Journal of the First-Year Experience & Students in Transition*, 27(2), 67-81. Available online: <http://www.ingentaconnect.com/contentone/fyesit/fyesit/2015/00000027/00000002/art00004?crawler=true>.

An exploratory study of the emotional intelligence (EI) of student leaders participating in a Supplemental Instruction (SI) program was conducted to determine whether a significant relationship exists between leadership effectiveness and EI as measured by the Bar-On Emotional Quotient Inventory (EQ-i) and to assess the impact of the leadership experience on EI scores through pre- and post-testing. The results revealed a statistically significant difference in the Total EQ-i of the more effective leaders as compared to the others. The more effective leaders also scored higher on all the EQ-i subscales, with the differences on Social Responsibility, Impulse Control, and Reality Testing being statistically significant. As for changes in EI, only the scores on the EQ-i Problem Solving subscale increased significantly between the pre- to post-testing sessions. Implications for practice and future research are addressed.

Jarrett, C. J., & Harris, J. A. (2009). SI Plus: A program description and an analysis of student feedback. *The Learning Assistance Review*, 14(2), 33-42.

The purpose of this single-case descriptive study was to explore student and instructor perceptions of Supplemental Instruction in an upper-level physical chemistry course that was historically-difficult. The research took place at a doctoral/research intensive land grant university in the Northeast. The case study methodology used included a focus group, one-on-

one interviews with instructors and students, document review, and class and SI statistics. Results indicated that faculty and students perceived SI to be a valuable resource in achieving persistence or academic success.

Jarvi, S. W. (1998). A quantitative and qualitative examination of Supplemental Instruction and its relationship to student performance (collaborative learning, academic support) [Dissertation, The University of Connecticut, 1998]. *Dissertation Abstracts International*, 59(05), 1484A. Academic support programs are well entrenched on virtually every college campus. These programs have not always been warmly received, however, and their place on many campuses is a source of constant debate. They have to be evaluated effectively and often to determine if they are achieving their intended goals and contributing to the overall mission of the institution. Supplemental Instruction (SI) is one example of a support program because it utilizes peers to foster a collaborative learning environment and targets high risk classes as opposed to high risk students. Quantitative and qualitative methodologies were employed in this study. The sample for the quantitative component included 2,295 cases of a student completing 1 of 12 introductory level Biology or Chemistry courses in which SI was offered at a large New England Research University. From the total sample, 860 students attended at least one SI session. Qualitative techniques were employed to collect data from both participants and non-participants of SI during one semester. Direct regression where the independent variables of Scholastic Aptitude Test scores, cumulative grade point average, semester standing, and level of SI participation. The dependent variable was student performance in the class as measured by average exam scores. Analyses of data found that in 7 of 12 classes involved, level of participation in SI explained a significant additional amount of variation in exam scores with accompanying large effect sizes. Qualitative findings revealed core categories related to why students attend SI: belief that SI attendance helps to raise test scores; SI sessions were fun and made participants feel more comfortable; students liked SI since it gave an opportunity to work in teams with other students; enabled attendees to stay academically competitive; and sometimes SI sessions compensated for poor lectures. The two major reasons for students not participating in SI were that time constraints precluded attendance and the other reason was a belief that SI attendance was unnecessary.

Javaher, N. (2010). *Outcome differences in participating and nonparticipating Hispanic students in Supplemental Instruction classes supporting Organic Chemistry I and II at New Mexico State University*. (Ph.D. dissertation), New Mexico State University, United States.

Lack of academic success by Hispanic students in higher education has caused university administrators to seek alternative programs to improve rates of retention and their academic success. Hispanic students are less likely than White students to complete advanced science classes, including chemistry (National Center for Education Statistics, 2006). With the shortage of an educated workforce, the nation is dependent on educating the fastest-growing ethnic/racial population. Of the 17,200 students enrolled in New Mexico State University (NMSU) in fall 2008, 40% were Hispanics, which makes the university a Hispanic-serving institution. Many programs at the university support Hispanic students, including Supplemental Instruction (SI). This study investigated whether participation in the SI program was associated with retention and better course performance among Hispanic students in Organic Chemistry courses at NMSU from 2001 through 2005. The study also examined gender differences among Hispanic students with respect to SI. The results revealed that participation in SI was, statistically, associated with retention of Hispanic students in both Organic Chemistry I and II classes and with fewer grades of D's and F's in Organic Chemistry I classes at NMSU during the mentioned semesters. The examination of gender differences revealed no significant difference; however, it was apparent that there were more female Hispanics enrolled in life sciences at NMSU compare to male

Hispanics during the semesters of fall 2001 through spring 2005. This study was significant because it examined a method to retain Hispanic students in a Hispanic-serving Institution.

Jenkins, A. (1994). Thirteen ways of doing fieldwork with large classes/more students. *Journal of Geography in Higher Education*, 18(2), 143-155.

This article describes thirteen strategies for geography instructors to consider to increase instructional effectiveness with large classes. The article is addressed to geography teachers and other field-based subjects in the United Kingdom. Suggestion number suggests finding ways to add new members to the academic staff. Supplemental Instruction (SI) is suggested as a way to involve students in helping to teach each other in large classes.

Jimenez, R. (2018). *Implementing an online Supplemental Instruction program*. Conference Proceedings of the Society for Information Technology & Teacher Education Conference. This paper will offer an Online Supplemental Instruction (OSI) Implementation framework that higher education institutions can use to implement their own OSI program. The paper will review traditional SI program structures, the theoretical underpinnings supporting SI programs, and the foundations of Online Supplemental Instruction (OSI). The theoretical frameworks reviewed include constructivism, active learning theory and Tinto's theory of student persistence. In addition, a review of the OSI Implementation Framework is introduced. The OSI implementation framework is explained and how it can be used by higher education institutions to develop their own OSI program. Constructivist learning environments and TPACK influences that inform the OSI Implementation framework are discussed. Finally, recommendations and conclusions about the OSI Implementation Model will be discussed. This includes student training to support their needs in using online environments and in developing a "train the trainer" program and ongoing support for the student leaders (SILs) that will be leading SI/OSI sessions.

Jimenez, R. (2018). *Supporting STEM college student success via traditional and online Supplemental Instruction: A mixed-methods causal comparative study*. ((Ph.D. dissertation).), New Jersey City University.

The goal of this causal-comparative, mixed methods study was to measure the degree of success that supplemental instruction (SI) promotes success and retention. The overarching goals of supplemental instruction are to improve student grades, reduce attrition, and increase student retention in a science, technology, engineering, and math (STEM) field. The study encompassed a review of traditional SI program structures, the theoretical underpinnings supporting SI programs, and the foundations of online supplemental instruction (OSI). Theories used to frame the study included constructivism, active learning theory, and Tinto's theory of student persistence. An OSI pilot was conducted in the Fall 2017 semester and discussed in terms of its implementation and the data collected. The quantitative and qualitative data collection procedures were discussed, and the analyzed results were compared to the existing literature. Finally, recommendations and implications to the field and future OSI implementations were discussed.

Jobidon, E., Owen, W., Robinson, M., & Prier, A. (2016). *Supported learning groups (SLGS) in a first-year engineering chemistry course*. Conference Proceedings of the Canadian Engineering Education Association. Available online:

<https://ojs.library.queensu.ca/index.php/PCEEA/article/view/6501>

The Engineering Undergraduate Office at the University of Waterloo first started using Supplemental Instruction (SI) in a common first-year chemistry course, ChE102, in September 2013 and continued in September 2014 and 2015. This paper shares the mechanics of how SI was implemented for 11 cohorts totaling approximately 3900 students over the past 3 fall terms. Findings suggest that students who attend SI after midterms have higher final grades in their

CHE 102 course as well as a higher overall term average. As well, the academic standing of students (based on their midterm grades) can help to accurately predict which students will attend SI sessions. Similarly, attending SI after midterms can also help a certain type of student improve their marks in CHE 102 and also their term average.

Johnston, C. (1995). *Peer tutoring in economics at the University of Melbourne*. Conference Proceedings of the Australian Economic Education Symposium, Adelaide, Australia. This paper describes an adaptation of the Supplemental Instruction (SI) model used at the University of Melbourne (Australia) in 1993. The model integrates Diploma of Education students in an undergraduate economics group learning program (Macroeconomic theory and Macroeconomic Policy). Several adaptations of the SI program: the group facilitator was a volunteer postgraduate Diploma of Education student; two wine and cheese evenings were scheduled to provide the facilitator and students to interact socially and exchange experiences with one another. It found that small groups operate more effectively in terms of group cohesion, longevity and perception of improved performance when supported by postgraduate students. Postgraduates developed an enhanced range of skills in relation to group management, cooperative learning and communication.

Jones, J. P. (2013). The impact of the Supplemental Instruction leader on student performance in introductory accounting. *American Journal of Business Education*, 6(2), 247-254. Available online: <http://www.cluteinstitute.com/ojs/index.php/AJBE/article/view/7690>. This study explores the association between a supplemental instruction (SI) program and student performance in an introductory accounting course. SI is a proactive academic support program that is aimed at improving student learning in traditionally "high-risk" college courses by integrating learning and critical thinking strategies with technical course content. This paper examines and describes the classical SI model as it has been applied in both non-business and business disciplines. We then extend the work of Etter, Burmeister, and Elder (2000) and Jones and Fields (2001) which examine the effectiveness of the SI model in introductory accounting by providing empirical tests after controlling for differences in SI group leaders. The SI leader's duty is to provide structure to the collaborative learning environment and to integrate study skills and learning strategies with course content. However, empirical analysis incorporating controls for differences in SI leaders is lacking. Results, based on both nonparametric chi-square analysis and analysis of covariance (ANCOVA) indicate that SI is an effective program that increases academic performance as measured by total points earned in the course. Further, results suggest that the SI program remains effective across multiple SI leaders.

Jones, J. P., & Fields, K. T. (2001). The role of Supplemental Instruction in the first accounting course. *Issues in Accounting Education*, 16(4), 531-547. This study investigates empirically the role of Supplemental Instruction (SI) as a means of enhancing student performance in the first accounting course. ANCOVA-based results from 1,359 students in nine sessions of Principles of Accounting indicates that SI was effective at increasing academic performance; after controlling for self-selection bias, participation in both voluntary and mandatory SI sessions was found to be positively associated with the total points earned in the course. Additionally, a step pattern is observed in the increased performance for both the voluntary and mandatory attendance phases of the study, indicating that the level of SI attendance may play a role in the benefits obtained. The implications of this analysis for the accounting curriculum are addressed.

Josephsen, K. (2001, 2001, October 1). Illinois State University to discuss student retention, *The Pantagraph*, p. A3.

This newspaper story describes the use of Supplemental Instruction (SI) at Illinois State University-Bloomington and its impact on increasing student retention.

Kalil, A., Jones, C., & Nast, P. (2016). Application of Supplemental Instruction in an undergraduate anatomy and physiology course for allied health students. *Supplemental Instruction Journal*, 2(1), 33-52. Available online: <http://info.umkc.edu/si/wp-content/uploads/2016/09/siJ-Volume-Two-Issue-One.pdf>.

Anatomy and physiology is a field of science essential to the studies of all healthcare professionals. However, quite often, such subject matter, particularly when taken by less experienced students, results in poor performance and high failure rates. The current study investigates the incorporation of Supplementary Instruction (SI) as an academic assistance program which utilizes peer-led study sessions in order to improve student grades, rates of success, and learning experiences. The results indicate that students who participated in SI sessions consistently outperformed non-SI students. There was a positive linear relationship between the numbers of SI sessions attended and the higher final grade earned. In addition, an end of term survey indicated that the SI addition was well-liked by the students and helped them to better prepare themselves for the challenges of the course. This study demonstrates that students who routinely participate in SI sessions improve their final grades and success rates in an anatomy and physiology course. The current report confirms that the SI academic support model enables students to develop and incorporate effective learning techniques and problem solving skills which ultimately translate into higher student success rates and enhanced learning experiences.

Karcher, B., & Pierson, B. (2017). *Quantified self in engineering education: How are students studying and is it working?* Conference Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Vancouver, British Columbia, Canada.

This paper examines student study activities and behaviors in undergraduate engineering courses at Purdue University. The goal is to better understand specifically which study tactics correlate with success in courses where students typically struggle. Students used Pattern, a tool developed at Purdue to log, track, and visualize study habits for one week leading up to each exam during the Spring 2017 semester. At the end of the semester, students were surveyed on their perceptions of Pattern, how the data helped them, and what additional features it needs. Early results indicate that in certain courses, time spent studying is not as important as how students study and that certain activities are more correlated with success. Finally, this paper outlines future development needs for tools like Pattern. The implications of this study could inform study strategies for students in engineering courses, improve student success, and assist in designing better help opportunities for students.

Kastelic, J. (1997). *Adjunct study skills: An integrated, student-centered approach to learning in community college*. (Master's of Arts thesis), University of San Francisco, San Francisco, CA. This research report describes one academic study skills program offered at a community college in northern California. It presents a variety of data to show how this integrated, student-centered, collaborative-based adjunct program affected the immediate and long term academic performance and study behaviors of its multicultural, multilingual participants. Students who enrolled in the target course in political science and concurrently completed its corresponding adjunct course over a three quarter period participated in this study. The adjunct course (Skills 130A/PS) was a variation of the Supplemental Instruction (SI) model. Students must attend at least seven weekly sessions and complete four independent study skills labs. SI leaders facilitate the adjunct course which carries academic credit and can generate extra credit points for the linked political science course (Political Science 1). A qualitative and quantitative study

was conducted. The students enrolled in linked adjunct course earned higher rates of A & B final course grades, lower rates of D, F & W grades, and increased levels of study skills abilities as compared with students who did not enroll in the adjunct course.

Kastor, E. (1984, 1984, April 2). Education: Reading, writing and reasoning, *Washington Post Newspaper*, p. B5.

This newspaper article provides an overview of the Supplemental Instruction (SI) program and its use to develop reasoning skills. Research suggests that half of all students entering college lack the basic reasoning skills to completely understand the content of their courses. It contains an interview of Deanna Martin, creator of the SI program.

Kauffman, D., & Wolfe, R. F. (1990). Supplemental Instruction with mentoring support: A vehicle for faculty development. *The Journal of Staff, Program, and Organization Development*, 8(2), 101-104.

The Supplemental Instruction (SI) program at Anne Arundel Community College (Arnold, MD) was modified to use faculty members as SI supervisors. While this was the initial focus for the faculty members, the mentor role evolved into an opportunity for them to observe colleagues and to grow as teachers. Faculty mentors were placed in classes outside their own discipline. The classroom instructor and faculty mentor would meet periodically to provide feedback to each other and discuss strategies to improve instructional effectiveness.

Kaye, P. (1994). Introducing Supplemental Instruction in law. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 51-54). Birmingham, England: Staff and Educational Development Association

Supplemental Instruction was introduced at the University of Central Lancashire (United Kingdom) in the law program. While the targeted courses did not have high rates of low grades or withdrawal, there were several other reasons for their selection: enhancement of students' competencies and skills; leadership development; appreciation for learning outside of the formal classroom environment; and increased understanding of substantive legal issues.

Keim, K., & Kiser, M. (2019). SI or peer tutoring: Is one really better than the other? *Journal of College Academic Support Programs*, 2(1), 52-53. Available online: <https://journals.tdl.org/jcasp/index.php/jcasp/issue/view/issue/15/5>.

Supplemental Instruction feels more like a preventative measure in that, if students utilize it first, they might not need peer tutoring later on. Ultimately, neither option should be considered better nor worse but should be considered in terms of how the student uses it to achieve academic success. In this case, I believe that it would benefit Charlie to utilize both SI and peer tutoring resources. He could maximize his chances of understanding the material by attending SI sessions regularly to gain a deeper understanding of the material taught in class. Then, as further questions arise while solving homework problems and studying, he should seek more individualized help by meeting with a peer tutor.

Keisha, R. L. (2018). *An investigation of the relationships of student engagement and academic performance of Supplemental Instruction students concurrently enrolled in a gateway mathematics course at California State University in Southern California*. (Ph.D. dissertation), Pepperdine University. Available online:

https://media.proquest.com/media/pq/classic/doc/4325883275/fmt/ai/rep/NPDF?_s=lqTN6K0j7liGuj%2FE%2B1hwuekKCw%3D

This study, conducted at California State University (CSU) in Southern California, focused on student engagement factors and academic performance of Supplemental Instruction (SI) students concurrently enrolled in a gateway mathematics course. The purpose of this

quantitative correlational survey study was to investigate engagement factors employed by SI students enrolled in gateway mathematics courses; the researcher explored the relationships of the SI students' engagement factors to their gateway mathematics course grades. The participants completed a web-based survey in which they responded to items regarding their behaviors, thoughts, and feelings as experienced in the gateway mathematics course and the SI class sessions. The responses were scored within 4 engagement factor scales including skills engagement, emotional engagement, participation/interaction engagement, and performance engagement. The results of this study provided support for 2 alternative hypotheses: (a) there was a positive relationship between each of the 4 engagement factors and the gateway mathematics course grades of the participants, and (b) there was a positive relationship of the linear combination of the 4 engagement factors to the gateway mathematics course grades of the participants. The findings of this research study supported 3 conclusions: (a) engagement is a multidimensional construct, and the more students are engaged in their studies, the more likely they are to earn higher grades in a gateway mathematics course; (b) academic support and resources are essential for student learning; (c) college success, specifically, positive academic course performance, is a significant indicator of persistence toward college completion. Recommendations based on the findings and conclusions of this study include regular collaboration of efforts among all university stakeholders to provide a variety of student-centered venues for academic support and resources to engage students in developing self-efficacy for academic success in gateway mathematics courses.

Kelley, A. (2016). *Analyzing the relationship between attendance in hybrid Supplemental Instruction and tutoring sessions and success in courses with traditionally high failure rates*. (Ph.D. dissertation), Texas Women's University.

Academic assistance programs have been around in some form or another since the mid-1600s, and they have grown and developed just as the demographics of students in tertiary institutions have. The Supplemental Instruction model is an assistance program that was built as a response to the needs of the shifting student body, and Texas Woman's University is one of many institutions that have adopted a hybrid supplemental instruction model in an effort to increase student performance in their classes. The purpose of this research was to determine which, if any, factors impact the success of a student in the TWU Supplemental Instruction and Tutoring program using logistic regression analysis to build prediction models for success. The models that were created showed that, contrary to the hypothesis of this study that the number of SIT sessions attended would provide the largest impact, whether a student was determined to be at risk by the standards set by the TWU SIT program and whether the student attended the minimum number of required SIT sessions were the variables most influential on success.

Kelly, B. A. (1991). *Selection of leaders to facilitate Peer Assisted Study Sessions (PASS)*. Unpublished manuscript. University of Queensland, Australia.

This article describes the selection procedures for Peer Assisted Study Sessions (PASS) leaders. PASS is a locally used name at Queensland Institute of Technology and the University of Queensland in Australia for the Supplemental Instruction (SI) program. Several suggestions include distributing leaflets and encouraging former PASS participants to apply as leaders. Group interviews are used to save time and to make students feel more at ease during the interview process. To meet the need for the program to fit the institutions use of Total Quality Management (TQM), PASS leaders were asked to complete a questionnaire at the end of their PASS sessions and to maintain a diary of session activities. This information was used to improve the PASS program and provide helpful feedback to the course instructors.

Kelly, B. A. (1992). *And it came to PASS: Peer Assisted Study Sessions*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This paper discusses the development of the Peer Assisted Study Sessions (PASS) program at Queensland University of Technology (Brisbane, Australia). PASS is based upon the Supplemental Instruction (SI) model. The program was piloted in two classes in Anatomy for Nursing and Statistics for Information Technology. Research results indicated a lower rate of withdrawal and higher final course grades for participants.

Kelly, B. A. (1995). *Peer-Assisted Study Sessions: An instrument for quality assurance in high risk subjects*. Conference Proceedings of the Higher Education Research and Development Society of Australia Conference.

This paper describes the use of Peer Assisted Study Sessions (PASS), a local name for the Supplemental Instruction program as it is used at the Queensland University of Technology in Australia. The PASS program is being used as part of the institution's quality assurance (QA) system to regularly examine the needs of its customers (i.e., students enrolled in the courses that had PASS attached to them, faculty members who taught the courses, and the general community who employed the students). There was special concern for courses in which the faculty members were instructing students from other college majors. The PASS leaders served as a conduit for weekly communications with the faculty members regarding the comprehension level of the students and can make decisions regarding modifying their classroom delivery. This "just-in-time" feedback system provides immediate benefit to the students and lectures as weekly incremental improvements can be made.

Kelly, B. A., & Gardiner, R. (1994). *Student peer mentoring: An effective strategy to promote student learning*. HERDSA Annual Conference. Unpublished manuscript.

The Peer Assisted Study Sessions (PASS) program is based upon the Supplemental Instruction (SI) program developed in the U.S. PASS was used at the Queensland University of Technology (Brisbane, Australia). A pilot program was carried out in 1992. Since then, the SI program has spread to seven disciplines in five faculties, and has attracted four 1994 CAUT grants.

Kelter, P. B., & Carr, J. D. (1996). *Personalizing the large general chemistry lecture experience*. Unpublished manuscript. The University of Nebraska at Lincoln. Lincoln, NE.

This report that includes information about the use of Supplemental Instruction (SI) was published online in connection with New Initiatives in Chemical Education, an on-line symposium, June 3 to July 19, 1996. SI was selected since it helps to provide a support structure to help individuals in the large class sections of Chemistry 109 and 110. Data from Fall 1995 showed that SI participants received a higher final course grade (2.80 vs. 1.99), a higher rate of A and B final course grades (53.1% vs. 34.9%), a lower rate of D and F final course grades (13.6% vs. 39.4%). Data suggests what when students are classified on the basis of ACT quartile scores, those who participated in the SI sessions receive a considerably higher grade in Chemistry 109 than those who did not if they had higher ACT scores (top quartile: SI, 3.18 vs. 2.53 non-SI; middle two quartiles: 2.60 vs. 2.04; bottom quartile: 1.97 vs. 1.68).

Kemmet, L. C., & Mizeur, L. M. (2003). *Supplemental Instruction: Students helping students*. Unpublished manuscript. North Dakota State University. Available from the author: Linda M Mizeur, Department of Chemistry, North Dakota State University, 1025 16th St. N., Fargo, ND 58102, Lindell.Kemmel@ndsu.nodak.edu

Supplemental Instruction (SI) was used at North Dakota State University in the chemistry department and targets five courses: Conceptual Chemistry, General Chemistry I and II, and Organic Chemistry I and II with positive academic achievement for SI participants.

Kemppainen, A., Hamlin, A., & Manser, N. (2018). *Supplemental Instruction in a first-year engineering course: A study from the Learning with Academic Partners (LEAP) Program*. Conference Proceedings of the 2018 IEEE Frontiers in Education Conference (FIE), San Jose, CA, USA.

This innovative practice full paper reviews the formation and effects of the Learning with Academic Partners (LEAP) program at Michigan Technological University in the first two years of operation. The LEAP Program combines the job requirements of a traditional Teaching Assistant (TA) with those of a Supplemental Instruction (SI) Leader. While each program has their benefits, to date, no one has evaluated the effects of a combined program such as the one established at Michigan Tech. To determine these effects, we focused our analysis on measuring course performance and student attitudes of student groups in a second semester first-year engineering course, ENG1102 - Engineering Modeling and Design: Spring 2017 (no LEAP), Spring 2017 (no LEAP/pilot LEAP with optional attendance), and 2018 (LEAP with mandatory attendance).

Kemppainen, A., Hamlin, A. J., & Diment, H. (2017). *LEarning with academic partners (LEAP) Success and growing pains in the first year* Conference Proceedings of the IEEE Frontiers in Education.

Supplemental Instruction (SI) is a technique that has been shown to be successful in supporting students in historically challenging courses and improving grades and retention [1]–[3]. SI was started at the University of Missouri-Kansas City (UMKC) in 1973, but has since branched out to approximately 1500 institutions in 30 countries. The program benefits all areas of an institution: students, SI leaders, faculty, and administration. The students benefit by developing a deeper understanding of the course material as they work closely with and are mentored by an SI leader. Mentoring occurs with students who are close in age and have a working knowledge of the environment in which the mentee is meant to operate in [4]. Mentoring allows students to develop coping skills necessary for success. This technique works particularly well for students who would not normally seek assistance [5]. Successful mentoring emphasizes the student's strengths, leading to increased self-efficacy and retention. The SI Leaders develop leadership and facilitation skills as well as increased skill in the course material. Faculty benefit by using their SI leaders to connect them with students: their problems, areas of confusion, and learning challenges. Finally, the administration benefits by increased retention at the University

Kenney, P. A. (Writer). (1988). Supplemental Instruction sessions in math courses [Videotape]. In M. Garland (Producer). Kansas City, MO: Center for Supplemental Instruction, University of Missouri-Kansas City

This video tape features Dr. Patricia Kenney discussing ways in which Supplemental Instruction (SI) in mathematics courses differ from those in other content areas. Kenney served as a math SI leader during her doctoral research on the effectiveness of SI in math sessions at the University of Texas at Austin.

Kenney, P. A. (1989). Effects of Supplemental Instruction (SI) on student performance in a college-level mathematics course [Dissertation, The University of Texas at Austin, 1988]. *Dissertation Abstracts International*, 50(02), 378A.

This doctoral dissertation describes a research study that used Supplemental Instruction (SI) in a first-semester calculus course for business and economics majors at the University of Texas at Austin. The experimental design for this study used Campbell and Stanley's Nonequivalent Control Group model. The study used two lecture classes with the same instructor. Each class was divided into two discussion sections, and of those, one from each received the SI treatment. In the control sections the teaching assistant performed typical duties. In the SI sections the assistant performed the same duties but in addition she provided instruction on the

study skills relevant to the course as it progressed and other activities that SI leaders would perform or facilitate. The results showed a statistically significant difference favoring the SI treatment group: the control group mean course grade point average of 2.43 and that for the treatment group of 3.00; the control group mean semester grade point average (GPA) of 2.51 and that for the treatment group GPA of 2.95. A multiple linear regression model was then chosen as a more complete method of analysis. Three of the independent variables had coefficients which were significant at the .05 level -- high school class rank, discussion section attendance, and control/treatment group membership. This helps to answer the question of whether SI was just a form of "double exposure" to the course content. Since SI sessions were qualitatively different than the traditional discussion sections (as evaluated by outside observers using a observation protocol) and that the students who participated in the SI sessions earned higher mean final course grades, it appears that SI sessions were more than double exposure. A multiple regression analysis of semester grade point average found that three of the variables were significant at the .05 level -- the SAT Mathematical score, discussion section attendance, and group membership. Controlling for exposure, it was suggested that these gains were due to the benefits of SI, not to the increased exposure of the group to course material. To investigate any residual effects from the SI program, the students from the initial study were tracked for an additional semester. Results from the follow-up study showed that students who had experienced SI had a pattern of fewer F grades in and withdrawals from the second-semester business calculus course. Of the 26 students who failed or withdrew from the original calculus course, former SI participants were more likely to immediately reenroll in the course (six students) than the non-SI participants (one student). Another study focused on the academic performance of SI and non-SI participants in a succeeding academic term in courses where SI was not offered. Former SI participants earned no F grades or withdrew from the second-semester business calculus course. The former SI participants earned a slightly higher mean final course grade (2.63 vs. 2.48), though it was not a statistically significant difference. The researcher speculates that the absence of SI with the second calculus course may had a bigger impact on former SI participants -- narrowing the positive difference in academic achievement with the control group -- since a support service which they were used to accessing was not available in the next course in the sequence.

Kenney, P. A. (1989). *Effects of Supplemental Instruction on student performance in a college-level mathematics course*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA. Available online: ERIC database. (ED347874). This paper describes a research study that used Supplemental Instruction (SI) in a first-semester calculus course for business and economics majors at the University of Texas at Austin. The experimental design for this study used Campbell and Stanley's Nonequivalent Control Group model. The study used two lecture classes with the same instructor. Each class was divided into two discussion sections, and of those, one from each received the SI treatment. In the control sections the teaching assistant performed typical duties. In the SI sections the assistant performed the same duties but in addition she provided instruction on the study skills relevant to the course as it progressed and other activities that SI leaders would perform or facilitate. The results showed a statistically significant difference favoring the SI treatment group: the control group mean course grade point average of 2.43 and that for the treatment group of 3.00; the control group mean semester grade point average (GPA) of 2.51 and that for the treatment group GPA of 2.95. A multiple linear regression model was then chosen as a more complete method of analysis. Three of the independent variables had coefficients which were significant at the .05 level -- high school class rank, discussion section attendance, and control/treatment group membership. This helps to answer the question of whether SI was just a form of "double exposure" to the course content. Since SI sessions were qualitatively different than the traditional discussion sections (as evaluated by outside observers

using a observation protocol) and that the students who participated in the SI sessions earned higher mean final course grades, it appears that SI sessions were more than double exposure. A multiple regression analysis of semester grade point average found that three of the variables were significant at the .05 level -- the SAT Mathematical score, discussion section attendance, and group membership.

Kenney, P. A. (1990). *Effects of Supplemental Instruction on student performance in a college-level mathematics course: A report of additional results*. Unpublished manuscript. Annual Meeting of the American Educational Research Association. Boston, MA.

This paper details additional results from an experiment on the effects of Supplemental Instruction (SI) on student performance in a college business calculus course. The paper is a continuation of research first reported at the 1989 AERA Annual Meeting. SI participants who withdrew from the course most often cited their perceived lack of prerequisite skills or to problems with calculus concepts. The author postulates that the exposure to SI raised their awareness of their lack of skills. Non-SI participants who withdrew from the course most often cited "personal" reasons. Of the 26 students who failed or withdrew from the original calculus course, former SI participants were more likely to immediately reenroll in the course (six students) than the non-SI participants (one student). Another study focused on the academic performance of SI and non-SI participants in a succeeding academic term in courses where SI was not offered. Former SI participants earned no F grades or withdrew from the second-semester business calculus course. The former SI participants earned a slightly higher mean final course grade (2.63 vs. 2.48), though it was not a statistically significant difference. The author speculates that the absence of SI with the second calculus course may had a bigger impact on former SI participants -- narrowing the positive difference in academic achievement with the control group -- since a support service which they were used to accessing was not available in the next course in the sequence.

Kenney, P. A. (1990). *Suggestions for mathematics Supplemental Instruction sessions*.

Unpublished manuscript. Pennsylvania State University at College Park. College Park, PA.

This paper was developed to accompany a videotape that provides suggestions for strategies to use during Supplemental Instruction (SI) sessions. These suggestions are based upon direct experience while serving as a SI leader in a calculus course at the University of Texas at Austin while she was completing here Ph.D. on the effectiveness of SI. Some of the suggestions included: constantly referring to the course syllabus throughout the academic term; discussing effective note taking in math classes by the SI leader sharing their strategy; discussing ways to maximize the usefulness of the textbook; providing additional structure to the SI sessions; focuses on the problem-solving protocols rather than on just finding correct answers; SI leader providing worksheets to guide SI sessions that help generate group discussion, focus on key concepts, help review for exams, and practice problem-solving skills; test question prediction; and taking practice exams to prepare for in class examinations.

Kenney, P. A. (1997). *Supplemental Instruction in mathematics: Needs and approaches, critical aspects of mathematics training and the role of SI*. Unpublished manuscript. Pennsylvania State University at College Park. College Park, PA.

Mathematics presents a challenge to many students in higher education. This paper describes some of these challenges and two approaches to Supplemental Instruction (SI) that may help students. Critical components of math SI sessions: 1) a welcome period during which the glossary terms and protocols are discussed; 2) a period during which students use the protocols to solve problems similar to the homework; and 3) a period during which students may attempt some homework problems.

Kenney, P. A., & Kallison, J. M. (1992). *Learning to study college-level mathematics: Effects of a Supplemental Instruction (SI) program in first-semester calculus courses*. Conference Proceedings of the American Educational Research Association 1992 Annual Conference, San Francisco, CA.

This paper details results from a Supplemental Instruction program designed for students in college-level calculus courses during Fall 1989. The studies were conducted at the University of Texas at Austin by two teaching assistants employed by the mathematics department and were selected and trained by the SI program by the staff of the University's Learning Skills Center. The first study compared the performance of students in Business Calculus. While SI was beneficial to all SI participants (2.39 vs. 1.96 for non-SI participants), it was especially helpful for lower-ability students. The second study focused on an Engineering Calculus course. While the difference was closer for the two groups (2.01 vs. 1.91 for non-SI participants), SI provided disproportionate help to the lower-ability students as measured by SAT quantitative scores. More than 70 percent of students felt that the study strategies introduced by the SI leaders were either "very helpful" or "helpful." Almost 80 percent indicated that exposure to study strategies for calculus changed the way they studied either "very much" or "somewhat," and that the techniques that these skills would help them in future courses either "very much" or "somewhat." More than 80 percent of the students responded that it was either "very important" or "important" that all SI leaders incorporate study strategies into discussion sections. SI leaders mentioned the positive impact of the SI program on themselves as well: reflect about their teaching methods; develop new teaching methods; and learned how to integrate learning strategies with content instruction.

Kenney, P. A., & Kallison, J. M. (1994). *Research studies of the effectiveness of Supplemental Instruction in mathematics*. New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc.

Given the emphasis on the need to succeed in college-level mathematics courses, these authors take a careful look at the effects of Supplemental Instruction participation on student performance. In addition to reviewing other research studies, this chapter focuses on the use of SI in Fall 1989 at the University of Texas at Austin in Calculus for Business Students and Calculus for Engineering and Natural Science Students. This paper describes a research study that used Supplemental Instruction (SI) in a first-semester calculus course for business and economics majors at the University of Texas at Austin. The experimental design for this study used Campbell and Stanley's Nonequivalent Control Group model. The study used two lecture classes with the same instructor. Each class was divided into two discussion sections, and of those, one from each received the SI treatment. In the control sections the teaching assistant performed typical duties. In the SI sections the assistant performed the same duties but in addition she provided instruction on the study skills relevant to the course as it progressed and other activities that SI leaders would perform or facilitate. The results showed a statistically significant difference favoring the SI treatment group: the control group mean course grade point average of 2.43 and that for the treatment group of 3.00; the control group mean semester grade point average (GPA) of 2.51 and that for the treatment group GPA of 2.95. A multiple linear regression model was then chosen as a more complete method of analysis. Three of the independent variables had coefficients which were significant at the .05 level -- high school class rank, discussion section attendance, and control/treatment group membership. This helps to answer the question of whether SI was just a form of "double exposure" to the course content. Since SI sessions were qualitatively different than the traditional discussion sections (as evaluated by outside observers using a observation protocol) and that the students who participated in the SI sessions earned higher mean final course grades, it appears that SI sessions were more than double exposure. A multiple regression analysis of semester grade point average found that three of the variables were significant at the .05 level -- the SAT

Mathematical score, discussion section attendance, and group membership. Additional studies were conducted concerning SI. The first study compared the performance of students in Business Calculus. While SI was beneficial to all SI participants (2.39 vs. 1.96 for non-SI participants), it was especially helpful for lower-ability students. The second study focused on an Engineering Calculus course. While the difference was closer for the two groups (2.01 vs. 1.91 for non-SI participants), SI provided disproportionate help to the lower-ability students as measured by SAT quantitative scores.

Kentros, S., Wadhwa, M., Sreeramareddy, L., & Kaur, K. (2019). *Improving retention through Team-Based Learning Finch Labs and peer-educators in Intro to Programming*. Conference Proceedings of the 50th ACM Technical Symposium on Computer Science Education, Minneapolis, MN, USA.

We have introduced Peer-Educators through the Supplemental Instruction program and four Team-Based Learning laboratory assignments in our Introduction to Programming course. These four laboratory assignments are using Finch Robots to facilitate student comprehension of basic object-oriented programming concepts. In contrast to other lab assignments, Finch labs are team-based activities that revolve around programming Finch, a programmable robot to do activities like moving, sensing the environment, playing music, etc. Introducing the Finch labs has multiple benefits for the students. It helps better anchor the basic concepts of object-oriented programming, since interacting with the Finch robot is done by instantiating a Finch object and performing method calls on the object. This helps students understand many of the object oriented topics of the course, like object instantiation, method calls, passing arguments to a method and changing the state of an object. Furthermore, the labs facilitate peer learning in a natural way, since students group to work on a physical object. The goal of our intervention is to increase retention in our introduction to programming offerings. We are currently on the third year of our project and after having concluded in the interventions we want to adopt we are evaluating them through post-activity surveys, end of the semester surveys and comparison of retention data.

Kernick, G., Kedian, J., Seneque, M., & Louw, R. (1993, 1993, December). *Supplemental Instruction: Toward a conceptual framework*. Conference.

Many academic leaders at postsecondary institutions in South Africa report that many students lack the necessary skills to become successful autonomous learners. Supplemental Instruction (SI) is being used to help students develop these skills outside of class since the traditional passive lecture-based educational delivery system will be slow to change. SI is differentiated from traditional tutorial sessions since in SI it is learner-controlled.

Kerr, E. F., & Samuels, M. (2019). Using Graduate and Experienced Undergraduate Students to Support Introductory Courses *From general to organic chemistry: Courses and curricula to enhance student retention* (pp. 85-103): ACS Publications

Students hoping to major in chemistry or other science fields in college often find their plans derailed by difficulties in introductory classes. Graduate students and more experienced undergraduates can be valuable resources for addressing failure rates in introductory courses. This chapter discusses the research on three types of programs using peer-instructors to support introductory courses: graduate and undergraduate teaching assistants, Supplemental Instruction, and Peer-Led Team Learning. The structure and outcome of each program are reviewed along with training strategies used to prepare peer-instructors. Both undergraduate and graduate students are able to produce positive results in student success and experience when supporting introductory courses. Successful training strategies provide peer-instructors with practical strategies for their teaching, opportunities to practice before entering the

classroom, and ongoing support and feedback throughout their time teaching. This chapter discusses various structures, and how to choose the appropriate one for your course.

Khan, B. R. (2018). *The effectiveness of Supplemental Instruction and online homework in first-semester calculus*. (Ph.D. Dissertation), Teachers College, Columbia University, NYC: NY. Available online <https://academiccommons.columbia.edu/doi/10.7916/D8CN8MW4>

The purpose of this study was to evaluate whether supplemental instruction and online homework can improve student performance and understanding in a first-semester calculus course at a large urban four-year college. The study examined the metacognitive and study skills and posttest scores of students. The study also focused on students' and instructor's perception and experiences of supplemental instruction and online homework using WebAssign. The study used a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ) to reveal any significant differences in metacognitive and study strategies between students in a class with supplemental instruction/online homework and students in a traditional class. Students' scores on their final examination were analyzed to reveal the effect of mathematical achievement between the control and experimental groups. Surveys and interviews were utilized to provide anecdotal evidence as to the overall effectiveness of the online homework management system and supplemental instruction. Results of the study showed no substantial difference between the control group and the experimental group in seven out of eight sub-scales of metacognitive and study strategies: metacognitive self-regulation, time and study environment, effort regulation, help seeking, rehearsal, organization, and critical thinking. But, students with supplemental instruction/online homework showed a higher level of elaboration learning strategies. The interaction of pretest and type of class (traditional or treatment) did not have a significant effect on students' posttest score. There was no substantial effect of pretest on posttest, but the treatment influenced students' posttest score. Students' gender, race, class level, or the number of courses they registered for were insignificant predictors of their posttest scores. The instructor and students agreed that time spent in supplemental instruction sessions and on WebAssign were worthwhile and beneficial. They believed supplemental instruction and online homework using WebAssign may have influenced students' understanding and performance in the course.

Khan, R., & Wang, K. (2019). *Development of an intervention scheme to address low retention rate of a first-year calculus course: A systematic analysis of current trends*. Conference Proceedings of the 2019 Proceedings of the Canadian Engineering Education Association (CEEA-ACEG) Conference, Ottawa Ontario. Available online:

<https://ojs.library.queensu.ca/index.php/PCEEA/article/view/13833>

Students in engineering and the sciences often complete their studies in mathematics before they have an opportunity to develop an appreciation for the application of mathematical concepts in their major field. It can be argued that without a solid foundation in mathematics at the calculus level, an engineering or science student will find difficulty in understanding and applying the knowledge involved in upper-level classes. In this study, we examined an Ontario university where the dropout rates could reach as high as fifty percent from a mandatory first-year calculus course and as a response, we would like to develop an intervention mechanism. Using a conceptual framework, we systematically analysed various intervention mechanisms employed by institutions around the world. The framework looks at each intervention strategy and tries to understand how the mechanism identifies who needs intervention, how it is funded, and the steps necessary for a student who would want to receive such an intervention voluntarily. This study will help us to identify key features that are effective in current intervention methods, address the gaps that were observed, and to develop an intervention scheme that addresses high dropout rates from the first-year calculus course.

Kibble, J. D. (2009). A peer-led supplemental tutorial project for medical physiology: Implementation in a large class. *Advances in Physiology Education*, 33(2), 111-114. The purpose of this study was to evaluate the practicality of implementing a peer-teaching program in a large class (~350 students) of medical students and whether such a program is beneficial. Case-based problems were developed by faculty members to facilitate student problem solving and discussion. Voluntary student enrollment was available during the first week of a semester. Tutorials took place during out of class time and were facilitated by peers from the previous class. Tutors were selected for their outstanding performance in physiology; they were provided with training in facilitation skills and were given a package of model answers. Sixty-eight students enrolled in this pilot program and were organized into groups of ~8 students. On average, students attended four of six tutorials. Posttutorial quiz scores were significantly greater than paired pretest scores. Surveys showed that students had high expectations at the outset, which were matched with positive perceptions at the end of the tutorial program; the use of near-peer tutors was especially well received. Tutors also gave high approval ratings for their experiences. In conclusion, the peer tutoring program was logistically straightforward to implement in a large class and was endorsed by the participants.

Kilpatrick, B. G., Savage, K. S., & Wilburn, N. L. (2011). *Supplemental Instruction in the first intermediate accounting course: Investigation of an intervention strategy to improve student performance*. Working Paper Series 11-13. W. A. Franke College of Business. Northern Arizona University. Flagstaff, AZ. Available online: <http://franke.nau.edu/images/uploads/fcb/11-13.pdf> Supplemental instruction (SI) is an academic assistance program that utilizes peer-assisted study sessions for students in targeted historically difficult courses. The SI model was developed at the University of Missouri, Kansas City (UMKC) to provide an approach to learning that targets high-risk courses rather than high-risk students (Center for Supplemental Instruction, UMKC). The UMKC SI model, followed by our university, requires the SI Leader to attend all classes and to facilitate regularly scheduled study sessions. The SI Leader is a peer tutor who has previously demonstrated superior academic achievement in the target course. In contrast to regular tutoring, SI is presented as a non-remedial, proactive, voluntary opportunity for all students to increase their study skills and understanding of course material. Although the effectiveness of SI has been examined in prior literature for lower-division students in accounting principles courses, there is a lack of research regarding its effectiveness for upper-division accounting students. Therefore, the objective of this research is to gain insight into the use and effectiveness of SI for upper-division accounting students in the first intermediate accounting course (financial accounting and reporting I, or FAR I). This class is typically considered the “gateway” upper-division accounting course because its successful completion is a key prerequisite for the subsequent accounting curriculum, yet it is historically characterized by high student withdrawal and failure rates. We assess the effectiveness of SI on the performance of upper-division accounting students in our FAR I course, after controlling for variables that have been shown in prior research to be determinants of student grades in the first intermediate course. Additionally, we present qualitative information regarding which students used SI, purposes for which students used SI and perceived level of help on each, perceived benefits of SI from the students’ perspective, and why some students did not use SI. This paper is organized as follows: the next section provides background information on SI and determinants of performance in the first intermediate accounting course. The third section describes our methodology and data collection process and the fourth section discusses the data analysis and results. The last section provides a summary and conclusions.

Kimmins, L. R. (2014). Meet-up for success: The story of a peer led program's journey. *Journal of Peer Learning*, 6(1), 103-117.

Technological advancements have forced space and time to evolve to present a virtual university that allows increasing numbers of students to study from a university rather than at university. This study examined the impact of a version of Supplemental Instruction (SI) with students. The best people to guide and advise students through their university journey are experienced students. As Longfellow, May, Burke, and Marks-Maran (2008, p. 95) put it, teachers may be content or subject experts, but current “students are experts at being students.” Studies by Falchikov (2001) found that student leaders provide “expert scaffolding” that steps students from one level of learning to the next within the discipline area. Peer-assisted programs contribute to the development of a caring learning community as their trained leaders scaffold learning and negotiation between lecturer and student, both of which are desirable for student success and sustainable learning practices. Peer-assisted programs also provide a body of students with leadership qualities. This paper briefly explores the history and evolution of an on-campus peer led program to one that is embracing technology and online modes of peer learning. The program’s endurance hints at excellence and its dynamic nature is founded on innovation. Peer led programs have been found to benefit student leaders as much as the students who attend the sessions. Recent research on student leadership is uncovering the benefits to universities, as well as to individual students, of creating a pool of student leaders who can be retained after graduation as quality lecturers and tutors. It also produces graduates who possess the leadership skills prized by employers. Engagement with leadership activities such as those provided by peer led academic programs is a means of benefitting all participating students. This area is under-researched at this point. It is an area that needs further exploration and extension.

King, P. (1992). Kingston University: A British supervisor's Supplemental Instruction experience. *Supplemental Instruction Update*, 1, 3.

This newsletter article describes the use of Supplemental Instruction (SI) at Kingston University in London, UK. The author describes the use of the Assistant SI supervisor to help supervise an expanding SI program. The need for all SI leaders to attend frequent update training sessions is urged with the entire group meeting at the beginning of the meeting and then breaking into smaller groups based on academic disciplines for the remainder of the time.

King, P. (1994). *Supplemental Instruction as a staff development model*. Birmingham, England: Staff and Educational Development Association.

This article describes the partnership between the faculty development unit at Kingston University (United Kingdom) and a member of the instructional faculty (professional full-time tutor who also delivered lectures to the students) as they used Supplemental Instruction for student enrichment and staff development. Several courses were targeted in the School of Surveying: Quantity Surveying and Urban Estate Management and European Estate Management studies. The tutor adopted several SI session activities to use during times that were traditionally conducted in a tutorial format. Behavioral changes in students included: students took initiative in sessions for selecting and discussing topics; students worked with each other to identify additional information; students asked more challenging questions of the tutor in class; and students looked to each other for support when challenged with academic matters.

King, P. (1994). *Supervision of Supplemental Instruction leaders: A practical guide*. Birmingham, England: Staff and Educational Development Association.

This chapter describes the Supplemental Instruction supervision system at Kingston University in the United Kingdom. Common issues mentioned by SI leaders included: SI session difficulties; SI session skills; strategies to build SI attendance; and SI leader morale.

Kirchner, J. (2014). *Student experiences of the community college developmental writing classroom*. (Ph.D. dissertation), University of Nebraska.

The low success rate of students in community college developmental education classes has caused not only institutions and their instructors but also those outside of the classroom to search for alternative programs and delivery methods to improve student outcomes. As college completion rates become increasingly tied to state funding, many community colleges are re-thinking their programs, considering acceleration of coursework, learning communities, and Supplemental Instruction as replacements for the traditional developmental sequence. While these programs have shown success in some community colleges, much of the research is quantitative in nature and based on completion rates. The purpose of this study is to lend an instructor's and students' voices to the conversation on developmental education. The study focuses on one community college developmental writing classroom for one term. Through student stories, the study reveals community college students' challenges and strengths, adding to the understanding of what causes some students to succeed while others fail. The study is a narrative inquiry, with data drawn from field notes, interviews, student writing, and instructor journal writing. Chapters include stories of racial and social tension in the classroom, challenges of overcoming previous negative schooling experiences, resistance to classroom procedures and requirements, difficulties in shifting from refugee camp schooling to college expectations, and student determination despite overwhelming challenges. The student stories reveal a changing population in one suburban Midwestern community college and help provide a context for conversations about curriculum and program revisions.

Kirkham, R., & Ringelstein, D. (2008). Student Peer Assisted Mentoring (SPAM): A conceptual framework. *e-Journal of Business Education & Scholarship of Teaching*, 2(2), 39-49.

This paper presents a conceptual framework for the Student Peer Assisted Mentoring (SPAM) program and describes the theories that support it. SPAM is an adaptation of Supplemental Instruction (SI). SPAM was first piloted in an accounting course in Australia. Three categories of SPAM sessions are held each academic term for the students: more formal session in which the academic lecturer for the course reviews and explains the issues and problem solving techniques related to current class topic. The second category of SPAM is a less formal session when the SPAM mentors work with the students in the class in a cooperative fashion to discuss the academic content. The third category of SPAM sessions are those that are formed by students in the class without the help of the SPAM mentors. Students take responsibility for these groups and develop more skills as a result. In addition to the academic benefit to the participating students, the SPAM Mentors also benefit: their own learning improves due to reworking the material a second time; and develop communication skills, leadership skills, and learning how to deal with the dynamics of managing a group.

Klein, D. (1990, 1990, January 16). Program lets students teach class: Volunteers from biology classes are taught how to think, *Daily Kent Stater Newspaper*, p. 8.

This newspaper article provides an overview of the Supplemental Instruction (SI) program at Kent State University (OH). Lowell Orr and LaVerne White from the biology department reported that SI participants earned higher mean final course grades in two courses: "Cells and Systems" and "Strategies for Survival in the Biological World." Students with high attendance patterns (10 or more times per term) generally receive a final course grade one full letter grade higher than non-SI participants.

Knich, D. (2006, 2006, July 13). USC's goal is a good year in first year, *The Post and Courier*, p. A 1.

This newspaper article describes how the Supplemental Instruction (SI) program has been implemented at the University of South Carolina in Columbia. The director of the SI program is interviewed and provides an overview of the development of the SI program at USC.

Knott, A. (1997). *Towards developing a theoretical and institutionally contextualised model of Supplemental Instruction in the curriculum which entails greater intra- and inter-institutional collaboration between Supplemental Instruction supervisors and academic development practitioners in the region*. Conference Proceedings of the South African Association for Academic Development Conference, Alpha Training Centre, Broederstroom, North West Province, South Africa.

This paper critically discusses the model of Supplemental Instruction (SI), an academic student assistance program that has been implemented on the Port Elizabeth campus of Vista University within the context of offering suggestions on how SI can be used by academic development (curriculum and institutional development). SI is one part of a comprehensive learning environment that promotes alternative teaching and learning methodologies and delivery systems that are relevant to the diverse needs of all students.

Koch, E. (1996). *The relationship of attendance of Supplemental Instruction with the performance of first year students at the University of Port Elizabeth*. Conference Proceedings of the Conference on Student Contributions to Learning, Rhodes University, Grahamstown, Republic of South Africa.

The use of Supplemental Instruction (SI) at The University of Port Elizabeth (South Africa) was investigated by examining the statistical relationship of attendance of SI with performance through multiple regression analysis. The sample consisted of first year students in the Science and Humanities faculties. In most of the courses there was a positive relationship between attendance of SI and performance. This was especially true for students who attended five or more times.

Koch, E. (1997). *Lecturing between hope and despair: Lecturers' perceptions of academic development needs of students and lecturers at the University of Port Elizabeth*. Unpublished manuscript. University of Port Elizabeth, Centre for Academic and Organizational Development. Port Elizabeth, Republic of South Africa.

This report assessed the perceptions of lecturers of the success of academic development at the University of Port Elizabeth in the Republic of South Africa. The problem which emerged from the discussions was the growing number of underprepared and unprepared students who desire to attend tertiary education. Supplemental Instruction (SI) is regarded as a good program, but lecturers do not think that it reaches the targeted group of student effectively and deals adequately with the underlying problems. Since SI is voluntary, not all students who should come do so. Additionally, lecturers believe an increase in the structure of SI sessions may raise academic performance of the underprepared students who they believe need this. Additional solutions offered by the lecturers include: extended curriculum to provide more time-on-task; alternative learning methods by inclusion inside the class the use of collaborative learning, computerized self-paced instruction, and other methods.

Koch, E., & Mallon, P. (1998). Evaluation of Supplemental Instruction: A performance assessment approach. *South African Journal of Higher Education*, 12(3), 173-178.

This article about the use of Supplemental Instruction (SI) was originally presented at the South African Association for Academic Development Conference in Bloemfontein, Republic of South Africa. This research investigation assesses the performance of the SI program in terms of efficiency, quality, and effectiveness. Three concern areas were identified: voluntary attendance in SI sessions, unstructured approach in science courses, and ineffectiveness in increasing the

pass rate of very under-prepared students. Key factors associated with positive program outcomes included: skill and ability of the SI leader with both facilitation but also knowledge/enthusiasm for the subject; involvement and support of the course lecturer; type of work covered in SI sessions; training both initially and ongoing of SI leaders; and more structure in SI sessions in science and other problem-solving areas.

Kochenour, E., & Roach, K. (1999). *SI: An effective program within student affairs*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

This article is based on one previously published in the November/December 1997 issue of the *Journal of College Student Development*, 38(6), 577-586. The article contains a study from the University of Utah that examined the effectiveness of SI with nearly 12,000 students enrolled in 82 classes. Among the findings: average grade of participating students was 0.603 higher than nonparticipants; percentage of attendance in SI decreased as class size increased; cost of SI was \$4.00 per contact hour which does not include administrative overhead and was less expensive as compared to other forms of academic assistance offered to students such as tutoring.

Kochenour, E. O., Jolley, D. S., Kaup, J. G., Patrick, D. L., Roach, K. D., & Wenzler, L. A. (1997). Supplemental Instruction: An effective component of student affairs programming. *Journal of College Student Development*, 38(6), 577-586.

The effectiveness of Supplemental Instruction (SI) was examined using 11,000 participants enrolled in eight courses at the University of Utah, a large research university. Correlational analyses and analysis of covariance support the hypothesis that SI is an effective program. The data was collected between Autumn 1992 and Spring 1994. Students on average attended about 3.7 times for each academic quarter. There was a positive correlation between higher grades and higher levels of attendance in SI: zero, 2.387; 1 to 2, 2.597; and 3 or more times, 2.848. Though students of various previous levels of academic achievement attended SI in similar patterns, research suggests that SI sessions had the most impact on students with lower previous grade point averages. Additional analysis examined the interaction of SI performance and class size, PGPA and other variables. An unusual finding was that the percent of SI attendance decreased with increasing class size.

Kodabux, A., & Hoolash, S. K. A. (2015). Peer learning strategies: Acknowledging lecturers' concerns of the Student Learning Assistant scheme on a new higher education campus. *Journal of Peer Learning*, 8(1), 59-84. Available online: <http://ro.uow.edu.au/ajpl/vol8/iss1/7/>.

While this article is not directly based on Supplemental Instruction or names commonly used in other countries such as Peer Assisted Learning or Peer Assisted Study Sessions, the authors do describe their program as similar. The article addresses an issue seldom addressed in most of the literature about how peer learning is perceived by the faculty members that host the program within their courses. For that reason, it is included. The rest of this abstract comes from the authors' words: The Student Learning Assistant (SLA) scheme was introduced in 2010 at Middlesex University Mauritius Branch Campus (MUMBC). The scheme is similar to traditional peer learning strategies, such as Peer Assisted Learning (PAL) and Peer Assisted Study Sessions (PASS), which are widely operated in higher education environments to motivate student engagement with their learning. Different departments at MUMBC employ the SLA scheme as a student-to-student support mechanism. General feedback from students receiving SLA support reveals benefits of the scheme in terms of students' active engagement with course materials and deeper understanding of their subject area. However, within these departments, lecturers' perceptions of the scheme are surprisingly varied. Since the 1970s, a comprehensive range of research has been undertaken on the expansion of peer learning and

the welcome benefits it affords to students. Yet, the focus on student experience has been at the expense of overlooking lecturers' views of the scheme. This paper seeks to bridge this gap. It aims to examine lecturers' experience of the scheme and to recommend actions to overcome some of their apprehension with the project.

Koehler, C. (1995). Supplemental Instruction and critical thinking. *Supplemental Instruction Update*, 1, 3.

This article by an assistant professor of Communication Studies at the University of Missouri-Kansas City describes the utility of Supplemental Instruction (SI) for developing the critical thinking skills of SI participants. SI sessions involve a natural environment for inquiry by a community of learners. The SI leader helps participants to develop independent thinking. As students become engaged and active participants in the intellectual discourse that occurs during SI session, students move to higher levels of thought.

Kornblum, S. L., El, Z. K. A., Menezes, G. B., Won, D., & Allen, E. L. (2017). *Enhancing engineering first-year experience through Supplemental Instruction*. Conference Proceedings of the American Society for Engineering Education. Available online: [file:///C:/Users/Owner/AppData/Local/Packages/MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/enhancing-engineering-first-year-experience-fyre-through-supplemental-instruction%20\(1\).pdf](file:///C:/Users/Owner/AppData/Local/Packages/MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/enhancing-engineering-first-year-experience-fyre-through-supplemental-instruction%20(1).pdf)

The College of Engineering, Computer Science and Technology (ECST) at Cal State LA recently introduced the First-Year Experience (FYrE@ECST) program that focuses on building a more academically focused engineering mindset in freshmen engineering majors during their first year of college. While FYrE@ECST consisted of a number of proven practices integrated into the freshmen experience, the goal of this paper is to present the benefits of implementing a supplemental instruction (SI) model, adapted from the UMKC model to enhance student learning in Calculus and Physics, which are pre-requisite courses for most core upper division engineering courses, but have very high attrition level. In 2014 leading up to the development of FYrE@ECST, we examined 6-year graduation rates of the most recent 5 years, and thus we had data from the Office of Institutional Research for the Fall 2007 through Fall 2011 first-time freshmen cohorts. Out of those total 1052 students, only 567 even took Calculus I, and out of those who took Calculus I, 203 failed the course on the first try, yielding 35.8% of students needing to repeat the course. Historically, very few (~6%) of our freshmen completed their Physics I requirement within their first 2 terms. Therefore, FYE@ECST interventions focused on effective learning pedagogy and practices in these traditionally challenging but foundational courses. In particular, we wanted to demonstrate the benefit of SI workshops in a majority first generation, underrepresented minority, and predominately academically unprepared student population. The peer-led workshops are mandatory for FYE@ECST students and designed to promote inquiry-based and collaborative learning environment and increase students' mathematics self-efficacy. Supplemental Instruction was assessed using self-efficacy surveys, physics and math grades, pre- and post-tests, and focus groups. FYE@ECST students were compared to concurrent (CG-2) and historical (CG-3) control groups. The math average GPA for FYE@ECST students at the end of the first year was 2.9, compared to 2.2 and 2.45 for CG-2 and CG-3, respectively, and completion rate of Physics I within the first 2 terms for FYE@ECST students was 81%, compared to 9.4% for CG-2 and 6.3% for CG-3. Results from focus groups and surveys indicated that students had a very positive experience in the SI workshops.

Kotze, G. S. (1994). *Essentials of a program for Supplemental Instruction as academic support for technikon students in mathematics courses at entry-level*. (Ph.D. dissertation), Faculty of

Education (Department of Diadactics) at the University of the Orange Free State, Bloemfontein, Republic of South Africa.

This Doctor of Philosophy dissertation is focused on the effectiveness of Supplemental Instruction (SI) with postsecondary students in entry-level mathematics courses at an institution in the Republic of South Africa. The SI model was evaluated regarding its effectiveness with providing the necessary psychological, philosophical, educational, and sociological components that can contribute towards successful mathematics mastery. Through qualitative and quantitative evaluations, the SI model was found to support increased academic achievement and mastery of mathematical concepts.

Kowal, P., & Shaw, G. (1998). Academic support: The bridge and catalyst for academic success and student development. In P. L. Dwinell & J. L. Higbee (Eds.), *Developmental education: Meeting diverse student needs* (pp. 29-34). Morrow, GA: National Association for Developmental Education

Many learning support professionals consider themselves developmental educators. The process of facilitating the academic growth of students is grounded in developmental theory. This chapter discusses how academic assistance programs such as Supplemental Instruction, tutor training, freshman experience programs and collaborative efforts promote the cognitive and personal development of participating students.

Krause, S. (2007). *A case study of TRiO Student Support Services programs for nontraditional students at selected Midwestern universities*. (Ph.D. dissertation), University of South Dakota. The purpose of this case study was to examine the qualities of Federal TRiO Student Support Services tutorial programs for nontraditional students at selected universities and colleges in the Midwest region. The participants in this study were four Federal TRiO Student Support Services programs within the Midwest region that served a large number of nontraditional students. Identified directors, administrators, and selected faculty were contacted by telephone to obtain permission to conduct this study about their program and services. The data collected in this study provided important information on how universities and colleges developed a tutoring program that supported nontraditional students for TRiO programs under the Federal guidelines and what these programs look like. Specific findings were: (a) all four programs were set up to meet federal guidelines; (b) all four programs received similar levels of funding and served about the same number of nontraditional students; (c) the types of support services included individual teaching, mentoring, one-on-one advising sessions, and group activities; (d) three types of group learning services were offered, workshops, group tutoring, and Supplemental Instruction; (e) faculty involvement and quality staff were the key component of a successful program; (f) communication of the program objectives to administrators, faculty, and staff was paramount to the success of the program; (g) the greatest strength of the programs was a committed, caring staff; and (h) the greatest challenge of the programs was funding.

Kreke, P. J., & Gibbon, T. C. (2003). *Organic chemistry and Supplemental Instruction*. Unpublished manuscript. Mount St. Mary's College. Maryland. Available from the authors: Patricia Kreke, Science Department, Mount St. Mary's College, Emmitsburg, MD 21727, kreke@msmary.edu, gibbon@msmary.edu

Supplemental Instruction (SI) is used at Mount St. Mary's College (MD), a small liberal arts college, in an organic chemistry course. Qualitative and quantitative research studies have found benefits of the SI program for SI participants, SI leaders, and the faculty members who host SI in their course.

Langan, M. B. (1999). *The effect of Supplemental Instruction on the grades of college students*. (Master's of Arts thesis), University of Detroit Mercy, Detroit, MI.

This study of Supplemental Instruction at the University of Detroit Mercy focused on conditionally admitted students in the University College Program during 1997 concerning their grade point average. These students were enrolled in one or more of the following courses: Principles of Human Anatomy, Principles of Chemistry II, General Chemistry I, Elementary Algebra, College Algebra, Mathematical Analysis I, and Elementary Functions. SI attendance was broken into four categories: 0-25%, 26-50%, 51-75%, and 76-100%. While SI attendance was statistically significant in relation to higher final course grade, there was not a perfect corresponding relationship with increasing rates of SI attendance: 0-25%, 1.83 GPA; 26-50%, 2.07; 51-75%, 1.83; and 76-100%, 2.37.

Lapish, K. K. (2002). *An assessment of the Supplemental Instruction program of the academic support center at Clemson University*. (Master's of Arts thesis), Clemson University, Clemson, SC.

Latino, J. A., & Unite, C. M. (2012) *New Directions for Higher Education* (Vol. 157). San Francisco, CA: Wiley Periodicals
Several pages of this book chapter were devoted to an overview of the SI model.

Laurs, D. E. (2018). Perceived impact of PASS leadership experience on student leaders' transferable skills development *Journal of Peer Learning*, 11(1), 27-40. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1138&context=ajpl>.
The PASS (Peer Assisted Study Support) program has been operating at Victoria University of Wellington, New Zealand, since 2000, and currently provides weekly study sessions in more than 50 courses each year. As well as enhancing the first-year learning experience, PASS contributes to an institution-wide award that acknowledges the impact of extra-curricular activities on students' graduate attributes and employability skills. Selected from high-caliber candidates, PASS leaders already possess strong communication and thinking skills. Nevertheless, an online survey of current and former leaders between 2009-2014 [n=185] revealed a significant majority perceived that the experience of leading a study group, in particular the associated writing of weekly reflections, enhanced their confidence, cognitive and communication skills, as well as contributing to their CVs and job application success. Such results highlight the potential for student leaders to translate their day-to-day experiences into added value for life after university.

Lazari, A., & Simons, K. (2003). Teaching college algebra using Supplemental Instruction versus the traditional lecture method. *Georgia Journal of Science*, 61(4), 192-198.
This article describes the use of Supplemental Instruction (SI) at Valdosta State University with a college algebra course. Students with predicted weaker entry level math skills, as measured by the SAT, who participate in SI will achieve similar final course grades with students who have average math skills. More often students with weaker entry math skills chose to voluntarily participate in SI sessions.

Lee, K. R. (2018). *An investigation of the relationships of student engagement and academic performance of Supplemental Instruction students concurrently enrolled in a gateway mathematics course at California State University in Southern California*. (Ph.D. dissertation), Pepperdine University, Los Angeles, CA.
This study, conducted at California State University (CSU) in Southern California, focused on student engagement factors and academic performance of supplemental instruction (SI) students concurrently enrolled in a gateway mathematics course. The purpose of this quantitative correlational survey study was to investigate engagement factors employed by SI students enrolled in gateway mathematics courses; the researcher explored the relationships of

the SI students' engagement factors to their gateway mathematics course grades. The participants completed a web-based survey in which they responded to items regarding their behaviors, thoughts, and feelings as experienced in the gateway mathematics course and the SI class sessions. The responses were scored within 4 engagement factor scales including skills, emotional, participation/interaction, and performance engagement. The results of this study provided support for 2 alternative hypotheses: (a) there was a positive relationship between each of the 4 engagement factors and the gateway mathematics course grades of the participants, and (b) there was a positive relationship of the linear combination of the 4 engagement factors to the gateway mathematics course grades of the participants. The findings of this research study supported 3 conclusions: (a) engagement is a multidimensional construct, and the more students are engaged in their studies, the more likely they are to earn higher grades in a gateway mathematics course; (b) academic support and resources are essential for student learning; (c) college success, specifically, positive academic course performance, is a significant indicator of persistence toward college completion. Recommendations based on the findings and conclusions of this study include regular collaboration of efforts among all university stakeholders to provide a variety of student-centered venues for academic support and resources to engage students in developing self-efficacy for academic success in gateway mathematics courses.

Lee, K. R. (2018). *An investigation of the relationships of student engagement and academic performance of Supplemental Instruction students concurrently enrolled in a gateway mathematics course at California state university in southern California*. (Ph.D. dissertation), Pepperdine University. Available from

<https://search.proquest.com/openview/aa7d2c51eae1cd80b926a21e6016967/1?pq-origsite=gscholar&cbl=18750&diss=y>

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Lee, R. C. (1998, 1998, June 16). UTA offering help with tough courses: Supplemental Instruction boosts grades, officials and students say, *Fort Worth Star-Telegram*, p. 1.

This newspaper article describes the use of Supplemental Instruction (SI) at the University of Texas-Arlington. The article contains interviews with school officials and students about the SI program.

Legge, K. P. C. (2010). *Does mandatory Supplemental Instruction work in development math education? A study of students enrolled in developmental math courses at a suburban community college in the northeast.* (Ed.D. dissertation), Temple University.

The number of students entering the community college in need of developmental math has not changed, remaining at a steady 60% over the past seven years. This study compared the success rate of Mandatory Supplemental Instruction (MSI) sessions within four sections of a developmental math course compared with the success rates of students enrolled in both the Traditional Classroom setting and the Individualized format at Suburban Community College (SCC) during the Fall 2009 semester. These MSI format courses were compared with both the Individualized format of MAT 060 and the Traditional Classroom format of the same course. The students included in these sections were a combination of students who were: 1) suggested by advisors to enroll in this developmental math course after receiving a low score on the college's Accuplacer placement test for algebra or continuing the progression of developmental math from the lower level arithmetic class; 2) mandated to attend MSI after successful completion of the Jump Start Math Program, or 3) self-selected into the MSI group anticipating the need for additional help in the course. The two primary data sets available for this study are student math final grades and student participation/attendance records. Secondary sets of data include informal focus group notes, final exam scores, student attendance records for both class lectures and MSI sessions, and Supplemental Instruction Leader anecdotal records. The findings of this study conclude that success rates of students enrolled in the MSI sections of developmental math do not differ significantly from those enrolled in the Traditional Classroom format of developmental math; however, both groups did differ significantly from the Individualized format of developmental math, in that the students enrolled in the Individualized format succeeded at a lesser rate and withdrew at a greater rate than their MSI or Traditional Classroom counterparts. This study also concluded that female, full-time students succeeded at a greater rate across the board, which is consistent with the literature. These findings were significant for a number of reasons. Although the difference between the treatment group and the Traditional Classroom group was not significant, there are a variety of reasons at the program level as to why this may have been so and there are many future constructs that SCC can put in place to strengthen and reassess the MSI program. Although this study was focused on the MSI treatment, the data revealed a greater issue existing in the Individualized format of developmental math at SCC. Future considerations can be made in this particular delivery method to improve success rates of students involved in this program. Future research on MSI in the form of persistence and retention rates, graduation rates, transfer rates, subsequent math course grades and success in other college-level classes can be explored to provide the MSI program with more data to determine if particular groups of students are benefiting from this format.

Levine, P. (1975, 1975, November 13). 'Whiz-Kids' and troubled flock to learning center, *UNews (University of Missouri-Kansas City Student Newspaper)*, pp. 1, 13.

This newspaper article describes the use of Supplemental Instruction (SI) with some of the most gifted students at the University of Missouri-Kansas City. Skills that these students used in high school are not sufficient for the academic rigor experienced at the university.

Levitz, R. (1990). Supplemental Instruction takes off. *Recruitment and Retention in Higher Education Newsletter*, 4(11), 7.

This newsletter article provides a short overview of the Supplemental Instruction (SI) program. George Russell, chancellor at UMKC was quoted, "The SI approach avoids both the remedial stigma of typical assistance programs and the high costs of one-on-one tutoring."

Levy, T. (1991, 1991, October 14). Students get into the upliftment business, *Business Day Newspaper*, p. 10.

This newspaper article describes the use of Supplemental Instruction (SI) at Wits University in South Africa. The SI program will be started by commerce students at the university. The SI program will be aimed at assisting Black students who have been disadvantaged by the secondary school system.

Lilley, L. L. (1997). Retention of racial-ethnic minority students within Virginia baccalaureate schools of nursing (nursing education) [Dissertation, George Mason University, 1997]. *Dissertation Abstracts International*, 58(07), 3559B.

The purpose of this dissertation research study was to examine the relationship between retention strategies and retention rates of racial-ethnic minority baccalaureate nursing students attending public universities and colleges within the State of Virginia. Tinto's Model of Student Departure was used as the framework for the study. A cross-sectional one-part mailed survey design was used for this study. A descriptive methodology was used to summarize and describe the data. Qualitative comments were also analyzed for themes about retention. Statistically significant findings included: lack of close tracking of retention of racial-ethnic minority students by the schools; no statistical significance between the variable of retention problems and the variables of tutoring for racial-ethnic minority students; and fewer than 37% of the schools had Supplemental Instruction or related programs available at the department or school level, although they may have been offered elsewhere on campus.

Lin, J.-L., & Woolston, D. C. (2008). *Important lessons in engineering education learned from seven years of experience in undergraduate academic support programs*. Conference Proceedings of the ASEE/IEEE Frontiers in Education Conference, Saratoga Springs, NY. Supplemental Instruction (SI) was used in the College of Engineering at the University of Wisconsin-Madison. SI has been successfully implemented with Calculus, calculus-based introductory Physics, Statics, introductory dynamics courses. These courses serve as gatekeepers for the engineering degree programs. Previous to introducing SI, about a quarter of the students experienced academic difficulty in these courses. SI is listed as a formal course in the course timetable for zero credits. Enrollment in the SI course is optional. In general, SI students earn a higher or slightly higher average course grade as compared with nonparticipants. Fewer SI students have grades lower than C. SI participants leave engineering as a degree program at a rate of about 20% while the departure rate for the nonparticipants is nearly double, 37%.

Lindsay, K., Carlsen-Landy, B., Boaz, C., & Marshall, D. (2017). Predictors of student success in Supplemental Instruction courses at a medium sized women's university. *International Journal of Research in Education and Science*, 3(1), 208-217. Available online: <http://dergipark.ulakbim.gov.tr/ijres/article/viewFile/5000202370/5000179703>.

Supplemental Instruction (SI) is a program that seeks to improve student success by targeting classes with high failure rates, as defined with a failure percentage of 30% or more. It is organized by an administrative SI supervisor who supervises SI leaders, which are students that have successfully completed the courses that they have been assigned. The SI supervisor also collaborates with the course instructors who aid in screening the competency of the SI leaders. Improved self-confidence, teamwork, independence and course performance have been reported as benefits of SI. This project sought to explore the effect of SI on success and failure,

along with gender, age and race. The type of course was also used as a factor in order to control for it as a confounding variable. In order to ascertain the effect of these variables on success, a technique called logistic regression was used. Caucasian female students who took bacteriology and did not attend SI were used as the reference group. Students were about twice as likely to succeed if they completed the required number of SI sessions and one fifth as likely to succeed if they were in a SI class and did not meet the minimum number of sessions. Hispanic students were 40% as likely to succeed, and African American students were about one third as likely to succeed when compared to Caucasian students. Students between 20 and 29 years old were half as likely to succeed, and those 30 or older were one quarter as likely to succeed when compared to teen students. Those in algebra were about three times more likely to succeed than those in bacteriology, chemistry and statistics. When the students that withdrew were removed, the chances of success were about the same, except for African American students which were one quarter as likely to succeed, and those that did not meet minimum sessions were one quarter as likely to succeed. The model explained more variation when the students that withdrew were included. As SI had a strong influence on success, it should be considered as a tool to enable retention of students in high risk courses.

Line, C. J. (2018). *The effects of Supplemental Instruction on student success at Delaware Technical Community College*. (Ph.D. dissertation), University of Delaware. Available online: <http://udspace.udel.edu/handle/19716/23792#files-area>

Delaware Technical Community College (DTCC) is a two-year, open admission college that has served the needs of Delawareans for over 50 years. Throughout these years, low pass rates in certain developmental and gatekeeper courses have been a noticeable problem. Two such courses are Elementary Algebra (MAT020) and Anatomy & Physiology I (BIO120). Different attempts to address this problem include revision of syllabi, course redesigns, reorganization of the tutoring services, and incorporating technology into the classroom. Despite these efforts, the problem still persists at the college and continues to be a challenge to student success. In order to ameliorate this problem, DTCC implemented a new program in supplemental instruction. Created in 1973 at the University of Missouri-Kansas City (UMKC), supplemental instruction (SI) is a peer-led academic support service. An SI coordinator, a college staff or faculty member trained in the UMKC model, leads the SI program. SI is characterized by sessions in study skills and notetaking as well as incorporation of group collaboration and various learning strategy activities. These sessions are developed and managed by a trained SI leader who has previously taken the course, been highly successful in it, and attends the class again to serve as a model student. DTCC launched its new SI program in August 2016, starting with two sections of BIO120 and two sections of MAT020. The main goal of the SI program is to increase the pass rates in BIO120 and MAT020, which will lead to greater student success. The purpose of this Education Leadership Portfolio (ELP) is two-fold: (1) to illustrate my leadership role in the research, development, and implementation of the new SI program, and (2) to analyze the effectiveness of the program in order to make recommendations for future improvements. Creating, implementing, and evaluating SI at DTCC involves multiple steps. SI coordinators were interviewed, hired, and trained in the UMKC SI model. Then, the SI coordinators had to recruit, hire, and train the SI leaders. Each semester, the SI coordinators and SI leaders work closely to make the program successful. There are a few ways to analyze the program's effectiveness. First, SI coordinators compare the grades of the students who attend the SI sessions to the grades of the students who did not attend at all. Next, the coordinators conduct weekly observations of the SI sessions and examine the results to determine if the expectations of the program are being met. Finally, student surveys and interviews determine which aspects of the program the attendees liked and which ones they would change, as well as the possible reasons that non-attendees did not go to the SI sessions. The results of the grade, observation, and survey analyses show how well the program is meeting its goals. Moreover, this ELP

provides the insight needed to make recommendations for improving the program in the future. Through continued professional training and rigorous evaluation, this program has the potential to reach its ultimate goal of improving student retention of material, mitigating failure and dropout rates, and increasing the graduation rate of the college.

Lipsky, S. A. (2001). Enhancing students' academic performance via Supplemental Instruction and linked courses. *The ACT 101 Journal*, 8(1), 3-6.

The Learning Center program at Indiana University of Pennsylvania is a comprehensive freshman-experience program providing academic support services to approximately 400 at-risk freshmen. Supplemental Instruction (SI) is an important component of this program to increase student academic achievement and persistence. Participating students earned a final course grade approximately half a letter grade higher than nonparticipants with nearly two-thirds of students participating in the SI program.

Lipsky, S. A. (2006). A credit-bearing course for training SI leaders. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 33-42). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter describes key components in the design of a training counselor for Supplemental Instruction (SI) leaders. It looks at course topics and accompanying theoretical frameworks and explains how content is delivered.

Lipsky, S. A., & Kapadia, M. (2013). Effects of work experiences for academic peer educators. *Synergy*, 6, Article 3. Available online: <https://www.myatp.org/wp-content/uploads/2015/04/Synergy-Vol-6-Kapadia.pdf>.

This study employed a qualitative research model to understand the potential outcomes of the Supplemental Instruction (SI) program on the SI leaders. Thirteen experienced SI leaders participated in focus groups. The study was completed as part of the program's assessment and accountability system in addition to understanding a topic not often investigated in a rigorous fashion. The study revealed several findings: (1) intellectual growth (knowledge of subject matter, learning strategies, and higher-level cognition; (2) personal growth (listening, interpersonal communication, time management, leadership, and self-confidence; and (3) professional growth (work and career-related knowledge and self-efficacy). The SI leaders saw how these skills would be useful as they began their work careers. For SI leaders who had considered a career in education, the experience of serving with the program had solidified their decision. Some SI leaders now were considering a decision or change from previous interests for a career in teaching.

Livingston, S., Duda, D., & Lucas, K. (2000). *Supplemental Instruction at LaGuardia Community College*. Conference Proceedings of the PEPnet 2000 Innovation in Education: Postsecondary Education Programs Network Annual Conference, Denver, CO.

The Supplemental Instruction (SI) program at LaGuardia Community College (NY) has been expanded and adapted to serve students who are deaf and hard-of-hearing. Too often interpreters have been expected to serve the role of tutor with the advantage of specific training. In the LaGuardia model, the interpreter is trained to provide services as interpreter as well as SI leader. Some of the adaptations of the SI model include the following. The interpreter also takes as many notes as possible while they are interpreting the lectures. This allows them to provide some model note taking for the hearing impaired students to consider for adoption. "Text interpretation" is another strategy of the hybrid SI leader. In this activity key passages from the textbook or other print resources are made into transparencies and projected during the SI session. This activity is used for vocabulary development of key terms and support improved reading comprehension. At the beginning of the academic term all the hearing impaired

students are encouraged to enroll in the same section of the core curriculum course that is supported by the hybrid SI leader. Results suggest that SI participants earn higher final course grades.

Lockie, N. M., & Van Lanen, R. J. (1991). Utilizing Supplemental Instruction to enhance student performance in a freshman level chemistry course. *Transactions of the Illinois State Academy of Science*, 84(10), 10.

This abstract describes the use of Supplemental Instruction (SI) with entry-level chemistry students at Saint Xavier University (Chicago, IL).

Lockie, N. M., & Van Lanen, R. J. (1992). Supplemental Instruction in Chemistry: A collaborative relationship among students, faculty, and a peer facilitator. *Illinois Association for Personalized Programs Newsletter*, 1, 3-4.

This newsletter article describes the use of Supplemental Instruction (SI) at Saint Xavier College (Chicago, IL) in chemistry courses. Data from a 1990-91 study with a Chemistry 108 course suggests that SI participants earn higher mean final course grades and receive lower rates of D, F and withdrawals (15.4% vs. 37.1%) than non-SI participants.

Lockie, N. M., & Van Lanen, R. J. (1994). Supplemental Instruction for college chemistry courses. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 63-74). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc.

Strategies for maximizing the effectiveness of Supplemental Instruction in college chemistry courses are presented. The authors share lessons from use of SI in Principles of Inorganic Chemistry, Principles of Organic Chemistry and Biochemistry, General Chemistry 1, and Organic Chemistry I and II at Saint Xavier University (Chicago, IL). Some of the SI session strategies include: problem-solving strategies; review of basic chemistry content; accurate use of chemical language; collaborative learning activities that promote active learning by all SI session participants; quizzes to provide comprehension checkpoints; and sharing study strategies with each other.

Lockie, N. M., & Van Lanen, R. J. (1997, 1997). *Nursing students' success and retention in chemistry courses: A collaborative approach*. Conference Proceedings of the 1997 International Nursing Research Congress Abstracts, Vancouver, Canada.

This article describes the use of Supplemental Instruction (SI) with improving academic performance of nursing students in chemistry courses. The authors used the SI program at Saint Xavier University in Chicago, IL.

Lockie, N. M., & Van Lanen, R. J. (2008). Impact of the Supplemental Instruction experience on science SI leaders. *Journal of Developmental Education*, 31(3), 2-4, 6, 8, 12, 14.

This article reports on a qualitative study describing the experiences of Supplemental Instruction (SI) leaders in science courses at Saint Xavier University (Chicago, IL). Themes that emerged from this analysis for the SI leaders included: (a) greater appreciation of the diversity of student learning styles; (b) increased understanding of the subject matter; (c) greater self-confidence as learners; (d) development of closer relationships with faculty members; (e) application of the strategies and skills learned as an SI leader in other courses, (f) realization of the importance and values of collaborative learning, leadership and communication skills

Lockie, N. M., Van Lanen, R. J., & McGannon, T. (2013). Educational implications of nursing students' learning styles, success in chemistry, and Supplemental Instruction participation on

National Council Licensure Examination-Registered Nurses performance. *Journal of Professional Nursing*, 29(1), 49-58.

The purpose of this study was to examine the relationship between a number of demographic and academic variables of baccalaureate nursing graduates (n = 197) and their performance on the National Council Licensure Examination-Registered Nurses (NCLEX-RN). Variables examined in this study include gender, race, transfer status, Chemistry 108 grade, and student learning style and participation in supplemental instruction sessions. Variables found to be predictors of performance on the NCLEX-RN were Chemistry 108 grade, student learning style, and race. The results of this study can be used by nursing faculty to enhance nursing students' success on the NCLEX-RN. The use of these predictors will allow early identification of those students who are likely to have difficulty in passing the NCLEX-RN, thus providing adequate time and opportunities for appropriate interventions.

Loh, H. (1992). *Peer Assisted Study Sessions for LSB181, Anatomy for the Nursing Students, 1992*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This report discusses the use of Supplemental Instruction (SI), which is called Peer Assisted Study Sessions (PASS) at the local institution with nursing students enrolled in a anatomy course. Approximately half the students attended the SI sessions during the academic term. The program reduced the failure rate of students (7.8% vs. 19.1%), increased the percent of students receiving high marks (5, 6 or 7 on a scale of 0-7), and improved the mode and mean final course grade.

Loh, H. (1993). *Strategies to overcome the high failure rate in a subject*. Conference Proceedings of the 6th International Conference on the First Year Experience, Boston, MA. The Queensland University of Technology (Brisbane, Australia) has investigated the applicability of Total Quality Management (TQM) for improving student academic success. An anatomy course for nursing students saw its failure rate drop from 22.8% to 13.6% after the introduction of several interventions, including Supplemental Instruction (SI). The local institutional name used is Peer Assisted Study Sessions (PASS). Course lecturers listed the following benefits of the program: rapid dissemination of information and instruction to students via the SI leaders; rapid feedback from students concerning course content; provided small group benefits in large lecture classes; improved and increased the amount of communications between students and the lecturer; and the lecturer was able to give students increased responsibility for the learning process. SI leaders mentioned the following benefits to themselves: developed leadership and character, improved their own learning and facilitating techniques, acquired skills in group management, developed presentation skills, and built their own confidence and esteem.

Loh, H. (1993). *Peer Assisted Study Sessions in anatomy for nursing students*. Conference Proceedings of the Peer tutoring: Learning by teaching, Auckland, New Zealand. This article describes the use of Peer Assisted Study Sessions (PASS), the local institutional name for their adaptation of the Supplemental Instruction (SI) model at Queensland University of Technology (Brisbane, Queensland, Australia). Following an institutional commitment to Total Quality Management (TQM), some TQM principles were found consistent with the SI model of academic achievement. An anatomy course with first year nursing students was selected as a pilot for the SI program. Program outcomes include the following for SI participants: reported an increase in their confidence with the course after participating in SI sessions (87%); reduced percent of students failing the course (7.8% vs. 19.3%); agreed that the SI leaders motivated them to work harder (80%); increased their learning skills (90%); increased their understanding of the content material (87%); and increased their ability to apply the knowledge gained from

class lectures (82%). SI leaders reported the following benefits to them: developed leadership and character, improved their own learning and facilitating techniques, acquired skills in group management, developed presentation skills, and increased their own confidence and self esteem.

Loh, H. (1994). *Strategies to overcome the first year high failure rate in anatomy for nursing students*. Conference Proceedings of the 7th International Conference on the First-Year Experience, Dublin, Ireland.

This paper describes the use of Supplemental Instruction (SI) since 1992 with nursing students at the Queensland University of Technology (Australia) in an anatomy course (LSB 181). At QUT, SI is known as PASS (Peer Assisted Study Sessions). Data from 1992 through 1995 suggest substantial benefits of the SI program to students, SI leaders and the course instructor. The performance of the students were examined on a 3 to 7 scale (3=fail, 4=pass, 5=credit, 6=distinction, 7=high distinction). SI participant interviews and 1995 survey data suggested agreement with the following statements regarding the impact of SI: increased confidence levels (87.0%), lowered anxiety levels (61.5%), higher motivation to achieve grades of distinction (84.6%), and developed new study skills (70.3%). Based on data from 1992 in the anatomy course the SI participants achieved significantly ($p < .01$) higher levels of academic achievement. In comparison with non-SI participants, there were more grades of level 6 or 7 (39% vs. 27%) and less grades of level 3 (10% vs. 25%). When comparing failure rates, the results favored the SI participants. SI participants in 1995 failed the class at a rate of 2.7% while the non-SI group failed the class at a higher rate of 13.3%. To investigate the possible impact of student motivation, the failure rate of students who desired to participate in SI but were unable to attend due to time conflicts failed at nearly the same rate (12.7%) as the entire non-SI group (13.3%). This appears to support the conclusion that student motivation was not the major variable impacting student academic performance. The overall class average (including all SI and non-SI participants) for grades of level 3 (failure) were reduced from 22.8% before the introduction of SI down to 7.1% after the fourth year of SI. SI leaders reported the following positive results: developed leadership skills; improved their facilitation skills; improved their study skills; acquired group management skills; and increased their own confidence and self-esteem. Instructors who had SI attached to their course reported the following positive results: rapid dissemination of information and instructions to the SI participants; provided benefits of small group instruction within the large lecture sections ($n = 400$); instructors received feedback from students which allowed them to "fine-tune" teaching and improve teaching performance; involvement with the SI program provided new avenues for grants; enhancement of curriculum vitae; and improved positive attitude and sense of achievement since students improved academic performance.

Loh, H. (1996). *Supplemental Instruction: A peer collaborative learning program applied within anatomy for first year nursing students*. Conference Proceedings of the 2nd Pacific Rim Conference on the First Year in Higher Education, Melbourne, Queensland, Australia.

This paper describes the use of Supplemental Instruction (SI) since 1992 with nursing students at the Queensland University of Technology (Australia) in an anatomy course (LSB 181). At QUT, SI is known as PASS (Peer Assisted Study Sessions). Data from 1992 through 1995 suggest substantial benefits of the SI program to students, SI leaders and the course instructor. The performance of the students were examined on a 3 to 7 scale (3=fail, 4=pass, 5=credit, 6=distinction, 7=high distinction). SI participant interviews and 1995 survey data suggested agreement with the following statements regarding the impact of SI: increased confidence levels (87.0%), lowered anxiety levels (61.5%), higher motivation to achieve grades of distinction (84.6%), and developed new study skills (70.3%). Based on data from 1992 in the anatomy course, the SI participants achieved significantly ($p < .01$) higher levels of academic

achievement. In comparison with non-SI participants, there were more grades of level 6 or 7 (39% vs. 27%) and less grades of level 3 (10% vs. 25%). When comparing failure rates, the results favored the SI participants. SI participants in 1995 failed the class at a rate of 2.7% while the non-SI group failed the class at a higher rate of 13.3%. To investigate the possible impact of student motivation, the failure rate of students who desired to participate in SI but were unable to attend due to time conflicts failed at nearly the same rate (12.7%) as the entire non-SI group (13.3%). This appears to support the conclusion that student motivation was not the major variable impacting student academic performance. The overall class average (including all SI and non-SI participants) for grades of level 3 (failure) were reduced from 22.8% before the introduction of SI down to 7.1% after the fourth year of SI. SI leaders reported the following positive results: developed leadership skills; improved their facilitation skills; improved their study skills; acquired group management skills; and increased their own confidence and self esteem. Instructors who had SI attached to their course reported the following positive results: rapid dissemination of information and instructions to the SI participants; provided benefits of small group instruction within the large lecture sections (n = 400); instructors received feedback from students which allowed them to "fine-tune" teaching and improve teaching performance; involvement with the SI program provided new avenues for grants; enhancement of curriculum vitae; and improved positive attitude and sense of achievement since students improved academic performance.

Loh, H. (1997). *Multidisciplinary peer collaborative study programs for first year Aboriginal and Torres Strait Islander students*. Unpublished manuscript. Queensland University of Technology at Brisbane. Queensland, Australia.

This report describes the use in 1995 of Supplemental Instruction (SI) at Queensland University of Technology (Australia) with first year Aboriginal and Torres Strait Islander (A&TSI) students. Many of these students began postsecondary education with high anxiety (79% student response), low to medium confidence in passing their courses, limited knowledge of study skills, and high to moderate difficulty levels within their respective subjects. A&TSI students had an attrition rate nearly double other students at QUT (32.7% vs. 18.4%). About half the A&TSI students participated in the SI program. Using a four point scale (greatly, moderately, slightly, not at all), data obtained from end of academic term student surveys of SI participants suggests that SI: was helpful for increased learning (70% of students selected "greatly"), lowered anxiety levels (45% greatly and 45% moderately), increased confidence levels (50% greatly, 50% moderately), improved enthusiasm and motivation to perform better (45% greatly, 45% moderately), and helped to create a favorable environment supporting learning (100% greatly). SI participant grades were evaluated on a seven point scale: fail, one to three; pass, 4; credit, 5; distinction, 6; high distinction, 7. When analyzing the grade distribution for all A&TSI students, 22.9% of SI participants earned grades of 6 or 7 as compared with 0% for the non-SI. When examining the failing grades (1, 2 or 3) the SI group had a dramatically lower rate (22.8%) when compared with the non-SI group (78.3%). SI leaders reported that their participation in the program led to the following outcomes: developed facilitation and group organizational skills; improved confidence and self esteem; and developed their own learning skills.

Loh, H., & Kelly, B. A. (1994). *Supplemental Instruction (SI) in anatomy for first year nursing students*. Unpublished manuscript. The Queensland University of Technology. Brisbane, Australia.

This paper describes the use of Supplemental Instruction (SI) since 1992 with nursing students at the Queensland University of Technology (Australia) in an anatomy course (LSB 181). At QUT, SI is known as PASS (Peer Assisted Study Sessions). The SI modeled was contextualized in several ways: two SI leaders facilitated each group, allowing for larger numbers to attend each SI session; principles of Total Quality Management were employed to

use SI as a feedback loop between the students and the lecturer, thereby providing data to the instructor to allow for immediate changes in the content and delivery. Data from 1992 through 1995 suggest substantial benefits of the SI program to students, SI leaders and the course instructor. The performance of the students were examined on a 3 to 7 scale (3=fail, 4=pass, 5=credit, 6=distinction, 7=high distinction). SI participant interviews and 1995 survey data suggested agreement with the following statements regarding the impact of SI: increased confidence levels (87.0%), lowered anxiety levels (61.5%), higher motivation to achieve grades of distinction (84.6%), and developed new study skills (70.3%). Based on data from 1992 in the anatomy course, the SI participants achieved significantly ($p < .01$) higher levels of academic achievement. In comparison with non-SI participants, there were more grades of level 6 or 7 (39% vs. 27%) and less grades of level 3 (10% vs. 25%). When comparing failure rates, the results favored the SI participants. SI participants in 1995 failed the class at a rate of 2.7% while the non-SI group failed the class at a higher rate of 13.3%. To investigate the possible impact of student motivation, the failure rate of students who desired to participate in SI but were unable to attend due to time conflicts failed at nearly the same rate (12.7%) as the entire non-SI group (13.3%). This appears to support the conclusion that student motivation was not the major variable impacting student academic performance. The overall class average (including all SI and non-SI participants) for grades of level 3 (failure) were reduced from 22.8% before the introduction of SI down to 7.1% after the fourth year of SI. SI leaders reported the following positive results: developed leadership skills; improved their facilitation skills; improved their study skills; acquired group management skills; and increased their own confidence and self esteem. Instructors who had SI attached to their course reported the following positive results: rapid dissemination of information and instructions to the SI participants; provided benefits of small group instruction within the large lecture sections ($n = 400$); instructors received feedback from students which allowed them to "fine-tune" teaching and improve teaching performance; involvement with the SI program provided new avenues for grants; enhancement of curriculum vitae; and improved positive attitude and sense of achievement since students improved academic performance.

Love, T., Keinert, F., & Shelley, M. (2006). Web-based implementation of discrete mathematics. *Journal of STEM Education: Innovations & Research*, 7(3), 25-35.

The Department of Mathematics at Iowa State University teaches a freshman-level Discrete Mathematics course with total enrollment of about 1,800 students per year. The traditional format includes large lectures, with about 150 students each, taught by faculty and temporary instructors in two class sessions per week and recitation sections, with about 35 students each, taught once per week by a teaching assistant. In this format, the course experienced the standard academic problems associated with the multi-section large lecture format: over 30% D/F/Withdraw rates; lack of uniformity and inconsistency in course objectives, delivery, and testing; low student morale and performance; and insufficient individualized feedback from instructors. In addition, students failed to see the connection of the material to subsequent courses and real world problems; spent great effort on repetitive calculations and little or none on computing; lacked skills in analyzing problems, data presentation, and graphical analysis; and often had substantial gaps in basic algebra skills that were not addressed properly by course content. Discrete Mathematics was redesigned to address these challenges with a Web-based, self-paced model. The Web-based environment integrates WebCT as learning management software, MapleTA as an online testing program, and textbook and related materials by Barnett, Ziegler, and Byleen (Prentice- 1. Web-based Implementation of Discrete Mathematics Discrete Mathematics was redesigned as a Web-based, self-paced course. The content of the course is covered in several best-selling textbooks, all of which cover fairly similar topics. A course with the same role within the curriculum and with comparable enrollment numbers is taught at all large universities. Therefore, a redesign of Discrete Mathematics has

wide applicability, and hence a substantial impact on mathematics learning in many colleges within Iowa State University and at public universities across the nation. Section 2 of this paper describes the traditional course components. Section 3 describes Hall) as the content basis. The redesigned course includes weekly small recitation sections, additional office hours, availability of the Math Help Room, and peer-mentoring through study groups and Supplemental Instruction. Integrated and proactive student support includes Web-based feedback through online office hours, a Web-bulletin board for each class, and Web-published individual current scores and class standing. The redesigned course syllabus is divided into manageable modules, with clearly communicated learning outcomes and objectives. Expansion of learning and understanding through the application of technology are achieved through incorporating Microsoft EXCEL spreadsheets for instantaneous graphics and simplification of extensive repetitive calculations. The Web environment also includes a new fourth main course topic of basic algebra skills early in the material as preparation for the other sections. Assessment of the course redesign was performed by the Research Institute for Studies in Education (RISE), in the College of Education, at Iowa State University. The general assessment strategy included a pretest- posttest control group design and long-term study of academic success. Student performance data were used to determine which differences in learning outcomes may be attributable to specific course components. Students in the Web-based sections performed no worse, and usually performed better, than did classroom-based students. These results are based on student performance on learning outcomes in Fall 2002, Spring 2003, and Fall 2003. In a straight comparison, the design sections did significantly better than the control sections on eleven out of thirteen exams compared, with comparable results on the remaining two exams. This difference exists despite significantly higher cumulative GPAs for students in the control sections for two semesters and insignificant differences in the third semester. This suggests that the Web-based course design is able to enhance the performance, and hence the chances for retention, of even less-highly achieving students (as determined by their lower GPAs). A longer-term study of academic success has tracked students through subsequent courses for which Discrete Mathematics is a prerequisite. These results are also positive, though less conclusive. The traditional course used 12 faculty and 15 teaching assistants to deliver the course at a cost of \$129 per student. The redesigned course is staffed with 3 faculty and 9 teaching assistants. The redesign costs \$77 per student, resulting in savings of \$93,600 per year. The goals of the course redesign and Section 4 describes the final course structure. Section 5 discusses the comparison of impact on students in the traditional and redesigned classes. Section 6 concerns the lessons learned from the course redesign.

2. Traditional Discrete Mathematics Course A course on discrete mathematics had played an important role at Iowa State University in its traditional format. This structure has both useful and concerning aspects that influenced the redesign.

Loviscek, A. L., & Cloutier, N. R. (1997). Supplemental Instruction and the enhancement of student performance in economics principles. *American Economist*, 41(2), 70-76.

The authors presented an empirical evaluation of Supplemental Instruction (SI) in an economics principles course at the University of Wisconsin-Parkside. Using a two-equation model and student transcript data readily available to instructors and academic researchers, the authors evaluated the effectiveness of the SI program in economics principles. The analysis explicitly considers the confounding factor of self-selection in program participation. They found that ordinary least squares significantly underestimates the positive impact of SI. The results suggest that formal programs designed to increase the intensity of instruction can have a demonstrable payoff in the form of increased student learning.

Loy, W., Crown, K., & Wessley, A. (1996). *Academic support service as a means for professional development*. Unpublished manuscript. St. Louis Community College at Meramec. St. Louis, MO.

This paper describes the use of Supplemental Instruction (SI) as serving both the purpose of providing academic support to students while providing a venue for faculty professional development. The authors presented the paper at the 1996 NISOD conference. During the process of instituting SI, faculty re-familiarize themselves with good student qualities. Faculty learn about collaboratively learning and study strategies that often can be incorporated into classroom. Faculty learn more about curriculum development and learning experiences. The instructor receives continual assessment and feedback through the SI program.

Lozada, N. (2017). *How Supplemental Instruction (SI) leaders experience transformative learning and the nature of civic engagement as a result of serving in a peer leadership role in higher education*. (Doctoral dissertation), Rowan University. Available online: <http://rdw.rowan.edu/etd/2478/> after November 2, 2019

To empower students to become influential social change agents, institutions of higher education must move away from traditional academic models of civic engagement and toward alternative approaches of engaging students outside of the classroom. Providing students an opportunity to serve in a leadership role can lead to the actualization of transformative learning experiences, which may materialize in a heightened development of skills that are transferable to future academic, professional, and civic aspirations. While the majority of research on peer-facilitated academic assistance programs, such as Supplemental Instruction (SI), examines positive effects on participants, few studies set out to examine the additional impact that the program has on undergraduate student leaders (Lockie & Van Lanen, 2008; Malm, Bryngfors, & Morner, 2012; Skalicky & Caney, 2010; Stout & McDaniel, 2006). This case study assists in filling the void in research on how undergraduate students benefit, both by experiencing transformative learning and the nature of civic engagement, as a result of serving in a leadership role within a peer-facilitated academic assistance program in higher education.

Lozada, N. (2017). The benefits of Supplemental Instruction (SI) for the SI leader. *Supplemental Instruction Journal*, 3(1), 64-79. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

The majority of research on peer assistance programs explores benefits for student participants, such as increased retention and course grades; however, benefits gained by the programs' student leaders are often overlooked. This qualitative research study describes how undergraduate students benefit from their experience serving as leaders in a Supplemental Instruction (SI) program at a four-year, private university. The SI Leaders who participated in the study expressed throughout their interview responses and within their graphic elicitations various ways in which they benefit personally by serving as an SI Leader. These benefits were categorized into the following six emergent themes: academic improvement, increased leadership attributes, more effective communication skills, fulfillment in helping others, effective time management, and relationship-building opportunities, all of which translate into higher levels of overall institutional engagement.

Lozada, N., & Johnson, A. T. (2018). Bridging the Supplemental Instruction leader experience and post-graduation life. *The Learning Assistance Review*, 23(1), 95-114. Available online: <https://files.eric.ed.gov/fulltext/EJ1170143.pdf>.

This qualitative study explores the experience of former Supplemental Instruction (SI) leaders who worked at a four-year, private university while completing their undergraduate degrees. Serving as an SI leader prepared them for their post-graduation lives through the transferability

of skills to post-graduate studies and employment: knowledge skills, interpersonal skills, communication skills, collaboration skills, and future vocational plans.

Lozada, N., & Johnson, A. T. (2018). Perspective transformation in the Supplemental Instruction (SI) leader. *Journal of Transformative Education*. doi: 10.1177/1541344618774544 doi-org.ezp3.lib.umn.edu/10.1177/1541344618774544

This qualitative case study explores how former Supplemental Instruction (SI) leaders experienced perspective transformation as a result of serving in a peer leadership role at a 4-year, private university through a blended theoretical framework based on the principles set forth by Mezirow and Nohl. Through their participation in interviews and graphic elicitations, former SI leaders offered valuable insights concerning the transformative nature of student leadership and its impact on the emerging sense of self in social and learning contexts. This study also assists in filling the void in research on how undergraduate students benefit by serving in a leadership role within a peer-facilitated academic assistance program in higher education. Participants communicated that working in an SI program provided them the ability to develop meaningful relationships with faculty, students, and peer SI leaders, which, in turn, fostered a greater sense of campus engagement and interest in other student leadership positions. Former SI leaders also expressed increased levels of confidence as they learned to navigate their student-facilitator roles.

Lukoshus, W. (2003, 2003, August 17). More than 50 classes at South Lake sites, *The Post-Tribune Newspaper*, p. B6.

This newspaper article describes the use of Supplemental Instruction (SI) at the Indiana University-Purdue Calumet.

Lukoshus, W. (2004, 2004, April 23). New program helps freshmen, *The Post-Tribune Newspaper*, p. B2.

This newspaper article describes the use of Supplemental Instruction (SI) at the Indiana University-Purdue Calumet. Preliminary research studies suggest lower withdrawal rates and higher retention rates for SI participants.

Lukoshus, W. (2004, 2004, December 31). 2004 a transformational year for Indiana University-Purdue Calumet, *The Post-Tribune Newspaper*, p. B2.

This newspaper article describes the use of Supplemental Instruction (SI) at the Indiana University-Purdue Calumet.

Lundeberg, M. A. (1990). Supplemental Instruction in chemistry. *Journal of Research in Science Teaching*, 27(2), 145-155.

This two-year study (148 students) at the University of Wisconsin (River Falls, WI) was designed to measure some effects of Supplemental Instruction in General Organic and Biological chemistry courses. Goals of the SI program included: develop conceptual understandings; articulate both understandings and misconceptions in a think-aloud fashion; connect, relate, and integrate scientific information; develop confidence and ability in problem solving; and learn how to learn science. Some of the challenges with students are: motivating students to use problem-solving strategies; failure to accurately understand the problem before using a problem-solving strategy; attempt to use rote memory when solving; and failure to integrate new material with old. Quantitative studies suggested that SI contributed to higher mean final grades (2.80 vs. 2.26, $p < .002$) and lower rates of D, F and withdrawals for SI participants. Qualitative studies of SI participant comments suggested that SI was helpful in a variety of ways. In addition, SI leaders maintained journals. Six themes emerged from the journals: accommodating needs of diverse learners; understanding versus memorizing; depth

versus breadth of discussion; relationships between ability, knowledge, and confidence; social relationships with students; and challenges to SI leaders' knowledge. The first three of these themes represent tensions that reoccurred several times over the academic term.

Lundeberg, M. A., & Moch, S. D. (1995). Influence of social interaction on cognition: Connected learning in science. *Journal of Higher Education*, 66(3), 312-335.

This article explores the use of Supplemental Instruction (SI) for increasing the academic success of women in science. "Connected knowing" -- a preferred learning environment for women that is a personal, cooperative approach to learning -- is thought by some to more naturally occur in SI sessions rather than the traditional pedagogical style used by most classroom professors. A research study of nursing students at the University of Wisconsin (River Falls) was conducted to test this idea. Qualitative research studies of the SI sessions suggested the following themes: spirit of cooperation, a circle of community, a shift of power to the SI participants, and risk-taking behavior (acknowledge uncertainty, experiment new ideas without fear of lower grades or punishment). Cognitive learning aspects included confirming the capacity for learning (encouragement), calibrated teaching (SI leader adjusted SI session agenda), and connected learning (placing abstract class lectures into context of personal lives). The article author provides several suggestions on how the classroom professor can introduce several of the SI session activities into their lecture sessions.

Lupkin, M. (1994, 1994, July 28). Linking science to students' lives. This summer program offers academic aid to minorities., *Philadelphia Inquirer Newspaper*, p. 3.

This newspaper articles mentions that Supplemental Instruction (SI) is a component in a special program for minority students at Rutgers University at Camden (PA) called "Success in the Sciences." Students are brought in for a special four-week enrichment program before the beginning of the freshman year to prepare them for the rigor of courses at Rutgers. SI is offered in connection with their first-year courses in math, chemistry and biology. The program has been partly funded with a \$500,000 grant from the William Penn Foundation and \$50,000 grant from the Coca-Cola Foundation.

MacGregor, J. (2000). Restructuring large classes to create communities of learners. In J. MacGregor, J. L. Cooper, K. A. Smith & P. Robinson (Eds.), *Strategies for energizing large classes, New Directions for Teaching and Learning*, No. 81 (pp. 47-61). San Francisco: Jossey-Bass

This article provides an overview of a variety of programs for providing peer collaborative learning groups either inside or outside the classroom. The Emerging Scholars Program (ESP) and Supplemental Instruction (SI) have several pages of text devoted to both of them providing a basic program overview and several citations to research studies that support their program claims of effectiveness for improved student outcomes.

Maclsaac, D. L., Falconer, K., A, Maglione, C. A., & Masxka, C. (2002). *Using Supplemental Instruction to improve minority success in gatekeeper science courses*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA.

This paper provides a post-hoc study of the use of Supplemental Instruction (SI) in the department of physics at SUNY Buffalo State College (Buffalo, NY). The study examined the impact of SI with 6,000 students over six semesters. Irrespective of student preparation level, the SI participants earned higher grades than non-participants. There were significant academic achievement gaps between the minority and majority student regarding preentry attributes. These differences were reduced to non-significance for students who participated in SI. Qualitative research confirmed the effectiveness for minority students, especially for those who were Native-American.

Macisaac, D. L., Falconer, K. A., & Maxka, C. (2003). *Using Supplemental Instruction to improve minority success in gatekeeper science courses*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the authors at the Department of Physics, SUNY Buffalo State College, 222SCI Bldg BSC, 1309 Elmwood Ave., Buffalo, NY 14222, macisadl@buffalostate.edu

Supplemental Instruction (SI) was used at Buffalo State College (NY) and several others to improve the academic achievement of minority students enrolled in challenging science courses. A study of over 6,000 students over six semesters compared SI participants and nonparticipants. Outcomes included: higher grades regardless of ethnic or racial background. With SI as a covariate, the academic achievement of all ethnic groups was the same.

Mack, A. C. (2007). *Differences in academic performance and self-regulated learning based on level of student participation in Supplemental Instruction*. (Ph.D. dissertation), University of Central Florida, Orlando, FL.

This study examined differences in academic performance and self-regulated learning based on levels of student participation in Supplemental Instruction (SI) sessions in two introductory undergraduate biology and chemistry courses offered at University of Central Florida in the Spring 2006 semester. The sample consisted of 282 students enrolled in the biology class and 451 students enrolled in chemistry. Academic performance was measured using students' final course grades and rates of withdrawal from the courses. The self-regulated learning constructs of motivation, cognition, metacognition, and resource management were measured using the Motivated Strategies for Learning Questionnaire (MSLQ). Relationships between students' gender and ethnic background and levels of SI participation were also analyzed in this research. Findings in both biology and chemistry courses revealed a statistically significant decrease in student motivation from beginning to end of semester. In chemistry, frequent SI participants also showed statistically significantly higher levels of motivation at the end of the semester than occasional and non-SI participants. There were no statistically significant gains in cognitive, metacognitive, and resource management strategies from beginning to end of semester. However, statistically significant differences in resource management were observed at the end of the semester among SI attendance groups in both courses. Students in the high SI attendance group were more likely to use learning resources than those who did not participate regularly or did not participate at all. Statistically significant differences in academic performance based on students' SI participation were found in both biology and chemistry courses. Frequent SI participants had significantly higher final percentage grades and were more likely to receive grades of A, B, or C, than those who either did not attend SI regularly or did not participate at all. They were also less likely to withdraw from the course than occasional or non-SI participants. In biology, no relationship between SI participation, gender, and student ethnic background was found. In chemistry, female students were significantly more likely to attend SI regularly than males. Chemistry minority students had significantly higher representation among occasional SI participants. An important implication involved the use of pedagogical approaches that make lecture classrooms more interactive and encourage student motivation and engagement. This study could be replicated in other science and non-science courses that offer SI sessions. Additional factors in the success of SI programs and student motivation can be added, such as SI leaders' experience and major. Follow-up studies on students who completed the courses included in this study can be conducted to determine whether they reenrolled in other science courses, continued attending SI sessions, and gained self-regulated learning skills.

Madyun, N., Grier, T., Brothen, T., & Wambach, C. (2004). Supplemental Instruction in a personalized system of instruction General Psychology course. *The Learning Assistance Review*, 9(1), 7-15.

At the General College in the University of Minnesota the Supplemental Instruction model was modified to better meet the needs of the TRIO students enrolled in a general psychology course. Rather than the traditional voluntary attendance model, these students were required to attend a college credit course that resembled a mandatory version of SI that meet twice each week throughout the semester. The SI course had six objectives: (a) teach the students to use the textbook as a primary resource; (b) build critical thinking skills; (c) self-regulation, selfing monitoring, meta-cognitive awareness, concentration, and peer support; (d) develop peer support for learning; (e) final exam preparation; and (f) provide explicit instruction and exercise3s geared toward helping students understand the nature and structure of the psychology course. A quasi-experimental evaluation design was used. The TRIO students enrolled in the SI course had higher grades than a comparison group of nonparticipating TRIO students.

Mahadev, A. (2019). *Insights from using Supplemental Instruction (SI) in data structures course to increase retention*. Conference Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education, Aberdeen, Scotland, UK.

Data Structures (CS 242) ranks as one of the most challenging courses in our core curriculum. It has the steepest learning curve for our students and has the lowest retention rate. Students find it challenging to master the mathematical concepts, learn the data structures and apply them in large programs. Three years ago, the department decided to offer Supplemental Instruction (SI) in CS 242 and in Discrete Structures (CS 225), a co-requisite for CS 242, in the hope of increasing retention in CS 242. In this poster, the author shares experiences with the SI approach, and the results of a student survey to assess the efficacy of SI in both these courses.

Mahadey, A. (2019). *Insights from using Supplemental Instruction (SI) in data structures course to increase retention*. Conference Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education.

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Mahdi, A. E. (2004). *Peer-supported learning groups: A collaborative approach to supporting students learning in engineering and technology*. Conference Proceedings of the WSEAS, Venice, Italy. Available online: <http://www.wseas.us/e-library/conferences/venice2004/papers/472-296.pdf>

This paper describes a non-traditional tutoring programme based on collaborative peer-support learning approach, and reflects on two years of its implementation to specific subjects in engineering and information technology based courses at the University of Limerick in Ireland. The programme, known as the Peer-Supported Learning Groups (PSLG), is an academic enrichment scheme which has been developed by adapting the SI model such that it meets the needs of the students in Ireland and, at the same time, fits into the Irish third-level education system. The paper begins by giving a rationale for the introduction of the PSLG to the targeted subjects and the reasons for choosing the SI model. This is followed by description of the operational structure of the programme highlighting the difficulties encountered at the initial stages and the measures taken to alleviate these difficulties. Quantitative measures for evaluating the effect of the PSLG on student's performance, as well as analysis of feedback

collected from the students and the leaders, are presented and discussed. The paper concludes by outlining issues for improving the current programme and associated further developments.

Mahdi, A. E. (2006). Introducing peer-supported learning approach to tutoring in engineering and technology courses. *International Journal of Electrical Engineering Education*, 43(4), 277-287.

Based on the Supplemental Instruction (SI) model, an adapted model is being used with electronic engineering and ICT-based courses at the University of Limerick in Ireland. Known as Peer-Supported Learning Groups (PSLG) this academic enrichment scheme fits into the Irish third-level education system. This paper begins by giving a rationale for the introduction of the PSLG to the targeted subjects, followed by descriptions of the operational structure of the program highlighting the difficulties encountered at the initial stages and the measures taken to alleviate these difficulties. Quantitative measures for evaluating the effect of the PSLG on students' performance, as well as analysis of feedback collected from the students and the leaders, are presented and discussed. Participating students earned higher scores on the mid-term and final exams. In addition, the PSLG participating students maintained their advantage over those who did not participate in subsequent academic terms. The paper concludes by outlining issues for improving the current programme and associated further developments.

Makins, V. (1991, 1991, July 5). Passing on a year's experience: How peer tutors at Kingston Polytechnic help students combat isolation, *The London Times*, pp. 1-3.

The article describes how Kingston Polytechnic in England has customized the use of Supplemental Instruction (SI) at their institution. The campus SI supervisor reports that a challenge in the SI sessions is the requirement that SI leaders redirect all questions back to the SI participants to answer.

Maldonado Gonzalez, M. (2000). The Supplemental Instruction culture: A qualitative program evaluation of context-specific patterns [Dissertation, Washington State University, 1999]. *Dissertation Abstracts International*, 60(11), 3904.

This study explores the Supplemental Instruction (SI) world at a land grant university of the United States of America and the peripheral cultural ecologist it generates. The qualitative study was conducted over a period of 10 weeks and it involved 50 students, 6 faculty members, 4 peer instructors and 1 staff member. It followed a two-phase research design. In the first phase, the delimitation of assessment goals and revision of program documents took place. In the second, phase the researcher conducted field observation, interviews, and surveys, and data were screened through several conceptualizations: participation frameworks (Shiffrin), linguistic of discrimination (Fawler), classroom ecology (Bowers & Flinders), teaching paradigms (Brooks & Brooks), and proxemics of communication (Hall). Five themes emerged: (1) Collaborative vs. competitive frameworks of participation: Unlike the discriminatory patterns of communication existing in the at-risk courses, communication in the study sessions is a pro-social activity in which students and leader share participatory roles. (2) Symmetrical vs. asymmetrical patterns of speech visibility: The relationship between the SI leader and the students exemplifies a proactive transmission of power that increases the students' speech visibility. A factor that is minimized in at-risk courses where the teacher's visibility is maximized. (3) Traditional vs. constructivist power ecology: The SI support a constructive flow of authority distributing participatory power among the students, who assume learning responsibilities through processes of collective thinking, negotiation of solutions, and peers' assistance. (4) Linguistic signs of coercive paternalism vs. nurture: The contrast between the superior-subordinate relationship in the at-risk-courses and the egalitarian relationship in the study sessions is exemplified through the linguistic indicators peculiar to the facilitators' discourse in each of these environments. The at-risk courses facilitator's discourse contains linguistic signs of coercive

paternalism, whereas the SI leaders' discourse reflects feminist caring linguistic signs. (5) Proxemicist alienation versus proxemicist inclusion: The proxemics and kinetic indicators embedded in the context of the at-risk courses impact the participants' territorial distance creating a climate of exclusion. In the study sessions the territorial distance is reduced, which fosters an atmosphere of students' inclusion. The study profiles the academic environment of SI and the interactions the participants displayed. Attention is given to the students' perceptions of SI and how it affected their academic performance. It proposes a grounded theory about the interplay of two academic cultures, suggests strategies for SI improvement, teaching development and future research.

Malm, J., Bryngfors, L., Carey, W., Holmer, A., L.-L., M., & Ody, M. (2019). *Status report for European SI/PASS/PAL-programmes*. Available online: https://www.si-pass.lu.se/sites/si-pass.lu.se/files/status_report_european_web_feb2019.pdf

This report is based on the contributions from SI/PASS/PAL supervisors at 63 Universities in Europe to a basic survey of 13 questions. Each institution that responded to the survey was invited to provide more detailed information about the programme including attendance statistics and examples of evaluation/impact; 45 universities provided these more detailed responses. At present, there are nine countries in Europe (mostly in the north-western part) with SI/PASS/PAL schemes. However, with supervisors trained recently from Belgium and Spain it is likely that an expansion will happen in the near future. There is a great variation in the programmes described below, which is a strength when growing the SI/PASS/PAL community. Some are quite small with one supervisor, a handful of Leaders and SI/PASS/PAL attached to a single subject. Others are huge with 10+ supervisors, several hundreds of leaders and where SI/PASS/PAL is attached to 100+ courses in all subject areas. Some programmes are relatively old and have existed since the mid-1990s when SI expanded beyond the borders of the US, while others are just about to start with a pilot. Furthermore, paying Leaders is usually the case in the Scandinavian countries, while the opposite seems to be generally true in Great Britain. Similarly, Leaders usually work in pairs in Britain while often working alone in Sweden. In common for all SI/PASS/PAL programmes are the initial training and continuous support of the Leaders and a follow-up/evaluation of the programme outcomes. The objectives with introducing or having SI/PASS/PAL varies between Higher Education Institutes (HEIs), illustrating how many different areas the learning model may address. Some examples of goals extracted from the Case Studies in the following pages are: improving student performance and retention, increasing student engagement with the subject and their understanding, to complement ordinary education and have organized study groups with a facilitator, enhancing students early learning experiences and let students see their peers as learning resources, to support: (1) a successful transition to higher education, (2) help 1st year students develop a sense of belonging, (3) academic success, (4) student health and wellbeing, (5) progression. Although Supplemental Instruction (SI), Peer Assisted Study Sessions/Schemes (PASS), and Peer Assisted Learning (PAL) are the common names for the learning programme, some HEIs show great ingenuity in finding other names. Having their own local name can be important for the HEI in marketing and identifying their programme internally. However, there are some dangers to be aware of. In Appendix 2, all Higher Education Institutes (HEI) in Europe are given that have had employees trained to SI-supervisors by the European Centre for SI-PASS or earlier regional centres in Europe. Furthermore, in the appendix HEIs are marked that have active SI-programmes (based on either answering surveys or having web-sites that indicate active programmes). To date, 137 HEIs in Europe have had employees trained as supervisors in SI. 73 (53 %) of these have active SI-Programmes. names may lead to confusion if we are talking about the same type of programme, potentially hindering information exchange. Secondly, when creating an own brand name it might be tempting to stray from the original model. Whilst this may be appropriate for the HEI, this means that the programme will not be comparable with others. The strength of the

SI/PASS/PAL model lies in having the same essential elements in the programme (see appendix) and it is important that practitioners adhere to it if they want to compare results and impact of their programmes across institutional and national borders. The SI/PASS/PAL learning model is well established at many HEIs in northern Europe. Whilst we know there are some HEIs that have yet to respond to the first call for information from the 63 programmes responding to the survey, we can make the following estimates (based on the estimate that 73 HEIs have active SI/PASS/PAL programmes): there are ~290 trained supervisors actively involved in the SI/PASS/PAL programmes, approximately 8,400 SI/PASS/PAL-leaders are employed each year, on average the leaders hold about 15 sessions during an academic year being 0,5-3 hours in length, there are ~1,530 courses supported by SI/PASS/PAL each year, the number of students having access to SI/PASS/PAL per year is ~141,200, the number of students attending at least one time per year is ~81,600 (58 % of those having access), the average attendance on SI/PASS/PAL sessions is ~31 %, the average number of students at a session is ~10, the number of contact hours is ~809,000 during an academic year. (Contact hours are the total number of hours students visit sessions during a year). The various follow-up and evaluation examples from different HEIs illustrate that many of the intended goals of SI/PASS/PAL programmes are met. Some examples provided in the Case Studies later in this publication include: higher student performance, improved communication and leadership skills as well as increased employability for Leaders, increased confidence for new students with regard to the student support the HEI gives, improved learning experience for students, teachers are provided with valuable information from Leaders on areas the students struggle with, improves and reduces questions from students to teachers. An area where the SI/PASS/PAL community in Europe can improve is in publishing their initiatives, experiences, and research studies. Hopefully, the examples below can serve as an inspiration to present your own material and conduct research.

Malm, J., Bryngfors, L., & Fredriksson, J. (2018). Impact of Supplemental Instruction on dropout and graduation rates: an example from 5-year engineering programs *Journal of Peer Learning*, 11(1), 76-88. Available online:

<http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1130&context=ajpl>.

This study focuses on quantitative long-term effects of Supplemental Instruction (SI) in terms of graduation and dropout rates. One of the main aims of SI is to introduce students to effective study strategies and techniques. If SI is introduced at an early stage for new students in higher education, it should therefore be expected that this action will promote timely graduation. This has also been indicated in studies at two US universities – University of Missouri Kansas City and Utah State University. This impact should obviously be of huge interest to any college or university that wants to introduce SI for their students. However, more studies from different settings and environments are needed to be able to generalise the findings from previous studies. This investigation is one such study for students at an engineering education faculty. The results from this study show that SI appears to have a pronounced effect on student persistence, and that the effect increases continuously with increasing SI attendance. A student's chances of graduating from an Master of Science (MSc) engineering program within six years, increases by approximately 20-35 % for a student attending all SI meetings in the first semester, compared to a student who does not attend SI. The risk of a student dropping out is reduced by approximately 20-40 % if he/she attends all SI sessions. The results also show that all students benefit from attending SI, independent of prior academic achievement and gender.

Malm, J., Bryngfors, L., & Morner Lise-Lotte. (2010). Supplemental Instruction (SI) at the Faculty of Engineering (LTH) Lund University, Sweden. An evaluation of the SI-program at five LTH engineering programs Autumn 2008. *Australasian Journal of Peer Learning*, 3(1), 38-50. Available online: <http://ro.uow.edu.au/ajpl/vol3/iss1/5>.

The study presents an evaluation of the Supplemental Instruction (SI) program in five engineering programs within the Faculty of Engineering (LTH) based on data from questionnaires to SI participants and SI leaders. Outcomes studied were their responses to the survey questions, credits taken by the students during the first year, and average grade data from high school for the first year students. The results show that participation in SI sessions markedly improves the chances of student success in studies during the first year and that the SI program creates a positive social introduction to engineering studies. The SI sessions also improved the participants' study techniques and development of common skills important for the engineer, such as problem solving, group work, and presenting/discussing results.

Malm, J., Bryngfors, L., & Morner, L.-L. (2011). Improving student success in difficult engineering education courses through Supplemental Instruction (SI): What is the impact of the degree of SI attendance? *Journal of Peer Learning*, 4(1), 16-23. Available online: <http://ro.uow.edu.au/ajpl/vol4/iss1/4>.

The main emphasis and outcome from almost all investigations made on Supplemental Instruction show that SI improves grades, percentage of students passing the course as well as increasing student retention. But what happens to students that failed on the SI supported course in spite of being active participants at SI-sessions? Did the extra effort put in by attending SI-sessions reward the students later on or was it just a waste of time? These questions have received no attention in previous studies on supplemental instruction. The main objective of the present study is to investigate these questions in an engineering education environment with focus on first-year students. The results of the study show that failure on the first major exam means a drastically reduced chance of successful freshman year studies. However, a good attendance record at SI-sessions seems to increase chances of student success although you failed the first exam. For instance, a student with high SI attendance during the first year takes 11 credits more than a student that did not participate in SI sessions. Almost two thirds of students failing the first exam but with high first year SI attendance fulfill the strategic goal of successful studies for the school of engineering at Lund University. This can be compared to one fourth having freshman year study success among students with no SI attendance. These results clearly indicate that attendance at SI sessions tend to reward participants in the long run although results in the short perspective – like failing the first exam in an SI supported course – are negative. The student attendance pattern was divided into four quartiles from low to high attendance. There was a progressive relationship between the number of times attended and the final course grade in engineering courses.

Malm, J., Bryngfors, L., & Morner, L.-L. (2011). *Failing on the first major exam at university in spite of attending Supplemental Instruction (SI) sessions – was SI just a waste of time?* Unpublished manuscript. Center for Supplemental Instruction, School of Engineering, Lund University. Lund, Sweden.

The main emphasis and outcome from almost all investigations made on Supplemental Instruction show that SI improves grades, percentage of students passing the course as well as increasing student retention. But what happens to students that failed on the SI supported course in spite of being active participants at SI-sessions? Did the extra effort put in by attending SI-sessions reward the students later on or was it just a waste of time? These questions have received no attention in previous studies on Supplemental Instruction. The main objective of the present study is to investigate these questions in an engineering education environment with focus on first-year students. The results of the study show that failure on the first major exam means a drastically reduced chance of successful freshman year studies. However, a good attendance record at SI-sessions seems to increase chances of student success although you failed the first exam. For instance, a student with high SI attendance during the first year takes 11 credits more than a student that did not participate in SI sessions.

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Malm, J., Bryngfors, L., & Morner, L.-L. (2011). Supplemental Instruction: Whom Does it Serve? *International Journal of Teaching and Learning in Higher Education*, 23(3), 282-291. Available online: <http://www.isetl.org/ijtlhe/pdf/IJTLHE1025.pdf>.

Supplemental Instruction (SI) is today a well-known academic assistance program that provides help for students in “difficult” courses. SI has repeatedly been shown to decrease the percentage of failures in the course as well as increasing course grades for students who attended SI sessions. Although SI is open for all students, its main objective is to come to terms with students’ high failure rates and retention problems. And even if SI has been shown to reduce failure rates and increase reenrollment figures, surprisingly few studies have been devoted to determine how well it benefits students with different prior academic ability. These studies tend to show that “weaker” students benefit from SI. The results for “average” and “strong” students are not as clear. The present study focuses on the benefit of SI for “weak”, “average,” and “strong” first-year engineering students in a calculus course. The results show that all three groups benefit from SI and that the failure rates among students with low prior mathematics achievement who had high SI attendance are almost as low as for students with high prior mathematics achievement who do not attend SI.

Malm, J., Bryngfors, L., & Morner, L.-L. (2012). Supplemental Instructional for improving first year results in engineering studies. *Studies in Higher Education*, 37(6), 655-666. doi: 10.1080/03075079.2010.535610.

Many studies have been made on the impact of supplemental instruction in supported courses, with most showing significantly better examination results for students attending supplemental instruction in comparison to those who do not. However, remarkably little attention has been devoted to following up whether the benefits of supplemental instruction reach beyond the course it supports. The present study focuses on the influence of supplemental instruction on the overall academic performance during the first year, for undergraduate engineering students at a Swedish university. The results show that students with average and high supplemental instruction attendance do significantly better than students not attending in terms of overall first-year credit performance. Students with low, average and high prior academic achievement all benefit from attending supplemental instruction sessions. The data also suggests that the transferable effects of study strategies and skills to non-supplemental instruction courses are substantial for attendees, leading to better results in these courses.

Malm, J., Bryngfors, L., & Morner, L.-L. (2012). Benefits of guiding Supplemental Instruction sessions for SI leaders: A case study for engineering education at a Swedish University. *Journal of Peer Learning*, 5(1). Available online: http://www.si-mentor.lth.se/fileadmin/lth/omlth/pedagogiskaprojekt/simentor/Benefits_of_guiding_JPL.pdf.

The study indicates that students who work as Supplemental Instruction (SI) leaders gain several benefits from their SI experience. The benefits can be divided into the following main themes: Improved communication skills; Improved interpersonal skills (including abilities to listen to other people’s thoughts and reasoning; creating trust between yourself and your group members; to meet and inspire different individuals; to make a group of individuals enthusiastic about performing a task; and to get students to help each other); Improved leadership skills (including being a leader of a group, talking in front of others, leading a discussion, organizing

the work for a group, and creating an easy-going, positive, and supportive atmosphere at the learning sessions); Improved self-confidence; and deeper understanding of course content

Malm, J., Bryngfors, L., & Morner, L.-L. (2013). *The potential of Supplemental Instruction in engineering education*. Conference Proceedings of the 41st European Society for Engineering Education Conference, Leuven, Belgium. Available online: <http://www.sefi.be/conference-2013/images/45.pdf>

The results from this study show that both the percentage of students passing a difficult first-year engineering course, and scores on the course exams, are higher for students attending SI compared to students not attending. There is also a clear relation between SI attendance and student performance, with higher attendance leading to higher student performances. The study also shows that female students are attending SI at a higher rate than male students. However, both genders seem to benefit to the same degree by attending SI meetings. Also all students, independent of prior academic ability, benefit from attending SI. A qualitative study based on a questionnaire to students attending SI, suggests that SI meetings provide elements missing in other scheduled learning opportunities in the courses, which are important for understanding course material

Malm, J., Morner, L.-L., Bryngfors, L., Edman, G., & Gustafsson, L. (2012). Using Supplemental Instruction to bridge the transition from secondary to tertiary education. *International Journal of Education*, 4(3). Available online: http://www.si-mentor.lth.se/fileadmin/lth/omlth/pedagogiskaprojekt/simentor/SI-upper_secondary_IJE.pdf.

Supplemental Instruction (SI) is today a well-known academic assistance program, providing help for students in "difficult" courses at colleges and universities. Little attention has been paid however to the possibility of also implementing the SI program in upper secondary school. In this study we present qualitative results from such an SI program in a Swedish setting. Here, students from the faculty of engineering at Lund University, act as SI-leaders at eleven upper secondary schools in the local region, in subjects such as math, physics and chemistry. The main conclusion is that the SI-methodology also seems to work in an upper secondary school environment. The students who attend SI regularly appear to obtain new study strategies to increase their understanding of the subject, besides improving on general skills such as teamwork, communicating on a subject, and making presentations in front of others. There are several advantages for the schools and university involved. For example they gain a formal and an informal link, which can prove useful in many circumstances when an exchange of information is needed, and both can use SI as a means to boost recruitment. For the upper secondary school, the students can get an alternative view on subjects, which hopefully stimulates interest and understanding. The students also get a more mature role model to turn to. For the university an additional advantage is that a more informal view of what it is like to study at university can be provided to upper secondary school students.

Maloney, R. S. (1992). *The Supplemental Instruction program as an alternative field experience for secondary education majors*. (Bachelor of Science with Honors thesis), University of New Orleans, New Orleans, LA.

The College of Education at the University of New Orleans, LA (UNO) requires all education majors to complete twenty five hours of a Professional Laboratory Experience (PLE), which has traditionally been as a teacher aide in an area high school, prior to the student teaching experience. The goal of the PLE is to provide a varied and enriching teaching experience for prospective student teachers. The primary purpose of this study is to study the use of Supplemental Instruction (SI) in College Life sections of English 0150 during Fall 1991 to provide an effective alternative field experience for secondary education majors prior to student teaching. Students were divided into two groups: one group served as SI leaders in the English

course and the other group were placed in the traditional high school teacher aide position. Surveys were given to the secondary education majors -- those who completed their PLE at the high school and those who served as SI leaders at the college -- prior to and at the completion of their PLE (course name EDCI 3205) to measure their preparedness to perform specific teaching tasks. The results suggest that there is a greater change in preparedness levels for those who participated as SI leaders in the following areas: (a) lesson preparation (write performance objectives, choose appropriate materials, vary methodology, allocate time for content coverage, construct evaluation instruments, and provide feedback of assessment and evaluation results); (b) classroom management (manage time, manage classroom routines, maintain student engagement, manage task related behavior, and monitor and maintain student behavior); and c) instructional skills (initiate lessons and activities, provide accurate content information, emphasize essential elements of content knowledge, and implement learning activities at an appropriate pace). The researcher suggested that one of the reasons for the significant gains for the SI leaders was that they had more power to select and experiment with activities. The high school teaching aides were limited by the cooperating high school teacher. Based upon analysis of the data, the researcher suggests that SI can serve as an alternative experience for education majors.

Mannikko-Barbutin, S., & Sjogrund, B. (2004). *The role of the SI leader in high school: Meeting new challenges*. Conference Proceedings of the 3rd International Conference on Supplemental Instruction, Boston, MA.

This conference paper describes the use of Supplemental Instruction (SI) at a high school in Sweden. The SI program is extended to secondary schools to ease the transition of the recent high school graduates as they enroll at the college-level.

Marcus, D. (1996). Supplemental Instruction with mentoring support at Anne Arundel Community College. In R. Shoenberg (Ed.), *Lessons learned from Fund for the Improvement of Postsecondary Education Projects III*. Washington, D.C.: Fund for the Improvement of Postsecondary Education, U.S. Department of Education. Available online: <http://www.ed.gov/about/offices/list/ope/fipse/lessons4/aacc.html>.

This chapter describes the use of Supplemental Instruction (SI) at Anne Arundel Community College (Arnold, MD) for faculty development purposes in addition to increasing academic achievement of participating students. SI leaders were paired with faculty mentors who participated in the initial training workshop for SI leaders. For the first four weeks of the term the faculty mentor participated as learners by attending class lectures and SI sessions whose student SI leaders they supervise and by keeping a journal of their experiences. Mentors were placed in courses outside their discipline so that they would focus on the learning process rather than being tempted to critique the instructional content of the course professor. Mentors reported that they increased their own teaching skills and their view of the learning process.

Marhaya, L. (2014). Application of Vygotsky's social constructivism theory on lecturers' perspective of Supplemental Instruction peer facilitation model. *Mediterranean Journal of Social Sciences*, 5(11), 37-42. doi: doi:10.5901/mjss.2014.v5n11p37 Available online: <http://www.mcser.org/journal/index.php/mjss/article/view/2998/2958>.

The study seeks to gather a perspective on the impact of supplemental instruction model as a student enhancement support mechanism from lecturers involved in two modules supported in the programme. This is a qualitative case study design study of a Supplemental Instruction model used as a student enhancement support mechanism by lecturers in one institution of higher learning in the Eastern Cape Province. Four lecturers, who are currently utilizing this model, which consist of two from each programme involved in the study, have been drawn. These participants have been purposefully selected based on knowledge and utilization of this

tool. A narrative approach soliciting their stories through the use of open ended questionnaire is seen as ideal in order to get rich data. Emerging themes were analysed using a thematic approach. The results suggest that there is a general satisfaction on how the academics perceive, experience and what they expect from the programme. The study concludes that all stakeholders could benefit if good relations are maintained. It is recommended that they should be continuous strengthening of relations amongst all stakeholders involved in the programme.

Marra, R. M., & Litziner, T. A. (1997). *A model for implementing Supplemental Instruction in engineering*. Conference Proceedings of the Annual Conference on Frontiers in Education Conference, Piscataway, NJ, USA.

Supplemental Instruction (SI) is used at Pennsylvania State University (University Park, PA) to help students earn higher grades in electrical engineering courses. Penn State's SI program was piloted as a part of our larger Undergraduate Teaching Intern Program. The Teaching Intern (TI) Program allows undergraduate students to partner with a professor on a particular course in order to learn about the responsibilities of being a faculty member. This paper provides an overview of both the SI and TI programs, specific details on how to run a course to train for these programs, and preliminary results of the SI program in terms of experiences of the three student SI leaders and achievement results of those students who attended SI sessions versus those who did not.

Marrone, M., & Draganov, L. (2017). Peer assisted learning: Strategies to increase student attendance and student success in accounting. In L. N. Wood & Y. A. Breyer (Eds.), *Success in higher education: Transitions to, within, and from the university* (pp. 140-165). Singapore: Springer. Available online:

https://www.researchgate.net/publication/310494402_Peer_Assisted_Learning_Strategies_to_Increase_Student_Attendance_and_Student_Success_in_Accounting.

It is well known that extracurricular peer-learning programs such as Peer Assisted Learning (PAL) have an impact on student retention, success, and overall student satisfaction. However, for PAL to work as intended, higher participation rates are needed as student attendance remains one of the challenges faced by program administrators. In our study, we analysed the reasons why students attend PAL, and which strategies can be followed to increase students' interest in the program. This chapter outlines how targeted messages can encourage different cohorts to attend PAL, and assists PAL administrators with how to conduct their recruitment campaigns to consistent with their universities' needs. The aim of this research was to understand how the reasons for attending SI might be influenced by students' demographics and characteristics. From the existing literature on the topic, we identified seven main reasons why students participate: Improve my grade; Pass the unit; Receive additional help; Lecturer's prompting; Check my knowledge; To make friends; and Studying with people. In this research, we have incorporated the reason "SI Leader's prompting" as it was being trialled at Macquarie University at the time. Through ordinal regressions, the study revealed a link between certain student characteristics and the reasons why students might attend. On the one hand, students with a higher GPA might be more likely to participate as a result of wanting to "improve my grade". On the other hand, verbal prompts offered by lecturers or SI Leaders could tend to be more persuasive in attracting students with a lower GPA. Domestic students could rate the reasons such as "get extra help", "pass the unit", and "improve my grades" higher than the international students.

Marshall, S. (1994). Faculty development through Supplemental Instruction. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 31-40). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass

Involvement of faculty members with the Supplemental Instruction program can lead to personal and professional renewal for the faculty participants. The author describes the impact of SI with faculty members at Salem State College. Faculty members received an indirect faculty development experience through the following activities: attending training workshops initially designed for the SI leaders; frequent meetings with the SI leader assigned to their class; and participating in monthly seminars that involved SI leaders in discussing learning and teaching skills (group facilitation skills, critiques of teaching presentations, motivation activities, dealing racism and sexism, reviewing SI data studies). Faculty members who participated in this faculty development project reported numerous positive changes in their attitudes and classroom behaviors.

Martin, D. C. (1980). Learning centers in professional schools. In K. V. Lauridsen (Ed.), *Examining the scope of learning centers* (pp. 69-79). San Francisco, CA: Jossey-Bass
This chapter describes the role of academic assistance for students in professional schools. The use of Supplemental Instruction (SI) for medical students is described. Several research studies suggest that SI contributes to higher academic achievement and the rate of D, F and course withdrawals have been reduced by 20 percent. Fifty to seventy percent of the medical students enrolled in a given course participate in the service. Data suggests that there is a transfer effect of SI, students who take advantage of SI maintain their GPA lead over nonparticipating students during the following academic term in the second course in the same sequence.

Martin, D. C., & Arendale, D. R. (1990). *Supplemental Instruction: Improving student performance, increasing student persistence*. Unpublished manuscript. University of Missouri-Kansas City, Kansas City, MO. Available online: ERIC database. (ED327103).
This report describes the Supplemental Instruction (SI) program at the University of Missouri-Kansas City. Among the topics in the paper: narrative overview of the SI model; history of the development of SI at UMKC and other institutions across the U.S.; outcomes for students and the institution; and potential for adoption by other institutions.

Martin, D. C., & Arendale, D. R. (Eds.). (1992). *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed. Vol. 7). Columbia, SC: The University of South Carolina and the National Resource Center for the Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED354839)
This monograph describes Supplemental Instruction (SI), a study assistance program designed to improve the academic success of college freshmen based on the idea that if students are not being successful in courses then perhaps they will withdraw from the institution. The first chapter reviews the SI model. Chapter two explains in detail how SI works in the freshman year. Chapter three offers a review of the research on SI. Chapter 4 examines why educators and students choose SI. Chapter five shows how SI has been adapted to an urban high school, to English composition classes, and to a law school at the University of Missouri-Kansas City. The last chapter reviews the foundation and theoretical framework of SI. An appendix lists institutions currently using SI.

Martin, D. C., & Arendale, D. R. (1992). Supplemental Instruction in the first college year. In D. C. Martin & D. R. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 11-18). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED354839).

This chapter describes how the Supplemental Instruction program can help meet some of the unique needs presented to students during their first year of college: integrating learning/study strategies within regular content courses; and supporting students enrolled in historically-difficult

first-year courses; assisting student subpopulations make a successful transition into college (academically talented, remedial/developmental, field-dependent). Like other successful programs for students in the first-year, central objectives of the SI program are to: develop a felt sense of community; involvement of students in the life of the institution; and providing an environment to support academic and social integration.

Martin, D. C., & Arendale, D. R. (1992). Review of research on Supplemental Instruction. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 19-26). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED354839).

This chapter compares a national research study concerning the effectiveness of Supplemental Instruction with studies from the University of Missouri-Kansas City. The National Center for SI collects SI data from a diverse sample of higher education institutions from across the U.S. The national study included data from 49 institutions that had offered SI in 1,477 courses of diverse curriculum areas. The findings suggest that SI participants in comparison with non-SI participants earn higher final course grades (2.46 vs. 2.12), earn a higher percent of A and B final course grades, and receive a lower percent of D, F and withdrawal final course grades (23% vs. 38%). Data collected from 1980 to 1992 in 217 courses with an enrollment of 9,365 students at UMKC confirms the national studies. Additional studies conducted at UMKC suggested higher academic achievement for SI participants with reenrollment (90.0% vs. 81.5%) and graduation rates (30.6% vs. 18.2%). Several studies from UMKC studied the potential impact of student motivation levels, ethnicity, and previous levels of academic preparation. These were not found to have a statistically significant impact upon the research studies.

Martin, D. C., & Arendale, D. R. (1992). Foundation and theoretical framework for Supplemental Instruction. In D. C. Martin & D. R. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 41-50). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition.(ERIC Document Reproduction Service No. ED354839).

This chapter provides an overview of SI's educational pedagogy. Piaget and Vygotsky's writings on constructivism serve as a major basis for describing how students "construct" their own knowledge. This requirement for students to actively create their own knowledge drives many SI session strategies. Tinto's theories on student departure based on students' need for academic and social integration also guide the implementation of the SI program. Additional theorists include Keimig (Hierarchy of Learning Improvement Programs), Weinstein (metacognition), and a variety of researchers concerning collaborative learning.

Martin, D. C., & Arendale, D. R. (1992). Understanding the Supplemental Instruction model. In D. C. Martin & D. R. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 3-10). Columbia, SC: The National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED354839).

Theoretical and philosophical underpinnings for the Supplemental Instruction model is included in this overview. Some of the major issues are reviewed: common factors in student attrition; focus on "high-risk courses" rather than "high-risk students;" proactive assistance before problems occur; key SI features; essential partners for SI success; creating awareness and generating support for SI on campus; and movement from a reactive to a proactive mode of student academic assistance.

Martin, D. C., & Arendale, D. R. (Eds.). (1994). *Supplemental Instruction: Increasing achievement and retention*. New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass

This monograph features nine chapters concerning: overview and foundation of the Supplemental Instruction (SI) program; use of SI for faculty development; SI in the content areas (humanities, mathematics, chemistry); research studies concerning SI; and the newest innovation of SI called Video-based Supplemental Instruction (VSI).

Martin, D. C., & Arendale, D. R. (1997). *Mainstreaming of developmental education: Supplemental Instruction and Video-based Supplemental Instruction*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/MainstreamingDE97.pdf>

This paper describes the development of Supplemental Instruction (SI) and Video-based Supplemental Instruction (VSI) to serve an effective way to mainstream the best features of developmental education into traditional college-level courses. The historical development and modern day implementation of both programs are described

Martin, D. C., & Arendale, D. R. (1998). Supplemental Instruction and Video-based Supplemental Instruction. In A. C. P. A. American Association for Higher Education, and National Association of Student Personnel Administrators, (Ed.), *Powerful partnerships: A shared responsibility for learning* (pp. 6-7). Washington, D.C.: Editors

This report describes the different ways that institutions build campus partnerships to deepen student learning both inside and outside the classroom. AAHE, ACPA, and NASPA formed a Joint Task force on Student Learning to identify successful models that have implications for pedagogy, curricula, learning environments, and assessment. Both the Supplemental Instruction and Video-based SI programs were highlighted as being a model for the first principle of learning and collaborative action: Learning is fundamentally about making and maintaining connections: biologically through neural networks; mentally among concepts, ideas, and meanings; and experientially through interaction between the mind and the environment, self and other, generality and context, deliberation and action.

Martin, D. C., Arendale, D. R., & Blanc, R. A. (1997). *Mainstreaming of developmental education: Supplemental Instruction and Video-based Supplemental Instruction*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/MainstreamingDE97.pdf>

This manuscript was originally delivered as a paper at a special conference in January 1998 on "Alternatives to Developmental Education" that was sponsored by the U.S. Department of Education funded National Center for Lifelong Learning based at Stanford University (CA). The conference was convened to deal with the growing concern by some states regarding traditional developmental education credit courses. The conference was designed to identify several alternative ways of accomplishing the same purposes as developmental courses (e.g., linked courses, critical thinking courses, SI, VSI). This paper first provides an overview of SI and VSI. Then it concludes with the pedagogical basis for both. In developmental education, research scholars embrace the reductionist approach by seeking first to identify the separate and distinct skills required for academic success, then to measure the degree to which these are present or absent in the individual, and finally to isolate and teach those skills that are in deficit. Practitioners assume that mastery of a series of independent skills lead to academic competency. SI and VSI break with this view and provide a holistic approach to education. Given sufficient efficiency on task, effective guidance, and the time and opportunity to do so, any serious student can learn.

Martin, D. C., Arendale, D. R., & Widmar, G. E. (1998). Creating communities for learning. In L. Hardge (Ed.), *Bridges to student success: Exemplary programs 1998* (pp. 27-33). Washington, D.C.: National Association for Student Personnel Administrators

This monograph chapter provides a basic overview of the Supplemental Instruction (SI) model. In addition to the basic overview, the authors describe how SI provides a pluralistic environment where students can learn to value the unique perceptions of others who may view the world differently than themselves. SI provides a structured environment for students to participate in learning communities outside the supervision of the class professor.

Martin, D. C., & Blanc, R. A. (1981). The learning center's role in retention: Integrating student support services with departmental instruction. *Journal of Developmental and Remedial Education*, 4(3), 2-4, 21-23.

This article provides a historical background for the creation of the Supplemental Instruction (SI) program at the University of Missouri-Kansas City. Research studies of SI in a first-year American history course at UMKC during Fall 1980 suggest the following: SI participants earned a higher percent of A and B final course grades (54.1% vs. 38.9%); had a lower rate of D, F and withdrawal grades (21.7% vs. 42.4%); had a higher rate of reenrollment the following academic term (86.2% vs. 72.1%); and there was no statistically significant differences (e.g., prior academic achievement, standardized test scores) between SI and non-SI participants.

Martin, D. C., & Blanc, R. A. (1984). Improving reading comprehension through reciprocal questioning. *Life Long Learning*, 7(4), 29-31.

"Reciprocal questioning" is a technique that promotes active learning. It helps students: a) become aware of the implicit as well as the explicit meaning of a reading passage; b) improve their analytic skills with respect to reading; c) improve their reasoning; and d) strengthen the questioning skills that are integral to comprehension. Reciprocal questioning is adapted from Manzo's "The ReQuest Procedure." Reciprocal questioning is a strategy used as appropriate with Supplemental Instruction or Video-based Supplemental Instruction sessions.

Martin, D. C., & Blanc, R. A. (1994). Supplemental Instruction: An organic model in transition, the views of SI's initiator. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 91-94). Birmingham, England: Staff and Educational Development Association

This chapter describes the history and development of Supplemental Instruction in the United States by the program's creator. The essential elements of successful SI programs are described. In addition, the chapter reviews the adaptation of the SI model for the British higher education system through the work of Jenni Wallace of Kingston University, London.

Martin, D. C., & Blanc, R. A. (1994). Video-Based Supplemental Instruction: A pathway to mastery and persistence. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 83-92). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc.

The Video-Based Supplemental Instruction (VSI) delivery system using Supplemental Instruction that is described here combines developmental studies with core curriculum courses, offering an alternative to remedial/developmental instruction. Students that are least prepared at the institution need a more powerful academic support service. The difference between the VSI approach and those traditionally used in postsecondary education lies in the centrality of students to the process as opposed to the centrality of the material to be learned: students conduct the preview; students determine the pace of the lecture; students assure their own mastery as the lecture progresses; students select the key points for immediate review; and students identify misconceptions and modify and adapt their conceptions to achieve, eventually,

more complete understanding. VSI was designed to allow such students to both earn credit for core curriculum courses while they develop the requisite learning strategies needed for academic success. This provides an alternative way to provide developmental education.

Martin, D. C., Blanc, R. A., & Arendale, D. (1996). Supplemental Instruction: Supporting the classroom experience. In J. N. Hankin (Ed.), *The Community College: Opportunity and Access for America's First-Year Students* (pp. 123-133). Columbia, SC: University of South Carolina: The National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED393486).

This chapter reviews the impact of the Supplemental Instruction program with fifty-nine two-year colleges across the U.S. The research study contained reports from 480 classes that enrolled 23,979 students. The data suggests that SI participation was correlated with higher academic achievement: higher mean final course grades (2.30 vs. 1.63); higher percentage of A or B final course grades (50.6% vs. 32.9%); and lower rates of D, F and withdrawals (25.9% vs. 46.3%). Similar findings occurred when the data was separated by broad academic disciplines: business, health science, mathematics, natural science, social science/humanities, and technical/vocational. In addition, the themes of attrition identified by Tinto (adjustment, isolation, difficulty, and incongruence) are used as a paradigm to examine the possible reasons for the positive impact of the SI program. Several SI programs reported the use of SI for faculty development: faculty serve as SI supervisors and adopt SI sessions strategies into their own lectures; faculty SI supervisors provide requested feedback to the course professors that they observe concerning class presentation activities; and faculty who observe SI sessions report using more student-led collaborative learning activities during their class sessions.

Martin, D. C., Blanc, R. A., & Arendale, D. R. (1994). Mentorship in the classroom: Making the implicit explicit. *Teaching Excellence*, 6(1), 1-2.

Based upon experiences gained through the Supplemental Instruction (SI) program, the authors make a number of suggestions on how faculty members can use SI strategies in their classes. Some suggestions include: remind students of the "big picture" throughout the academic term of the most important concepts; refer to the syllabus during the term so that students will value and use it; share the thinking process that the professor uses to solve the problems with the students; administer a short examination with low grade impact early in the academic term to give students an opportunity to test their comprehension level and encourage them to modify study behaviors and perhaps seek academic support (e.g., SI); provide visual matrices during lectures to give models to students on how to organize the material; and make explicit what is expected on examinations.

Martin, D. C., Blanc, R. A., & DeBuhr, L. (1982). Supplemental Instruction: A model for increasing student performance and persistence. In L. Noel & R. Levitz (Eds.), *How to succeed with academically underprepared students: A catalog of successful practices* (pp. 75-79). Iowa City, IA: ACT National Center for the Advancement of Educational Practices

This article provides a basic overview of the Supplemental Instruction (SI) program. Included is a research study of 746 students enrolled in seven Arts and Sciences courses in Spring semester 1980. SI participants earned higher mean final course grades (2.70 vs. 2.25) and received lower rates of D, F and withdrawal grades (18.4% vs. 44.0%).

Martin, D. C., Blanc, R. A., & DeBuhr, L. (Eds.). (1983). *Retention with integrity through Supplemental Instruction*. Kansas City, MO: The University of Missouri-Kansas City, Student Learning Center

This monograph provides a comprehensive overview of the Supplemental Instruction (SI) program. It can serve as a training manual for SI supervisors and SI leaders to implement the

program on a college campus. Topics include: overview of SI; establishing and conducting SI sessions; guidelines for SI leaders; SI program evaluation procedures; writing lab adaptations of SI; adapting SI to English composition classes; SI on a small campus; student denial; and diagnosing learning problems of gifted adults.

Martin, D. C., Blanc, R. A., DeBuhr, L., Alderman, H., Garland, M., & Lewis, C. (Eds.). (1983). *Supplemental Instruction: A model for student academic support*. Kansas City, MO: The University of Missouri-Kansas City and ACT National Center for the Advancement of Educational Practices

This monograph provides a basic overview of the Supplemental Instruction (SI) model: basic overview; UMKC student academic performance in seven Arts and Sciences courses during 1980 reported earlier in the 1983 article by Blanc, DeBuhr and Martin (final course grades, impact of student motivation, reenrollment rates, performance of students separated by upper and lower quartile scores, and changes in D, F and withdrawal rates for the courses) and new studies examining students of color and medical school students; generating campus awareness and support; case studies of SI's use outside of UMKC (Maple Woods Community College - MO, Bethel College - KS, Kansas State University - KS); training SI leaders; and evaluation procedures for program review.

Martin, D. C., DeBuhr, L., & Garland, M. (1987). *Developing critical thinking skills of college students through Supplemental Instruction*. Paper presented at the Third International Conference on Thinking, Honolulu, HI.

The authors describe the use of Supplemental Instruction (SI) for improving the critical thinking skills of students. Some SI session activities help foster improved thinking skills: modeling of thinking processes by the SI leader; probing questions; redirective and higher levels of questioning; facilitating student discussions of their thought processes; escalation of discussions from concrete to abstract levels; and precise use of content vocabulary.

Martin, D. C., & Gravina, M. (1990). Serving students where they fail: In class. *Thresholds in Education*, 16(3), 26, 28-30.

This article provides a general overview of the Supplemental Instruction (SI) model. Rather than focusing on "at-risk" students, the authors suggest that the emphasis should be placed on identifying historically difficult courses that create an environment that may be challenging for any student, despite previous academic success in other courses.

Martin, D. C., Hall, P. T., & Arendale, D. (1991). *Academic success for inner city high school youth: The positive effects of Supplemental Instruction with an urban high school*. Conference Proceedings of the National Association of State Universities and Land Grant Colleges Conference, Kansas City, MO. Available online: ERIC database. (ED354839)

This paper describe the use of Supplemental Instruction (SI) with an urban high school in Kansas City, Missouri. Westport High School is a culturally-diverse school located in the central city. Over half the students were one or two years behind grade levels in reading and mathematics and an equal number were economically disadvantaged. SI was provided to students enrolled in 9th and 10th grade English and history classes. SI sessions were scheduled during a scheduled time during the school day three times each week. Research studies suggested that there was improvement in final course grades of students in the English (A and B grades: 28.7% vs. 13.6% before SI; F grades: 23.2% vs. 32.7% before SI) and history classes. Interviews with students and teachers suggest that participation in the SI program also promoted higher levels of class participation and higher achievement on standardized test scores.

Martin, D. C., Hall, P. T., & Arendale, D. (1992). Use of Supplemental Instruction at an urban high school. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 31-33). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database (ED354839).

The authors describe the use of Supplemental Instruction -- traditionally a post-secondary academic program -- with an urban high school in Kansas City, Missouri. Westport High School is a culturally-diverse school located in the central city. Over half the students were one or two years behind grade levels in reading and mathematics and an equal number were economically disadvantaged. SI was provided to students enrolled in 9th and 10th grade English and history classes. SI sessions were scheduled during a scheduled time during the school day three times each week. Research studies suggested that there was improvement in final course grades of students in the English (A and B grades: 28.7% vs. 13.6% before SI; F grades: 23.2% vs. 32.7% before SI) and history classes. Interviews with students and teachers suggest that participation in the SI program also promoted higher levels of class participation and higher standardized test scores.

Martin, D. C., & Hurley, M. (2005). Supplemental Instruction. In M. L. Upcraft, J. N. Gardner & B. O. Barefoot (Eds.), *Challenging & supporting the first-year student: A handbook for improving the first year of college* (pp. 308-319). San Francisco, CA: Jossey-Bass

This chapter provides an overview of Supplemental Instruction (SI). After providing guiding principles of SI, evidence of effectiveness is cited from the original developing site, University of Missouri-Kansas City as well as several other representative institutions. Two adaptations of the SI model are cited: Video-based SI and the Advanced Preparation Program. The chapter closes with recommendations for increasing the effectiveness of SI.

Martin, D. C., Lorton, M., Blanc, R. A., & Evans, C. (1977). *The learning center: A comprehensive model for colleges and universities*. Aquinas College. Grand Rapids, MI. Available online: ERIC database. (ED162294).

Intended for use by educators responsible for developing post-secondary learning centers, this manual emphasizes the design and administration of such centers rather than the various aspects of skill instruction. Its seven chapters discuss the concept of a learning center; the components of the model, including Supplemental Instruction, recruitment and selection of staff, the training of tutorial and teacher assistants, learning materials, distinct labs, noncredit readiness in content areas, and extension of the model; diagnosis of institutional and individual needs; instructional methodology, specifically listening, note taking, study skills, vocabulary, and comprehension; affective consideration, with a discussion of a "relaxation" project; evaluation, including sample data and forms; and proposal preparation.

Martin, D. C., & Wilcox, F. K. (1996). Supplemental Instruction: Helping students to help each other. In G. Wisker & S. Brown (Eds.), *Enabling student learning: Systems and strategies* (pp. 97-101). Birmingham, England: Kogan Page Publishers and the Staff and Educational Developmental Association (SEDA). (ERIC Document Reproduction Service No. ED396611). This chapter reviews the development of the Supplemental Instruction (SI) model in the United States and its recent introduction into the United Kingdom. Several additions were made to the SI model with its use in the United Kingdom. Due to scheduling conflicts for SI leaders, it is necessary to provide several SI leaders in each course. An advantage of this decision is that the SI program provides more professional development opportunities for the SI leaders. Another feature of the SI program in the UK is the common practice of the SI leader providing feedback to the course professor and the course tutor concerning student comprehension of the lecture

material. The authors emphasize the need for academic support and learning enrichment for all students in higher education.

Martinez Rolon, L. (2014). *relacion con el aprovechamiento academico y persistencia en una institucion de educacion superior privada sin fines de lucro*. Universidad del Turabo, Puerto Rico.

The problem posed in this study was to examine the role of academic support programs on academic success and persistence of students attending a nonprofit institution of higher education. The purpose of this investigation was to determine the correlation between the participation of academic support programs and academic success and persistence of these. The conceptual approaches used to support this research are: the Tinto Model of Retention related to academic and social integration with the theory of Student Involvement by Alexander Astin . The research design used was an ex post facto causal comparative using archived data. The study population consisted of 4,586 students between participants and non-participants in the academic support programs for semesters from August to December 2010, January to May 2011, and August to December 2011. The results showed that there are statistically significant differences in academic success of students participating in the Supplemental Instruction Program and the Reading and Writing Center in comparison to their non-participating counterparts. However, in terms of participation in the Supplemental Educational Services Program no statistically significant difference in academic achievement between the two groups was found. Regarding persistence, the results showed that students who participate in an academic support program persist over the short and long term in the institution than the non-participant students.

Mas, C. V. (2014). Supplemental Instruction as a mandatory lab component for developmental education courses at community colleges. *Supplemental Instruction Journal*, 1(1), 22-37.

Available online: [http://info.umkc.edu/si/wp-](http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf)

[content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf](http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf).

Students enrolled in developmental education courses have very low rates of persistence, especially at the community college level. Nationally, only 31 percent of those referred to developmental math successfully complete their sequence (Bailey, 2009). At Austin Community College, only 44.1 percent of entering First Time in College (FTIC) mathematically underprepared students returned to college the subsequent fall semester (Texas Higher Education Coordinating Board [THECB], 2011) The number of persisting students from Fall 2010 to Fall 2011 drops even lower for FTIC students who are underprepared in reading and writing, at 39.7 percent and 42.5 percent, respectively (THECB, 2011). The following discussion will center on the idea that Supplemental Instruction should be a required component of developmental courses, especially developmental mathematics, at the community college level. Pairing developmental courses with a mandatory lab component addresses many of the contributing factors that aid in student retention: social and academic inclusion, time management and study skills, financial aid issues and the development of student self-efficacy. Also examined are the implications of turning the mandatory lab component of Austin Community College's Quality Enhancement Plan that began in Fall 2013, into Supplemental Instruction sessions.

Mason, D., & Verdel, E. (2001). Gateway to success for at-risk students in a large-group introductory chemistry class. *Journal of Chemical Education*, 78(2), 252-255.

This study examined students enrolled at The University of Texas at San Antonio regarding the impact of a special program for at-risk students enrolled in a chemistry course with no laboratory component. Supplemental Instruction (SI) was one part of this special program. The study was carefully controlled regarding the possible impact of variables. At-risk students were enrolled in

both a large lecture class and a small one. The results were mixed and the authors postulate on the possible advantages of the heterogeneous large course with students of varying academic abilities who interacted with the at-risk students and the more homogeneous small class with only at-risk students enrolled.

Mason-Innes, T. A. (2015). *The leadership identity development of Supplemental Instruction leaders: A case study*. (Ph.D. dissertation), University of Alberta, Calgary, Alberta. Available online:

http://theses.ucalgary.ca/jspui/bitstream/11023/2126/4/ucalgary_2015_masoninnes_tracey.pdf

Much of our understanding of leadership theory is based on hierarchical systems and is grounded in research from business settings. Although researchers have presented more collaborative, relational leadership models for post-secondary students, these models have not been widely applied to Supplemental Instruction (SI) leader training programs. Having a better understanding of how students become SI leaders, the influences that shape their experiences, and how the SI experience shapes their leadership development has the potential to not only help SI program administrators, but also to assist all student affairs practitioners as they develop leadership programs that address institutional leadership learning outcomes. This descriptive case study describes the background characteristics and experiences of the SI leaders at a mid-size, regional, western Canadian university (WCU). The leadership identity development (LID) model was applied as a conceptual lens for this study—a model that is well-respected in the student affairs field. Six participants volunteered to participate in three interviews as well as reflective writing exercises. A document review of the SI program was also conducted. Based on the findings of this study, four conclusions were identified. First, when looking at student LID with SI leaders or any student leader, it is important to understand, acknowledge, and know the whole student. Secondly, many learning outcomes associated with the SI leader position were found in this study and warrant more emphasis in the SI literature and SI leader training. Thirdly, leadership identity development occurred for the SI leaders because of the structure and the nature of the SI program philosophy itself, as well as from the specific SI program training for the SI leaders. Finally, post-secondary institutions and the institutions' student leadership programs need to adopt a leadership philosophy and ground their student leadership development in leadership scholarship, language, and theory to inform their programs. In the case of supplemental instruction, although the leadership identity development of the SI leaders is not a prominent or identified outcome, the findings from this study demonstrate that LID is likely occurring.

Matthews, R. S., & Newman, S. (2017). Chief academic officers and gateway courses: Keys to institutional retention and persistence agendas. *New Directions for Higher Education*(100), 63-73. doi: 10.1002/he.20262.

Among persistence and retention agenda initiatives undertaken by colleges and universities, gateway-course improvement efforts are often overlooked. However, the engagement of diverse institutional stakeholders in the transformation of gateway courses can contribute significantly to student success. Chief academic officers are in a unique position to sponsor such initiatives.

Matthews, S., Liparato, S., Shah, P., Smigell, E., Smith, T., & Schmidt, T. (1993). Supplemental Instruction and biology. *Supplemental Instruction Update*, 1, 3.

The article describes the use of Supplemental Instruction (SI) in biology at Wayne State University (Detroit, MI). The authors selected biology for several reasons: large lecture sections; lecture-focused course; fast-moving lectures; problem-solving approach; focus on interrelatedness of content material; and relationships between of ideas and concepts. Common SI session activities included: finding connections between classroom lectures and textbook; developing charts and graphs to organize and visualize information and demonstrate

relationships; moving away from just memorizing content to deeper discussions of meaning and relationships.

Maxwell, M. (1979). Overcoming problems of learning services. In M. Maxwell (Ed.), *Improving student learning skills* (pp. 158-160). San Francisco: Jossey-Bass

The author provides an overview of the Supplemental Instruction (SI) program. Deanna Martin, creator of the SI model, is quoted regarding the relationship between the faculty member and the SI program. The SI leader can serve as a feedback mechanism for the course professor regarding the comprehension level of the students if invited to do so. This provides an opportunity for the course professor to review or clarify lecture content at the next class meeting. Martin urges caution not to use the SI program as a tool by administrators to change teacher behavior or the bond of cooperation between the SI program and the professor may be placed at risk.

Maxwell, M. (1987). Improving student learning skills: An update. *Journal of Educational Opportunity*, 3(1), 1-9.

In an overview of strategies for students to employ in developing their learning skills, the author provides a short overview of the Supplemental Instruction (SI) program. SI is an example of a program that rather than being student-oriented is instead content-oriented and/or process-oriented.

Maxwell, M. (1990). Does tutoring help? A look at the literature. *Review of Research in Developmental Education*, 7(4), 1-5.

The author reviews the research on tutoring and examines the problems of doing research in this area. Research studies generally are unable to show that individual tutoring, by itself, leads to higher grades for developmental students. Some studies suggest tutoring is beneficial for high ability students. Supplemental Instruction is cited as an approach that research suggests does improve student academic achievement.

Maxwell, M. (1992). Cost effective alternatives to tutoring. *Journal of Learning Improvement*, 1(1), 1-4.

The author reviews several academic support programs that serve as alternatives to traditional tutoring since there is very little evidence that generally peer tutoring directly affects the student's grades. The article provides an overview of Supplemental Instruction (SI) and adjunct courses. The article reports on a 1986 data study that examined the use of SI at a geographically diverse collection of 35 institutions that had offered SI to 4,276 students in 154 classes of a variety of academic disciplines. The data suggests SI has a positive impact upon raising final course grades (2.44 vs. 1.78) and reducing D, F and course withdrawal rates (20% vs. 35%) and higher graduation rates within six years for SI participants (30.6% vs. 18.2%). It is suggested that part of the reason for SI's positive impact is that there is immediate transfer of the study strategies to course content.

Maxwell, M. (1993). Evaluating course-related learning programs (Supplemental Instruction, adjunct skills courses and the College Restoration Program). In M. Maxwell (Ed.), *Evaluating academic skills programs: A source book* (pp. 5-1 to 5-12, A15-11 to A15-16). Kensington, MD: M. M. Associates

The author provides a basic overview of the Supplemental Instruction (SI) model, a summary of research, and references to other SI publications. The appendix provides samples of SI participant questionnaires, suggested time lines of SI program activities, criteria for evaluating SI programs, and instruments for evaluation

Maxwell, M. (1997). Successful programs and strategies for teaching high-risk college students. In M. Maxwell (Ed.), *Improving student learning skills* (2nd ed., pp. 158-178). Clearwater, FL: H&H Publishing

This chapter provides an overview of the Supplemental Instruction (SI) program and Video-based Supplemental Instruction (VSI) program on pages 169 to 172. A case study of SI at California State University at Long Beach indicated that the program was modified due to financial funding problems to turn SI into an adjunct course bearing one unit of non-baccalaureate credit toward financial aid and other full-time enrollment obligations. Academically disadvantaged students (e.g., TRIO or Equal Opportunity Program students) attend SI at higher rates due to this higher level of commitment. Grades are based on a credit/no credit basis. Comparing performance of students with their own peer group reveals that underprepared students usually benefit more from SI than traditional students.

Maxwell, M. (1997). *What are the functions of a college learning assistance center?* : Available online: ERIC database (ED413031).

To be effective, college learning assistance centers (LACs) must reflect the mission and goals of the institution and be coordinated with existing programs and services. Based on the professional literature, LACs engage in fourteen major functions. One of them is providing Supplemental Instruction (SI) for academic support and enrichment in historically-difficult courses. Although most SI programs are voluntary and offer no credit, there are exceptions. At California State University at Long Beach the Learning Assistance Center offers 20 to 30 SI classes in different academic subjects each term. These students can earn one academic credit for attending weekly SI sessions and completing other course requirements.

Maxwell, M. (Ed.). (1997). *Improving student learning skills: A new edition*. Clearwater, FL: H&H Publishing

Supplemental Instruction and Video-based Supplemental Instruction are described in several sections of this comprehensive book on developmental education and learning assistance programs. Short selections are contained in Chapter 7, successful programs and strategies for teaching high-risk college students and Chapter 12, increasing science skills.

Maxwell, W. E. (1998). Supplemental Instruction, learning communities, and studying together. *Community College Review*, 26(2), 1-18.

This study was designed to investigate the extent to which peer relations increased among students who participated in a modified program of Supplemental Instruction (SI) at a large community college in California. SI was modified by using instructors from the regular courses and, to a lesser extent, by financial aid counselors. Only financial aid recipients from 19 courses were invited to attend voluntary SI sessions. This allowed the study to more clearly study the impact of SI with low-income students. SI participants received a \$100 grant if they attended weekly for the 16 week academic term (only 22% of SI participants earned the grant). Research suggests that the SI workshops promoted the growth of student study networks. At least 20% to 25% more of the SI students reported studying with other students and joining a study group outside of class.

McCarthy, A., Smuts, B., & Cosser, M. (1997). Assessing the effectiveness of Supplemental Instruction: A critique and a case study. *Studies in Higher Education*, 22(2), 221-231.

This article argues that methods of assessing effectiveness of Supplemental Instruction (SI) have been inadequate. The authors suggest ways of isolating SI effects on student achievement, and recommends broadening research methods to include qualitative forms of assessment and use of multivariate linear regression analysis of quantitative data. The article concludes with a case study at the University of Witwatersrand, Johannesburg, South Africa that

suggests that SI is highly effective in raising academic achievement of students from both low and high previous levels of academic performance. It may be that the authors' concerns are based on an unclear understanding of the differences between the educational systems in South Africa and the U.S. and how student variables are used in data analysis. Also, a more complete review of current published SI research methodology would reveal that many of their suggestions regarding qualitative and quantitative research methodology have already been implemented.

McConnell, C., & Chilvers, L. (2014). Developing and implementing a co-curricular PASS leadership module at the University of Brighton. In N. Jackson & J. Willis (Eds.), *LifeWide learning & education in universities and colleges*. United Kingdom: Learninglives. Available online: http://www.learninglives.co.uk/uploads/1/0/8/4/10842717/chapter_b10.pdf.

This PASS leadership module has been designed to enable student leaders to obtain additional academic credit for their commitment and contribution to the Peer Assisted Study Sessions (PASS) scheme, and support development of leadership skills. Student leaders are introduced to the skills, knowledge and strategies necessary to facilitate group learning, and use reflection as a key approach to improving their PASS sessions and personal development. The module offers a range of workshops, online materials, group and individual activities for students to draw upon, to inform their PASS sessions, and enable the leaders and PASS students to get the most out of the scheme. This chapter describes the peer learning scheme, how it was developed and the challenges faced during the first two years of implementation. It considers the variety of reflective and transformative learning theories that informed the design and development of the module and explores the transformational learning opportunities that leaders have experienced, drawing upon students' written 'critical incident reports' that enabled them to critically reflect on a particular case study or an area of personal development. It considers what has been learnt and how this learning might be used to improve the module in future.

McCormick, J. (1983). Writing lab adaptations of Supplemental Instruction. In D. C. Martin (Ed.), *Supplemental Instruction: A model for student academic support* (pp. 87-93). Kansas City, MO: The University of Missouri-Kansas City and the ACT National Center for the Advancement of Educational Practices

The author describes how the Supplemental Instruction (SI) was customized for use within the University of Missouri-Kansas City's writing laboratory. Since students in the group are enrolled in the same content course (e.g., American history), all have a common experience and see direct application of their writing skills since the discussions are not in isolation from the content course for which the writing assignment is due. This increases student motivation and aids in the transfer effect to other content courses. Peer review and mutual responsibility for critiquing each other's work encourages collaboration.

McDaniel, A. (2008). Recruiting and training Supplemental Instruction leaders. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 39-56). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

This chapter focuses on the recruitment and training of Supplemental Instruction (SI) leaders. Topics in this chapter include: establishing the SI leader qualifications; strategies for recruitment of SI leaders; using a three-phase process to interview SI leader applicants; extensive training of the SI leaders both before and during the academic term; observing and mentoring SI leaders during the academic term; and ongoing training and mentoring.

McDonough, C. A., Briedis, D., Buch, N., DeGraff, R. S., Sticklen, J., Stoner, S. J., . . . Wolff, T. F. (2011). *Peer-led Supplemental Instruction in an NSF STEP Project: The EEES Experience*. American Society for Engineering Education.

In recent years there has been a decline in the number of STEM students nationwide. Specifically, there is a high loss rate of early engineering students in the first half of their degree programs. The early “leavers” typically fall into two categories (i) those that face academic probation and (ii) those that perceive the education environment of early engineering as hostile and not engaging. Undergraduate engineering enrollment has declined substantially over the last decade in the College of Engineering at Michigan State University (MSU). The downturn can be attributed partly to the rapid decline of the American automobile and manufacturing industry, a traditional mainstay for the Michigan economy. In 2008, a five year NSF STEP grant (STEM Talent Expansion Program) was awarded to support a partnership between the Colleges of Engineering and Natural Science at Michigan State University and Lansing Community College (LCC). LCC is an urban community college with an enrollment of approximately 30,000 students located in close proximity to MSU. The two institutions have a strong history of collaboration. The project is titled Engaging Early Engineering Students (EEES). A primary goal of EEES is to increase matriculation-to-graduation retention rate in the MSU College of Engineering by ten percentage points. EEES project functions through the synergistic operation of four components designed to maximize student engagement with both the college and the learning process. The components are (i) Connector faculty; (ii) Supplemental Instruction; (iii) Course cross linkages; and (iv) Early intervention. The primary objective of this paper is to describe the implementation and outcomes associated with the first two and a half years of the Supplemental Instruction segment of the EEES project. Supplemental Instruction (SI) is an internationally recognized peer-tutoring program that integrates course content with active student learning in the form of peer facilitated study sessions. This approach to peer to peer learning has shown that participating students make greater gains than those achieved by classmates competing with each other or studying alone. Group learning has demonstrated benefits essential to creating a more welcoming educational environment, including helping to integrate students into academic life, teaching effective collaboration methods, and reducing prejudice. Additionally, peer tutoring has been shown to positively affect those students leading the study sessions in this report we describe: (i) a description of SI in the MSU College of Engineering and its implementation process; (ii) SI program collaborations; (iii) supporting research on peer tutoring and collaborative learning; (iv) program outcomes; and (v) future opportunities.

McGee, J. V. (2005). *Cognitive, demographic, and motivational factors as indicators of help-seeking in Supplemental Instruction*. (Ph.D. dissertation), Texas A & M University, College Station, TX.

The purpose of this study was to determine how cognitive, demographic, and motivational factors can be used to understand help-seeking behavior in college students. Specifically, the study examined engagement in Supplemental Instruction (SI) of undergraduate students at Texas A&M University. An additional purpose of the study was to determine the efficacy of SI. The sample for the study was 2,407 undergraduate students who were enrolled in eight randomly selected courses at Texas A&M University in the spring 2004 semester. Students enrolled in multiple course sections were eliminated from the study. The revised sample consisted of 2,297 students. Data collected for all students in the sample included student demographic information, SI attendance and participation, and final course grades. Students were also requested to complete an on-line survey instrument containing a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ) and questions related to parent education and household income. Ultimately, 1,003 students from the revised sample submitted surveys for a response rate of 43.7%. Based on attendance data and participation ratings,

students were classified into three engagement groups for subsequent data analysis: high engagement, low engagement, and non-SI. The following were among the major findings from the study: Hispanic students were significantly more engaged in SI than their White peers. Engagement in SI was inversely related to grade level classification. SI participants had significantly lower mean SAT math and verbal scores than students who did not attend SI. The motivational variables as a set had a statistically significant relationship with SI engagement. Extrinsic motivation, organization, academic self-efficacy, control beliefs, help-seeking, and peer learning were the motivational scales which best predicted SI engagement. Students who were highly engaged in SI had significantly higher mean final course grades than either non-participants or low engagement students even controlling for differences in SAT scores, cumulative grade point average, and motivation. The study helps provide some insight into the dynamics of academic help-seeking. It also contributes to the growing body of evidence which shows that SI is an effective intervention for improving student success in traditionally difficult courses.

McGinty, D. A. (1990). A path analysis of the effects of multiple programs on student persistence: dormitory residence, orientation, tutoring, Supplemental Instruction [Dissertation, The University of Texas at Austin, 1989]. *Dissertation Abstracts International*, 51(02), 368A. (University Microfilms No. 9016936).

The models of Spady and Tinto depict student dropout as the result of an inadequate integration into the social and academic systems of the college. This doctoral dissertation research study hypothesizes that persistence for the traditional freshman at a large university is based on background characteristics (gender, ethnicity, rank in high school, aptitude, and college enrolled in) and variables of the academic environment (tutoring, Supplemental Instruction, student orientation, living in residence hall, and grade point average). The model hypothesizes that the academic environment variables have important direct and indirect effects. These four academic programs are described in the literature as promoting student retention. This dissertation researched the effect each program has on student persistence as well as the effect of participation in multiple programs. Path analysis was selected to explain the interactive process of the variables. Multiple regression analysis was used to investigate the strength and direction of the relationships in the path model. It is postulated that the impact of the SI program may have been diminished due to the low number of SI participants (55 of the 560 students in the overall study) which may have clouded results during data analysis. There were moderately significant differences for residence hall, Supplemental Instruction, and the combined effects of orientation and dorm and GPA. SI participants with lower SAT scores performed at academic levels similar to non-SI participants who had higher SAT scores. Further exploratory analyses indicate that the different retention programs have varying effects on students based on ability and past performance levels. The results suggest that retention programs should be targeted at specific populations based on ability and past performance levels.

McGlone, F. D. (1994). *A training and implementation program for first year student peer mentors*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

The Queensland University of Technology (QUT) Faculty of Law (Brisbane, Australia) Supplemental Instruction (SI) program encouraged students to: develop deep approaches to learning, develop generic learning skills, and increase student autonomy while encouraging them to work and learn cooperatively with others. The SI program operates in two classes: Torts and Contracts with class sizes exceeding 350. In addition to improving academic performance of student participants, the SI leaders reported enhanced communication and interpersonal skills which they perceived to increase their job marketability.

McGlone, F. D. (1995). *The integration of the principles of Supplemental Instruction in undergraduate law subjects*. Conference Proceedings of the Inaugural Pacific Rim First-Year Experience Conference, Brisbane, Australia.

This paper describes the use of Supplemental Instruction (SI) at two classes in Australia's Queensland University of Technology Faculty of Law. SI was contextualized for use within the law curriculum as was described as a Student Peer Mentor (SPM) program. The program concentrated on improving qualitative learning outcomes for the students: promote student use of deep approaches to learning, develop generic lifelong learning skills, and increase student autonomy while encouraging them to work and learn cooperatively with their peers. Several unique features of SPM are identified: selected classes are not historically difficult, the class instructor and the SPM supervisor are the same person, and that the class has always provided a one hour staff-led small group seminar for each two hours of lecture. Other than those previously noted, many common features are shared by SI and SPM.

McGlone, F. D. (1996). Student peer mentors: A teaching and learning strategy designed to promote cooperative approaches to learning and the development of lifelong learning skills. *Queensland University of Technology Law Journal*, 12, 201-220.

This paper describes the use of Supplemental Instruction (SI) at two classes in Australia's Queensland University of Technology Faculty of Law. SI was contextualized for use within the law curriculum as was described as a Student Peer Mentor (SPM) program. The program concentrated on improving qualitative learning outcomes for the students: promote student use of deep approaches to learning, develop generic lifelong learning skills, and increase student autonomy while encouraging them to work and learn cooperatively with their peers. Several unique features of SPM are identified: selected classes are not historically difficult, the class instructor and the SPM supervisor are the same person, and that the class has always provided a one hour staff-led small group seminar for each two hours of lecture. Other than those previously noted, many common features are shared by SI and SPM.

McGrath, E. T. (1988). *Supplemental Instruction: A study of its efficacy on the Greenville College campus*. (Master's of Arts thesis), Greenville College, Greenville, IL.

The purpose of this master's thesis study from Fall 1986 and Spring 1987 was to evaluate the effects of Supplemental Instruction at Greenville College (IL) regarding: 1) mastery of course content (SI participants earned a higher final course grade -- 3.16 vs. 2.66 -- and a lower rate of D, F and withdrawal final course grades than nonparticipants (ratio of 3:4); 2) transference of learning skills from one course to another (former SI participants received a higher cum GPA in succeeding academic terms than nonparticipants, 3.14 vs. 2.66); and 3) higher course and institutional retention rates (97 percent for SI participants vs. 83 percent for nonparticipants).

McGraw, S. P., & Newkirk, S. L. (1995). Adaptation of Supplemental Instruction with mentoring support at Anne Arundel Community College. In S. P. McGraw & S. L. Newkirk (Eds.), *Fund for the Improvement of Postsecondary Education Program Book*. Washington, D.C.: Fund for the Improvement of Postsecondary Education, U.S. Department of Education

This chapter describes how Rosemary Wolfe, FIPSE Project Director for Supplemental Instruction (SI) with Mentoring Support, will be working with Ashland Community College in Kentucky to adapt the SI program for underprepared students enrolled in required general education courses; Daytona Community College to adapt the program to math courses and the peer review process; Dutchess Community College to adapt the program to lab courses; and Community College of Philadelphia to adapt the program to student success in difficult courses. Expected outcomes for faculty include increased interactive teaching skills and the development of new teaching approaches, an awareness of their teaching styles and an understanding of students' needs.

McGraw, S. P., & Newkirk, S. L. (1996). Disseminating proven reforms: Supplemental Instruction with mentoring support at Anne Arundel Community College. In S. P. McGraw & S. L. Newkirk (Eds.), *Fund for the Improvement of Postsecondary Education Program Book*. Washington, D.C.: Fund for the Improvement of Postsecondary Education, U.S. Department of Education

This chapter describes how Rosemary Wolfe, FIPSE Project Director for Supplemental Instruction (SI) with Mentoring Support, worked Ashland Community College in Kentucky, Daytona Community College, Dutchess Community College, and the Community College of Philadelphia. Expected outcomes for faculty include increased interactive teaching skills and the development of new teaching approaches, an awareness of their teaching styles and an understanding of students' needs.

McGuire, S. Y. (2006). The impact of Supplemental Instruction on teaching students how to learn. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 3-10). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter describes the characteristics of today's student population, looks at the learning theories on which the Supplemental Instruction (SI) model is based, and provides an overview of the benefits of and challenges to implementing SI in the 21st century.

McKaig, K. A. (2018). *Relationship of Supplemental Instruction and attitude of students enrolled in college algebra*. ((Ph.D. Dissertation)), Old Dominion University. Available online: https://digitalcommons.odu.edu/cgi/viewcontent.cgi?article=1596&context=ots_masters_projects

The problem of this study was to determine the relationship of Supplemental Instruction on the attitudes of college algebra students at a Southeastern university. The population for this study consisted of college algebra students enrolled in M102 and M103 courses in the Summer 2018 semester. While M102 and M103 cover the same material, M103 requires mandatory tutoring in addition to the classroom instruction. A survey of these students provided data on their attitudes toward mathematics at the beginning and end of their college algebra course. The first research question of this study asked to what extent attitudes differ, if at all, for students in college algebra courses with and without Supplemental Instruction. This question was examined using a two-sample t-test assuming equal variances and a Wilcoxon sign test. The results and conclusions of the study suggest Supplemental Instruction does not significantly impact the attitudes of college algebra students.

McKenzie, J., Alexander, S., Harper, C., & Anderson, S. (2005). Case studies: Projects and innovations which have been successfully adopted and adapted across contexts, Supplemental Instruction. In J. McKenzie, S. Alexander, C. Harper & S. Anderson (Eds.), *Dissemination, adoption, and adaptation of project innovations in higher education: A report for the Carrick Institute for Learning and Teaching in Higher Education* (pp. 34-42). Sydney, Australia: University of Technology Sydney. Available online: <http://hdl.handle.net/10453/12236>.

At University of Wollongong, it is a part of the university's officially adopted suite of systems for improving student learning and receives full-time support through funding and the presence of an officially trained and full-time SI coordinator. Its implementation is very widespread and centrally managed. PASS now operates in an average of five faculties per semester, including Informatics, Commerce, Engineering and Education and Health and Behavioral Sciences, and is in its fourth year of operation. Importantly, UOW maintains regular contact with the International Centre at UMKC, and have an established relationship with the new director and other staff members. This relationship has been recently formalized by the selection of their PASS Program Manager as the official Certified National Trainer for PASS/SI in Australia. At

Queensland University of Technology, PASS/SI is also an established program and it is this institution which has the longest history of using Supplemental Instruction in Australia. Professor Ron Gardiner, then the Associate Pro Vice-Chancellor (Academic) pioneered the program at QUT in 1992 after hearing about the SI program at a conference (Kelly & Gardiner, 1994). Henry Loh (lecturer) then started using the SI program for his subject, Anatomy in the School of Life Sciences in 1992 and received CAUT funding. Professor Gardiner was previously the SI/PASS Program Coordinator at QUT as well as being a certified National Trainer, and he was heavily involved in championing the program more broadly. This role continued after his retirement, when he delivered a three day workshop at UOW, at the request of staff who were interested in the concept prior to its establishment at that university. It is widely acknowledged that throughout the 90's, QUT had a very large and established SI program operating, and it is still perceived as having a strong tradition of embedding SI/PASS. However, while SI is still supported in some specific faculties by teaching support staff, in more recent years it has tended to operate in individual disciplines through the support of enthusiastic faculty members who perceive that the program is addressing particular problems they have identified in their teaching and learning, rather than being a systematic or university wide initiative. Overall the program is perceived to be less visible and systematically supported by the university by individuals both within and outside the institution. The perception being that the SI scheme is sustained 'because of the commitment of the individuals' and the perception that it is consistent with their own existing teaching principles, rather than fitting in with the university's strategic directions or agenda. At the same time, however, some of these localized adaptations of SI are recognized and perceived by other adopters as being exemplars of good-practice in the area, particularly in relation to how strongly SI is embedded within the discipline: Martin Murray has got it very strongly embedded ... I maintain a strong interest in what he does, and he has obviously done an excellent job with it. (Sally Rogan) Interestingly, in both case-studies, SI has been successful in terms of both the outcomes achieved for student-learning and its sustainability, but through the application of relatively divergent models of implementation and use.

McManus, S. M. (1992). *The relationship between Supplemental Instruction and student achievement in university mathematics courses*. (Master's of Science thesis), North Carolina State University at Raleigh, Raleigh, NC.

The relationship between Supplemental Instruction (SI) and student achievement during Fall 1990 at North Carolina State University at Raleigh (NCSU) was the focus of this study. The target population was 198 freshmen and sophomore students enrolled in entry-level mathematics courses at NCSU. During the academic term, 60 students attended one or more times (SI group) while 138 students chose not to attend any SI sessions (non-SI group). Students were enrolled in two sections of Math 241, a second-semester calculus course that was taught by the same professor. The initial section of the paper provides a review of the professional literature concerning SI. The author traces the importance of the following in understanding the unique method of SI: Piaget's constructivism, cooperative learning, student questioning skills, and study strategies. A Pearson Product Moment correlation ($r = -.1771$) and a Multiple Regression Analysis found no significant relationship between the number of SI sessions attended and final course grade. However, students who attended 5 or more SI sessions steadily increased throughout the academic term while the scores of other SI participants fluctuated. The researcher postulates that this suggests the beneficial effect of frequent SI attendance for improving academic performance. A t-test used found that students attending the SI sessions received statistically significantly higher final course grades than those who did not attend (mean final course grade: 86.44 vs. 77.62; $t = 2.95$, $df = 194$, $p < .01$). Following is a comparison between the SI and non-SI groups for each of the course exams. In each comparison the SI group earned higher mean grades: test 1: 76.41 vs. 71.92; test 2: 83.57

vs. 77.01; test 3: 87.57 vs. 79.06; test 4: 83.24 vs. 70.87; test 5: 86.12 vs. 78.82; final exam: 75.31 vs. 67.33; final course grade: 86.45 vs. 77.62. Each comparison was statistically significant except for test 1.

McMichale, E. (1994, 1994, November 29). 'Natural teachers': Tutors work alongside students in "K" program, *Kalamazoo Gazette*, p. C1.

This newspaper article describes the use of Supplemental Instruction (SI) at Western Michigan University located in Kalamazoo, Michigan.

McMillin, J. (1983). Adapting Supplemental Instruction to English composition classes. In D. C. Martin (Ed.), *Supplemental Instruction: A model for student academic support* (pp. 95-100). Kansas City, MO: The University of Missouri-Kansas City and The ACT National Center for the Advancement of Educational Practices

This chapter describes the customization of the Supplemental Instruction model for use in English composition classes at Point Loma College (CA). The author emphasized the following elements of SI with use in the composition classes: discovery of learning in a non-threatening environment; a focus on developing a "co-worker" relationship between the SI leader and students; an awareness of process as well as content in teaching and learning; importance of reasoning skills in developing writing competency; and the role of the student as a responsible agent in his/her own educational process. This chapter provides a simulated conversation of an editing session between the SI leader and the student to illustrate the above elements.

McMillin, J. (1992). Adapting Supplemental Instruction to English composition classes. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 34-37). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database. (ED354839).

This chapter, initially published in 1983, describes the customization of the Supplemental Instruction model for use in English composition classes. The author emphasized the following elements of SI with use in the composition classes: discovery of learning in a non-threatening environment; a focus on developing a "co-worker" relationship between the SI leader and students; an awareness of process as well as content in teaching and learning; importance of reasoning skills in developing writing competency; and the role of the student as a responsible agent in his/her own educational process. This chapter provides a simulated conversation of an editing session between the SI leader and the student to illustrate the above elements.

McNamara, S. P. (2014). *The effectiveness of retention strategies in an Associate Degree Nursing Program*. (Ph.D. dissertation), Walden University.

Student retention has long been a problem in nursing education as programs struggle with large attrition rates. Retaining matriculated students can be an effective strategy to increase graduation rates at a time when severe nursing shortages are forecasted. Many nursing schools across the country are implementing retention programs consisting of supplemental instruction (SI) and tutoring programs. The purpose of this study was to explore the effectiveness of one community college's retention program on student exam grade averages in the first 2 nursing courses. The college had collected a large volume of data but had conducted no analysis. The research questions for the study concerned whether SI and registered nurse (RN) tutoring, individually or combined, helped 1st year nursing students to improve their exam grade averages in 2 introductory nursing courses. The study framework was based on Bandura's social learning theory and Lewin's force field analysis. Correlation was used to analyze the relationships between the independent variables. Multiple regression revealed that SI had a minimal positive relationship with student exam grade averages in both introductory nursing

courses. Tutoring had a negative relationship with students' success in both courses. Tutoring had a negative relationship to conduct further research on a larger scale and explore the efficacy of continuing these modalities in nursing education. This project may lead to positive social change by providing nursing educators with information that may be used to plan and refine retention strategies in nursing education, which will ultimately benefit nursing students.

McPhail, R., Despotovic, W. V., & Fisher, R. (2012). Follow the leader: Understanding the impact being a PASS leader has on self-efficacy. *Journal of Peer Learning*, 3(7). Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1056&context=ajpl>.

The purpose of this qualitative study is to inform and advance the body of knowledge of the contribution that 'Peer Assisted Study Sessions' (PASS) provides for student leaders in terms of its impact on their self-efficacy - the personal belief in competence to succeed within certain situations (Bandura, 1986). To date, there has been little research providing a practical insight into whether acting as the leader of university PASS has a perceived impact on self-efficacy. The results of the qualitative research are based on interviews from a sample of 16 leaders. We found that being a PASS leader improved self-efficacy specifically in the areas of: cognitive development, performance, engagement and satisfaction. The results of this study may have implications for the development of future programs, particularly, in terms of attracting suitable candidates in the recruitment process, the future training of leaders and the provision of ongoing support for the leaders to participate effectively in such programs.

Meikle, J. (1993, 1993, February 16). Learning to help others, *Guardian Education Newspaper*, p. 10.

This newspaper article describes the use of Supplemental Instruction (SI) at Kingston University in the United Kingdom. In an interview with Jenni Wallace, SI Certified Trainer for the United Kingdom, she explains that SI sessions are positioned between the classroom lectures by the professor and the tutorial sessions. The SI sessions help students to be better prepared to maximize their time spent in the tutorial sessions. There are reports that former SI leaders and participants in succeeding academic terms form their own study groups in classes where formal SI sessions are not offered. Former SI leaders report that potential employers are impressed with the skills that they developed as facilitators of the study groups.

Meling, V., Mundy, M.-A., Kupczynski, L., & Green, M. E. (2013). Supplemental Instruction and academic success and retention in science courses at a Hispanic-serving Institution. *World Journal of Education*, 3(3), 11-23. doi: 10.5430/wje.v3n3p11 Available online: <http://sciedu.ca/journal/index.php/wje/article/view/2711/1688>.

This study provides insight into the effectiveness of Supplemental Instruction (SI) at a Hispanic-serving institution (HSI), particularly with Hispanic students. The United States Department of Education (2010) defines an HSI as having a 25% or greater full-time, Hispanic student enrollment and 50% or more of all students are eligible for need-based financial aid. It is essential for many Hispanic-serving institutions (HSIs) that have a high percentage of Hispanic populations to find ways where they will support and retain a growing number of minority degree-seeking students. One of the biggest challenges for HSIs is not only increasing retention, but additionally supporting the Science, Technology, Engineering, and Math (STEM) courses at these institutions. The study contributes to the existing research that shows that SI is an effective student success intervention in improving academic success and course retention among Hispanic students in STEM related courses. The results showed a significant difference in academic success and course completion among Hispanic students at an HSI with SI participation in Chemistry and Physics courses.

Meling, V. B. (2012). *The role of Supplemental Instruction in academic success and retention at a Hispanic-serving institution*. (Ph.D. dissertation), Texas A&M University.

Student retention has been a challenge for higher education institutions, an urgent issue that must be reassessed and improved at these institutions. It is essential for many Hispanic-serving institutions (HSIs) that have a high percentage of Hispanic populations to find ways where they will support and retain a growing number of minority degree-seeking students. Furthermore, one of the biggest challenges is not only increasing retention at HSIs, but additionally supporting the Science, Technology, Engineering, and Math (STEM) courses at these institutions.

Supplemental Instruction (SI) has been confirmed by multiple researchers to increase retention and academic success among students in higher education, particularly among minority students. The purpose of this ex post facto study was to evaluate and discover the impact Supplemental Instruction had on retention and academic success for Hispanic students in mathematics, chemistry, and physics courses at a south Texas HSI. The sample for the study consisted of 720 undergraduate Hispanic students who were enrolled in selected gateway STEM courses, College Algebra, University Physics I, or Inorganic Chemistry I, at this particular Hispanic-serving institution during the 2009-2010 academic year. Data collected for all students in the sample included student demographic information, SI attendance, final course grade, and course completion rates. Based on attendance data, students were classified into three SI attendance levels: non-SI, low, and high attendance. The results showed a significant difference in final course grades and course completion for Hispanic students between select groups. There was a significant difference between the non-SI group (0 sessions) and the low (1-10 sessions) level of SI participants in math, chemistry, and physics. There was also a significant difference between the non-SI group (0 sessions) to high level (11 and more) of SI participants in math, chemistry, and physics. There was no significance between the low to high SI level groups. The significant main effect that impacted academic success and course completion among Hispanic students at an HSI was SI participation. The study helps provide insight into the effectiveness of SI at a Hispanic-serving institution, particularly with Hispanic students. It also contributes to the existing research that shows that SI is an effective student success intervention in improving academic success and course retention among Hispanic students in STEM related courses.

Meling, V. B., Kupczynski, L., Mundy, M.-A., & Green, M. E. (2012). The role of Supplemental Instruction in success and retention in math courses at a Hispanic-serving institution. *Business Education Innovation Journal*, 4(2), 20-31. Available online:

http://busedinnovation.com/images/BEI_Jnl_Dec_2012_text.pdf#page=20.

Student retention has been a challenge for higher education institutions, an urgent issue that must be reassessed and improved at these institutions. One of the biggest challenges is not only increasing retention at Hispanic-serving institutions (HSIs), but additionally supporting the Science, Technology, Engineering, and Math (STEM) courses at these institutions.

Supplemental Instruction (SI) has been confirmed by multiple researchers to increase retention and academic success among students in higher education, particularly among minority students. The purpose of this study was to evaluate and discover the impact SI had on retention and academic success for Hispanic students in mathematics courses at a south Texas HSI. The results showed a significant difference in final course grades and course completion for Hispanic students between select groups. The significant main effect that impacted academic success and course completion among Hispanic students at an HSI was SI participation.

Mendes, S. H., Fede, J. H., & Wilks, M. B. (2017). Data-based program reform: A shift from Supplemental Instruction to weekly tutoring groups. *The Learning Assistance Review*, 22(2), 75-96.

The aim of this analysis was to determine from a pilot project whether a new style of course-connected learning support for students in gateway STEM courses could be more successful on the University of Rhode Island's campus than the traditional Supplemental Instruction (SI) model. The new model, Weekly Tutoring Groups (WTG), addressed several of the challenges (attendance, timing, group size) students and staff reported with the SI model. In the pilot semester, 212 students enrolled in courses previously supported by SI participated in WTG. Compared to SI, the new program saw an increase in students attending regularly, a significant difference in proficient grades between participants and nonparticipants, and a significant difference in the actual grades received by the participants compared to the grades they reported they would have received without participation in the WTG program. The success of the pilot semester has led learning center staff to continue with the WTG program rather than return to SI.

Mergelsberg, E. L. P., Mullan, B. V., Haywood, D., Pereira, R., Smith, A., Zaccagnini, M., & Allen, P. J. (2019). *Extending the theory of planned behaviour to predict and increase PASS attendance and students' performance: Can academic motivation improve efficacy?* Available online: <https://osf.io/vspzm/download>

PASS has shown to have multiple academic benefits for students, nevertheless, it is unclear what the working mechanisms of PASS are. Additionally, the attendance rates can be very low. Aim: Extending the theory of planned behaviour, by including performance as an additional outcome and academic motivation as moderator of the intention-behaviour gap and PASS attendance – performance relationship. Secondly, we developed an intervention based on the TPB to increase PASS attendance. Sample and Method: TPB measures, academic motivation, PASS attendance and final unit grade were assessed three times pre- intervention across two Australian universities (N = 965). The intervention was implemented during the semester and consisted a series of 'PASS Facts' delivered to students (total N = 2087) via multiple media. Results: The findings showed that the TPB predicted PASS attendance and performance. Academic motivation predicted performance, but it did not close the intention-behaviour gap nor moderated the PASS attendance-performance relationship. Furthermore, in all three implementations, the interventions did not increase the theoretical constructs. Conclusions: The TPB is an adequate model for predicting PASS attendance and can be extended to predict students' performance. It was recommended that future research investigates other factors than academic motivation that can close the intention-behaviour gap and explain how PASS attendance improves students' academic performance. Additionally, future research may develop a more active intervention, wherein students can practice a skill (i.e., time management) instead of passively receiving messages.

Merriwether, V. E. (1999). *Managing an expanding program or "SI empire"*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

The author discusses strategies in managing a large SI program, or a program that is expanding with very limited staff available to deal with the day to day activities of supervising SI leaders, as well as administrative duties.

Merwin, D. D. (1991). A comparative analysis of two tutoring methods assessing student achievement and retention [Dissertation, Montana State University, 1990]. *Dissertation Abstracts International*, 52(02), 438A. (University Microfilms No. 9109700).

The purpose of this doctoral dissertation research study was to compare the effectiveness of two tutoring methods with regard to achievement and retention for high-risk undergraduate students at Northern Montana College (Havre, MT) enrolled in English 150 during the 1986-87 academic school year (eleven courses sections over the fall, winter and spring academic terms).

Supplemental Instruction (SI) was compared with another form of tutoring. English 150 is a three-credit course considered to be developmental in content since it encompassed the basic skills areas (sentence structure, parts of speech, grammar, usage, punctuation, and paragraph development). The two tutoring methods were group tutoring (i.e., Supplemental Instruction, or SI) and individual tutoring. The treatment was randomly assigned to each of the eleven course sections and attendance was mandatory by the students. The problem was investigated by: (1) examining how the tutoring methods and other independent variables affected student achievement and student retention, and (2) comparing the two tutoring methods in terms of cost effectiveness. Achievement was measured by the pretest-posttest gain score from the Tests of Adult Basic Education (TABE). The TABE test for English measured students' competency in capitalization, punctuation, expression, and spelling. Retention was measured by the ratio percentage of the number of student credit hours earned compared to the number of hours attempted for the first and second years following treatment. The cost effectiveness of both tutoring methods was compared by determining the cost of one grade level of improvement. Some of the major findings were: students in SI tutoring had higher retention rates than students receiving individual tutoring for the first and second years following treatment; the combined results of the two tutoring methods did make a significant difference in student achievement; the SI tutoring method compared to the individual tutoring method was more cost effective (\$3.46 average cost for SI program to improve one grade level of one students vs. \$16.30 for one-on-one tutoring to do the same); and individual tutoring had a relatively short-term effect. An unexpected finding was that students who participated in SI groups continued to meet at other times outside of class and that the groups were heterogeneous groupings. Interviews with these students revealed that they had met the other students through the SI sessions. It was assumed that students would tend to meet with their own homogeneous affinity groups. The SI students revealed that they enjoyed the social interactions in the groups and felt more comfortable working with other SI participants when they needed additional academic assistance with the English 150 course. The SI program also had an impact upon the SI leaders. Three of the seven SI leaders changed their degrees -- two were business majors and one was a vocational-technical major -- to education so they could become professional teachers. One-on-one tutors reported frustration with the tutoring program when students canceled their scheduled tutoring sessions. Since SI leaders worked with groups, they did not encounter that problem.

Metcalfe, K. J. (1996). The impact of the training format on tutors' attitudes, beliefs, values, and practices in college level tutoring [Dissertation, State University of New York at Buffalo, 1996]. *Dissertation Abstracts International*, 57(09), 3780A.

There is a lack of empirical data to support which, of several training formats (models), is the best format for training tutors. The purpose of this present dissertation study was to identify which of four training formats produced a positive change in tutor's attitudes towards tutoring, the tutoring process, and its administration. Accredited Course (AC), Supplemental Instruction Liaison (SIL) Course, Comprehensive Course (CC), and Short Course (SC). A dual methodology was used. In the quantitative study, data was gathered from student-tutors in 30 postsecondary tutor training programs, using a pre and post-test quasi-experimental research design. The College Student Peer-Tutor Survey (CSPTS) was developed to assess whether length or amount of tutor training influenced a positive change in student-tutors' attitudes toward tutoring. The qualitative component of the overall study sought to capture the insights and perceptions of the tutor coordinators/trainers from the 30 tutor training programs in relation to: (a) understanding the programs' organization and instructional content, (b) refining the typology of formats, and (c) developing recurrent themes. As a result of training and experience tutoring, statistically significant changes in tutor's attitudes towards tutoring were evidenced in all four formats. SIL tutors showed more positive change in relation to the importance of "A tutor being an expert in the subject area he/she is tutoring in." Results from the qualitative component of

the study focused attention on three recurrent themes: (a) the need for further refinement of the typology of formats, (b) the need for staff development, and (c) the precariousness of program status.

Miles, C. A., Polovina-Vukovic, D., Littlejohn, D., & Marini, A. (2010). *The effectiveness of Peer-Assisted Study Sessions (PASS) Program in enhancing student academic success at Carleton University*. Unpublished manuscript. Toronto. Available online:

<http://www.heqco.ca/SiteCollectionDocuments/Carleton%20PASS%20ENG.pdf>

Carleton University introduced the Peer-Assisted Study Session (PASS) program to assist students who are registered in traditionally difficult or high attrition courses, with combined D, Fail or Withdrawal (WFD) rates of over 30 per cent, to succeed in their courses. The PASS program was first piloted at Carleton University in 2000, when support was provided through the Centre for Initiatives in Education (CIE) for one first-year psychology course. Currently administered by the Student Academic Success Centre (SASC), Carleton's PASS program has expanded greatly, with PASS support being provided for over 50 courses in a number of different faculties. The study sessions are offered and led by student facilitators who have already successfully completed the same course and receive additional training. The sessions offer students an opportunity to come together in an informal environment, where they are encouraged to compare class notes, discuss course concepts, develop strategies for studying and learning the course material, and predict test items. The researchers found that PASS significantly improved academic success among those students who took advantage of the opportunity. Students who attended PASS achieved higher final grades, on average, than students who did not attend, and the DFW rates were significantly lower among PASS participants than non-PASS participants.

Millard, M. (1995, 1995, October 19). First African-American to hold post: New Chancellor at City College helps win \$1.67 million grant, *The Sun Reporter*, p. 1.

This newspaper article describes how Del Anderson, the new Chancellor of San Francisco City College (CA), will use a \$1.67 Title III grant from USDOE to help students in "high risk" courses and to bring the Internet into the classroom. The chancellor, formerly president of San Jose City College, mentioned that she had developed many programs for students of color to help them achieve higher transfer and graduation rates.

Miller, C. J. M., & Packham, G. A. (1999). Peer-Assisted Student Support at the University of Glamorgan: Innovating the learning process? *Mentoring & Tutoring*, 7(1), 81-95.

Peer-Assisted Student Support (PASS) is based upon Supplemental Instruction (SI) and is the predominate name used in the United Kingdom. This article provides an overview of PASS. This article describes the use of PASS at the University of Glamorgan Business School.

Comparisons were made between participants and nonparticipants regarding achievement on unit exams. The results favored the participants.

Miller, D., & Schraeder, M. (2015). Research on group learning and cognitive science: A study of motivation, knowledge, and self-regulation in a larger lecture college Algebra class. *The Mathematics Educator*, 24(2), 27-55. Available online:

<http://tme.journals.libs.uga.edu/index.php/tme/article/view/309>.

At a research University near the east coast, researchers restructured a College Algebra course by formatting the course into two large lectures a week, an active recitation size laboratory class once a week, and an extra day devoted to active group work called Supplemental Practice (SP). SP was added as an extra day of class where the SP leader has students work in groups on a worksheet of examples and problems, based off of worked-example research, that were covered in the previous week's class material. Two sections of the course were randomly

chosen to be the experimental group and the other section was the control group. The experimental group was given the SP worksheets and the control group was given a question-and-answer session. The experimental group's performance was statistically significant compared to the control on a variety of components in the course, particularly when prior knowledge was factored into the data.

Miller, D. A. (2006). *Helping students understand technical calculus via an online learning supplement and group learning*. Unpublished manuscript. West Virginia University. Morgantown, WA. Available online:

http://math.unipa.it/~grim/21_project/21_charlotte_MillerDavidPaperEdit.pdf

This report describes an adaptation of the traditional Supplemental Instruction (SI) for online learners. This experiment was for students enrolled in a technical calculus course. This version of SI was voluntary for the students. Students that participated in the study performed significantly higher than non-participants, were motivated to learn, and had a positive attitude towards calculus, their perceptions on how the discussion sessions and the online SI sessions helped them to perform better in the course. The name for this adaptation of SI was called Technical Calculus Learning Supplement (TCLS).

Miller, K. J. (1996). *Developmental education at the college level*. Bloomington, IN: Phi Delta Kappa Educational Foundation.

This monograph provides an overview of developmental education at the postsecondary level. On pages 32 and 33 a short overview of Supplemental Instruction (SI) is provided

Miller, V., Oldfield, E., & Bulmer, M. (2004). *Peer Assisted Study Sessions (PASS) in first year chemistry and statistics courses: Insights and evaluations*. Conference Proceedings of the UniServe Science Scholarly Inquiry Symposium, Sydney, Australia. Available online:

<http://science.uniserve.edu.au/pubs/procs/wshop9/schws003.pdf>

Peer Assisted Study Sessions (PASS), based upon the Supplemental Instruction (SI) model, was used in first year chemistry and statistics courses at the University of Queensland in Australia. This study analyzed results from 2003 and found that PASS participants earned higher final course grades than nonparticipants. Other reported positive outcomes through qualitative research findings were higher student confidence, increased desire to continue in the academic discipline, increased in analytical and creative approach to learning, and greater sense of belonging within a community of learners.

Miner, J. (Writer). (1991). Politics of remediation [Videotape]. In J. Miner (Producer). Los Angeles, CA: DeAnza College

This video teleconference was concerned with a review of successful practices for serving academically underprepared students. Featured panelists included John Roueche and Lee Noel. An eight minute segment featured an interview with Deanna Martin, creator of the Supplemental Instruction (SI) model. Martin provided an overview of the SI program and discussed how the program can be used to serve both the best and least prepared students.

Mitra, S., & Goldstein, Z. (2017). Impact of Supplemental Instruction on business courses: A statistical study. *Informations Transactions on Education*, 1-13. doi: doi:10.1287/ited.2017.0178. Available online: <http://pubsonline.informs.org/doi/pdf/10.1287/ited.2017.0178>.

Many students in quantitative business courses are struggling. One technique designed to support such students is Supplemental Instruction (SI), which is most popular in the science, technology, engineering, and mathematics (STEM) disciplines. In this paper, we show the positive impact of SI on student performance in two bottleneck business courses in a large university. Our evaluation results establish that (i) SI has a statistically significant effect on

students' likelihood of passing both courses (after controlling for background variables), (ii) SI is more helpful for students identified as at risk than for those who are not, and (iii) it is important to consistently attend SI sessions for greater success. We also present models to predict consistent student attendance based on background factors with 90% accuracy and conclude with a brief qualitative study about students' self-perception of SI and the professional development attained by SI leaders.

Moleko, M. M., Halalele, D., & Mahlomaholo, M. (2014). Challenges experienced with the implementation of Supplemental Instruction at institutions of higher education. *Mediterranean Journal of Social Sciences*, 5(27), 240-251. Available online: <http://www.mcser.org/journal/index.php/mjss/article/view/5137/4959>.

This paper examines the challenges experienced with the implementation of supplemental instruction in institutions of higher education. Supplemental Instruction (SI) is a cooperative learning model designed to improve student performance in high-risk courses with a history of high failure rates. It is aimed at facilitating understanding of course content while at the same time assisting students to develop better learning skills. Although there is substantial evidence of the benefits of SI in institutions of higher education which have adopted it, there are challenges that hamper its successful implementation. The main findings in terms of the challenges were: lack of a coordinated plan; lack of articulated vision and ownership; SI leaders' inability to model effective instructional strategies; SI leaders' inability to effectively engage students in their own learning; and no feedback offered within the setup to keep stakeholders abreast and to promote individual growth. Critical Emancipatory Research (CER) was used for this study to analyze the data.

Moore, I. (1992). *Undergraduate students as assistant demonstrators in the first year physics laboratory*. Unpublished manuscript. Queensland University of Technology, School of Physics. Brisbane, Queensland, Australia.

This paper describes the use of a modified Supplemental Instruction (SI) program in the School of Physics at Queensland University of Technology (Brisbane, Australia). The pilot project used second and third year physics major students as assistant demonstrators in the first year physics laboratory. In addition to improvement by the students in the class, the assistant demonstrators also showed improvements in their class performance. Through qualitative research, it appears that the assistant demonstrators helped students to improve their own learning process, focus on the process rather than rushing to complete the task, and think of new issues and questions.

Moore, R., & DeLee, O. (2006). Supplemental Instruction and the performance of developmental education students in an introductory biology course. *Journal of College Reading & Learning*, 36(2), 9-20.

Supplemental Instruction (SI) was analyzed in an introductory biology class at the University of Minnesota with a student population of mostly academically-underprepared students. The findings favored SI participants over non-participants regarding higher final course grades. Other findings were that the SI participants attended class more often, took more advantage of instructor's office hours, and handed in more extra-credit homework. The authors suggest that SI can be especially effective for academically-underprepared students.

Mosley, A. T., Maize, D., & LaGrange, L. P. (2013). Pharmacy students' perception of a modified Supplemental Instruction program. *Currents in Pharmacy Teaching and Learning*, 5(3), 175-179. doi: 10.1016/j.cptl.2012.12.003. Available online <http://www.sciencedirect.com/science/article/pii/S1877129712001219>.

To determine pharmacy students' perceptions of the potential academic benefit, mandatory attendance policy, notification of and preparation for the sessions and negative stigma related to an academic assistance program at a new school of pharmacy. An anonymous, 16-question online questionnaire assessing the study's objective was administered to 137 of 167 first- (P1) and second- (P2) year students enrolled in a Doctor of Pharmacy program. The results of this study indicate that students who had been enrolled in the program perceived an academic benefit. Student insight on the mandatory attendance policy, the notification of and preparation for the sessions, and the negative stigma related to an academic assistance program led to changes that were incorporated into the supplemental instruction (SI) design and implementation. The early detection of high-risk students and immediate and ongoing interaction between these students and course faculty is perceived as a benefit and a unique aspect of our Doctor of Pharmacy program. This study introduces the development and implementation of an SI program and the findings may assist other schools of pharmacy in designing their own SI programs.

Muhr, C., & Martin, D. C. (2006). TeamSI: A resource for integrating and improving learning. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 85-94). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

Based on an adaptations of the basic SI model, TeamSI presents an approach to improve both students' understanding of their professional discipline and their self-development as more mature learners and leaders. This approach is being used with medical students in Sweden.

Munoz-O'Laughlin, J. (2012). *Supplemental Instruction as a remedy for the developmental mathematics university student* (Master of Arts thesis), California State University, Dominguez Hills, Dominguez Hills, CA.

Research was conducted at California State University, Dominguez Hills to determine the impact of Supplemental Instruction (SI) on underprepared first-year Educational Opportunity Program (EOP) students' successful completion of mathematics remediation. Course completion rates were tracked and a chi-square test was used to examine the relationship between the number of SI courses taken and completion of math remediation. Results indicated that EOP students who participated in the full sequence of SI courses offered completed their remediation at significantly higher rates than students who did not participate in SI. Requiring academic support like SI for underprepared students may be an effective way for universities to increase retention rates. The researcher suggested a follow-up study could include a third group for comparison, non-EOP students who entered the university at the same lowest math levels but did not participate in SI. Another issue was understanding the influence of motivation why the EOP students decided to participate in the full sequence of SI courses and worked hard to complete the developmental math requirements.

Muraskin, L. (Ed.). (1997). *"Best practices" in Student Support Services: A study of five exemplary sites*. Washington, D.C.: U.S. Department of Education. Available online: ERIC database. (ED416784).

This report examines "best practices" in the delivery of Student Support Services (SSS), one of the Special Programs for Disadvantaged Students collectively known as the TRIO programs. The study is based on case studies that were conducted in five local SSS projects during early 1996. The five projects were drawn from 30 projects in the National Study of Student Support Services, a longitudinal survey of students begun in 1991. A common theme of academic support at all five institutions was with providing learning assistance for developmental and popular freshman courses. Two of the five sites used Supplemental Instruction (SI) as an integral part of academic enrichment for SSS students. Another site used a variation of SI.

Murray, L. (1997, 1997, October 24). New program relies on peer instruction, *The Daily Reveille (Louisiana State University School Newspaper)*, p. 7.

This newspaper article provides a basic overview of the Supplemental Instruction (SI) model. SI will be implemented on the Louisiana State University campus in Spring 1998.

Murray, M. H. (1995). *Report on Peer Assisted Study Sessions in Engineering Mechanics 2*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This report discusses the use of Peer Assisted Study Sessions (PASS), the local institutional term for the Supplemental Instruction (SI) program used at Queensland University of Technology (Brisbane, Queensland, Australia) in CEB185, Engineering Mechanics 2. PASS participants earned higher mean final course grades (3.6 vs. 2.8 on a 0 to 7 scale). The most significant change in grades was in improving the performance of students who previously were projected to earn low grades and see them now achieve final grades in the mid-range. PASS participants mentioned the following reasons for attending the sessions: working on past exam and test solutions; discussion of problems; being able to ask questions freely and not look stupid; realizing there were different ways to tackle a problem; and interaction with fellow students and leaders who had recently done well in the course.

Murray, M. H. (1996). *Resources for the resourceless: Maximizing student learning*. Conference Proceedings of the 8th Conference of the Australian Association of Engineering Education, Sydney, Australia.

This article (which won "Best Paper" award at the conference) describes the use of Supplemental Instruction (SI) in the School of Civil Engineering, Queensland University of Technology (Australia). A basic engineering statics course in the first year has been transformed from a traditional lecturer-centered teaching mode into a student-centered resource-based model. Central to this transformation has been the integration of SI into the course. The SI sessions focus on interaction, discussion, and investigation rather than just simple problem solving. Before integration of SI in the course the total class (SI and non-SI students) mean final score was 46, in 1996 after the integration the score increased to 55. These results are based on the aggregated score from four quizzes during the semester, from a spaghetti bridge design/build/test project, and from a final end-of-semester exam. Based on standardized scores, the students in 1996 were less academically prepared than the ones in 1994 before SI was introduced. The SI participants received a higher mean final percentile grade in each year of the study (1995: 48 vs. 41; 1996: 56 vs. 42). There was a positive increase in final course score and higher levels of SI attendance. Students evaluated the SI session most useful of all course components (SI sessions, 53%; lecture, 22%; text book, 16%; study guide, 13%; and tutorial, 9%). SI leaders mentioned the following benefits of the program for themselves: increased skill in group management; improved public speaking; gained skills in team building; increased group facilitation skills; improved personal time management; and increased interest from potential employers because of skills developed as a SI leader.

Murray, M. H. (1996). Alternative to lecturer-centered teaching enhances student learning and costs no more. *Academic Staff Development Unit Update (Queensland University of Technology, Australia)*, 6-7.

This article describes the use of Supplemental Instruction (SI) in the School of Civil Engineering, Queensland University of Technology (Australia). A basic engineering statics course in the first year has been transformed from a traditional lecturer-centered teaching mode into a student-centered resource-based model. Central to this transformation has been the integration of SI into the course. The SI sessions focus on interaction, discussion, and investigation rather than

just simple problem solving. Before integration of SI in the course the total class (SI and non-SI students) mean final score was 46, in 1996 after the integration the score increased to 55. These results are based on the aggregated score from four quizzes during the semester, from a spaghetti bridge design/build/test project, and from a final end-of-semester exam. Based on standardized scores, the students in 1996 were less academically prepared than the ones in 1994 before SI was introduced. The SI participants received a higher mean final percentile grade in each year of the study (1995: 48 vs. 41; 1996: 56 vs. 42). There was a positive increase in final course score and higher levels of SI attendance. Students evaluated the SI session most useful of all course components (SI sessions, 53%; lecture, 22%; text book, 16%; study guide, 13%; and tutorial, 9%). SI leaders mentioned the following benefits of the program for themselves: increased skill in group management; improved public speaking; gained skills in team building; increased group facilitation skills; improved personal time management; and increased interest from potential employers because of skills developed as a SI leader.

Murray, M. H. (1997). Better learning through curricular design at a reduced cost. *Journal of the American Society of Engineering Education*, 1-5.

This paper describes the use of Supplemental Instruction (SI) in the School of Civil Engineering, at Queensland University of Technology, Australia. After an initial discussion of the changes economic and educational trends in Australia, the report reviews the use of SI with students in a first year engineering course (Engineering Mechanics 1). It is an introduction to rigid body statics, equilibrium, moments, forces, and properties of plane areas. Using the Australian system of 7 point grading (1 = lowest, 7 = highest), the data suggests that the performance of SI participants was higher than non-SI participants (1995: 3.3 vs. 2.7; 1996: 4.4 vs. 2.8). Due to the use of SI, the course was restructured with a reduction of professor lecture time. This resulted in a lower student unit cost. Before SI's introduction, the student unit cost was more than \$51 in 1994 (each week 2 hours of lecture and 1 hour of tutorials) and was reduced to less than \$42 in 1997 (each week one hour of lecture, one hour of tutorial, one hour of SI, study guides, computer exercises, and E-mail).

Murray, M. H. (1997). Students, learning resources: An inseparable triad. *Australian Journal of Engineering Education*, 7(2), 129-139.

This paper describes the use of Supplemental Instruction (SI) at the School of Engineering, Queensland University of Technology (Australia) with two first year engineering courses. SI is compared with the traditional, lecture-centered model of learning. The introductory engineering courses were reorganized to integrate SI into the learning delivery system. Based on the seven point grading scale employed in Australian education (1 = low; 7 = high), the academic performance of students with SI was raised to 4.3 from the previous level of 3.0 before the introduction of the SI model.

Murray, M. H. (1999). *SI down under - Australian innovations: Funding, solutions, and analysis*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

SI was established in Australia during the early 1990s. The author reports on the adaptations that have been made to the American SI model to meet challenges. Most Supplemental Instruction (SI) programs do not receive funding from central administration but instead have to solicit funds from separate academic units. Responses to this challenge include restructuring of courses to increase effectiveness and integration of SI along with the use of advanced SI leaders to serve as assistant SI supervisors since often the SI program receives no full-time administrative oversight but instead relies upon the individual course faculty members who offer SI in connection with their course. An unanticipated benefit of the SI program has been the professional development of the SI leaders.

Murray, M. H. (2001). Students managing to learn and teachers learning to manage. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student-assisted teaching: A guide to faculty-student teamwork* (pp. 50-55). Bolton, MA: Anker Publishing Company. Available online: ERIC database. (ED449713).

This chapter describes the use of Supplemental Instruction (SI) at Queensland University of Technology (QUT), an inner-city, multicampus university with 35,000 students in Australia. SI was implemented in the engineering course taught by the author. Final course scores were higher and attrition rates lower for SI participants in the 1995-96 study. The overall cost of offering the course was reduced through introduction of SI since additional part-time lecturers and tutors were replaced by the SI scheme. The author also reported benefits for the SI leaders in terms of personal and professional growth.

Murray, M. H. (2006). *PASS: Primed, persistent, pervasive*. Conference Proceedings of the National PASS Day Conference. Available online:

<http://www.uow.edu.au/content/groups/public/@web/@stsv/documents/doc/uow021512.pdf>

This paper describes how the Supplemental Instruction (SI) was customized for use in Australia and named Peer Assisted Study Sessions (PASS) since the early 1990s. PASS has been used at Queensland University of Technology in Australia in a first year, first semester course in the Bachelor of Engineering program since 1993. The course covered basic engineering mechanics. The PASS participants both enjoyed higher final course grades and dramatically lower rates of failure. The article also discusses some of the administrative issues faced with continued support for the PASS program with difficult economic challenges facing the institution. An external grant was secured from Exxon for five years to underwrite part of the program costs. The PASS program was partially led and managed by senior PASS student facilitators.

Murray, M. H., Grady, J., & Perrett, S. (1997). *Students managing students' learning*. Paper presented at the 9th Annual Conference of the Australian Association of Engineering Education. This paper describes the use of Supplemental Instruction (SI) at Queensland University of Technology (Brisbane, Australia) in engineering classes (Engineering Mechanics I and II). Student participant comments said that participation in SI sessions: developed greater understanding, more helpful than tutorials, made discussions more enjoyable, developed greater confidence, enjoyed group work, and found the atmosphere more relaxed and helpful. SI leaders mentioned the following benefits for themselves: reinforced own learning and study skills, developed more confidence, made academic coursework more challenging and satisfying.

Musah, R. A., & Ford, M. (2017). Peer-based Supplemental Instruction in STEM: Differences in effectiveness across transfer and nontransfer undergraduates. *Journal of Research on Educational Effectiveness*, 10(3). doi: 10.1080/19345747.2016.1213341

Although there is a large body of research on the effectiveness of supplemental instruction for college undergraduates, very little of it has focused on transfer students, who often confront additional sources of stress and historically perform more poorly than their native student counterparts. In this study, we investigated the effectiveness of a peer-based supplemental instructional program in general and organic chemistry at a large state university over a six-year period, while considering differences across transfer and nontransfer students. The results suggest that the supplemental instruction improved outcomes overall but that nontransfer students benefit to a greater degree than transfer students, in the form of higher grades and pass rates, from attending supplemental instruction. The results suggest that peer-based supplemental instruction is a useful method to improve undergraduate student performance in

chemistry, but more research is needed on ways to enhance the effectiveness of interventions in improving the performance of transfer undergraduate students in STEM fields.

Naidoo, J., & Paideya, V. (2015). Exploring the possibility of introducing Supplemental Instruction at secondary school level. *South African Journal of Education*, 35(2), 1-10. doi:doi:10.15700/saje.v35n2a1022.

Globally, mathematics and science pass rates at school level have been a much discussed and researched issue. Teachers are tasked with the responsibility of alleviating learners' challenges associated with the learning of mathematics and science. Thus, teachers are pursuing innovative techniques for improving the understanding of and increasing the pass rates in mathematics and science. Academics in higher education have recognised that first year students experience difficulty with high-risk courses such as mathematics and science. One successful innovative strategy used at university level is Supplemental Instruction (SI). This is a peer support programme, which targets high-risk courses, and is aimed at developing subject-specific learning skills to foster independent learners, who will take responsibility for their own learning. This article explores the SI context at university level, with the aim of adapting this type of support programme at secondary school level. Data was collected via a questionnaire administered to selected academics, interviews with academics, as well as interviews with university students who have participated in SI sessions at university level. An analysis of the data suggests that schools may be able to adapt the SI model with the aim of assisting learners to develop key study skills to improve understanding in mathematics and science. This improved understanding of content could lead to an improvement in mathematics and science pass rates at secondary school level.

Neal, E. M. (2013). *Student use of the Supplemental Instruction Program: A survey of students in an introductory American politics course*. Paper presented at the APSA 2013 Teaching and Learning Conference.

Many institutions of higher education – community colleges in particular – are focused on issues related to student success. In an effort to close the achievement gap between student demographic groups, college administrators encourage faculty to link their students to the academic support services provided on campus. Such efforts may be voluntary for the college or part of a coordinated institutional, regional, or national effort. One service employed by many colleges is the Supplemental Instruction (SI) program. The program is voluntary for students in “academically rigorous courses” and aims to “integrate how-to-learn with what-to-learn.” The program is touted by its proponents for helping students withdraw less and earn higher grades. This paper examines student use of the SI program in an introductory course in American Politics. Students in four sections of the course were surveyed about their use of the SI program and other academic support services provided at a Midwestern community college. The results of this preliminary survey are discussed.

Ng, R., Kaur, A., Farina, S., Mohamed, S., Latif, A., & Ramli, B. (2009). E-mathematics : pre-instructional and supplement instruction and their impact of student's online participation and final exam score. . *AAOU Journal*, 4(1), 27-36.

Open University Malaysia (OUM), Malaysia's first open and distance learning with over 70.000 students, offers more than 51 programs to-date. More than 90% of its students are working adults who are unable to leave their jobs or families behind to pursue their dream of getting a degree. The blended learning approach adopted by OUM provides the flexibility for working adult's to obtain the required paper qualification and to upgrade their knowledge. One of the important elements of blended learning is the use of online discussion forum where learning takes place beyond classroom. Mathematics, a traditionally difficult course, forms part of the prerequisite for students to obtain a business degree at OUM. The adult learners at OUM

generally have left school for at least five years and most of them have low grades in Mathematics at O' Level. Thus it is a big challenge for these adult learners to undertake a Mathematics course via online with minimum Face-to-Face contact with their tutors. This paper focuses on the implementation of pro-instruction workshop and supplemental instruction to find its impact on student's online participation and exam results of 88 students. The contents of the online forum were also analyzed using a 34-item instrument derived from the Community of Inquiry model. Results obtained showed that there was a strong correlation between workshop participation and final exam score. Independent samples t-test conducted showed that there was a significant difference between the mean score of online discussion ratio and final examination between participants attached to a tutor conducting the workshop and extended coaching compared to participants attached to another tutor using the normal teaching guide. The means COI score obtained for mathematics between the two tutors indicated that there is a difference in the teaching and cognitive presence but almost similar in the social presence.

Ng., R., Kaur, A., & Latifah, A. L. (2009). *Online Supplemental Instruction: An alternative model for the learning of mathematics*. . Conference Proceedings of the International Conference on Information,, Kuala Lumpur, Malaysia.

More than 90% of Open University Malaysia (OUM)'s learners are working adults who are unable to leave their jobs or families behind to pursue their dreams of getting a degree. The blended learning mode adopted by OUM provides the flexibility for working adults to obtain their paper qualifications and to upgrade their knowledge. Mathematics, a traditionally difficult course, forms part of the pre-requisite for learners to obtain a business degree at OUM. The adult learners at OUM generally have left school for at least five years and most of them have low grades in Mathematics at O' Level. Thus it is a big challenge for these adult learners to undertake a Mathematics course via online with minimum Face-to-Face contact with their tutors. This paper proposes an alternative model of learning mathematics known as Online Supplemental Instruction (OSI) model which involves three components; pre-tutorial workshop, online mentoring, and online video support. The research which involved 132 learners under the tutorship of two tutors was carried out to find the impact of the model on learners' online participation and final exam score. The contents of the online discussion forum were analyzed using a 34-item instrument derived from the Community of Inquiry (COI) model. Learners' online participation behavioral pattern was also analyzed. Results obtained showed that there was a strong correlation between learners who have participated in the OSI model of learning and their online participation and final exam score.

Nikolic, S., & Nicholls, B. (2017). *Exploring student interest of online peer assisted learning using mixed-reality technology*. Conference Proceedings of the International Conference on Interactive Collaborative Learning

Supplementary Instruction, also known as Peer Assisted Study Sessions (PASS), is a popular program supporting the educational development of students in a collaborative setting. Flexibility of delivery has been explored for a number of reasons including: work and family commitments; distance from campus; and integrating regional and transnational satellite campuses. Previous studies have found attempts to undertake online delivery of PASS lacking in student interest and have been restrained by the technology. This study attempts to build upon this research by investigating student interest and the suitability of using a mixed reality technology called iSee, based on video avatars within a 3D virtual world. Consistent with previous studies student interest was low, converting a planned quasi-experimental study into a simulation. The simulation suggests that the technology was suitable for online collaboration, with effective communication of course content between participants and a good sense of presence. This suggests this trial may gain greater student interest if undertaken within institutions offering predominantly online, distance education.

Ning, K., & Downing, K. (2010). The impact of Supplemental Instruction on learning competence and academic performance. *Studies in Higher Education*, 35(8), 921-928. Available online: <http://www.tandfonline.com/doi/pdf/10.1080/03075070903390786>.

This study investigated the effects of Supplemental Instruction, a peer-assisted learning approach, on students, learning competence and academic performance. The supplemental instruction intervention facilitated by senior students focused on developing students' use of study skills and enhancing their motivation and academic performance. Pre- and post-intervention learning competence measures (the 10 scales of the Learning and Study Strategies Inventory) were available for 430 first year undergraduate business students (Supplemental Instruction, n = 109; Non-Supplemental Instruction, n = 321) from a university in Hong Kong. Structural equation modeling demonstrated that Supplemental Instruction had a significant effect on academic performance, both directly and indirectly via enhancement of student learning competence, after controlling for pre-intervention learning strategy scores and previous academic achievement. This study provides evidence that Supplemental Instruction can be a very effective instructional strategy for promoting undergraduate student learning.

Nkosi, J. D. (2013). *A critical portrait of student voice among community college students of color*. (Ph.D. dissertation), California State University Fresno.

This study utilized Freire's conscientização as a framework to understand the development of student voice among traditionally underrepresented students of color in a sociology classroom at a large community college in the Central Valley of California. Understanding how student voice is developed in a community college classroom provides faculty with knowledge and practices to help students develop voice and therefore an ability to critically reflect on their classroom learning, apply knowledge to their lived experience, and develop a sense of agency in their ability to effect change. A case study design allowed for an in-depth examination of the elements that foster voice. Participant observations and semi-structured interviews with 10 students, the instructor, and Supplemental Instruction leader revealed conditions, practices, and pedagogies that nurtured student voice. Findings provide faculty with practical ideas to create community in the classroom, help students feel connected, and engage students with pedagogy that transforms the classroom into the real world to foster voice.

Nolting, P., & Ruble, K. (1999). *Supplemental Instruction with math study skills templates*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

SI can be expanded to include mathematics study skills as integral content to learning math and at the same time organize the SI design designs. The authors focus on the content of math study skills and provide examples of how these specific study strategies can structure the student learning activities.

Norton, J., & Agee, K. S. (2014). *Assessment of learning assistance programs: Supporting professionals in the field*. College Reading & Learning Association. Available online: <https://207.250.94.50/images/whitepaper/AssessmentofLearningAssistancePrograms2014.pdf> Every program in higher education must now demonstrate its contribution to the mission and goals of its institution and provide some measure of student learning outcomes. This white paper, commissioned by the College Reading and Learning Association, seeks to encourage learning assistance professionals by offering a practical approach to assessing their programs. Our purpose is to illuminate the many assessment resources available and the methods used by individuals in the field. Rather than review the general literature for higher education program evaluation from years past or the publications focusing on evaluation of developmental education courses, we highlight recent and current strategies used by learning assistance

practitioners to assess and improve their programs and services. This information would be valuable for evaluation of Supplemental Instruction and other peer learning programs.

Ochae, R. (1995). *Writing partners: Improving writing and learning through Supplemental Instruction in freshman writing classrooms*. Paper presented at the Annual Meeting of the National Council of Teachers of English, San Diego, CA. Available online: ERIC database. (ED395323).

A study was conducted at Black Hills State University (SD) which has an open admission policy and high attrition and dropout rates in the first writing course. Results suggested that SI helped SI participants to improve writing skills (gain of 15.7% on standardized test vs. 14.0% for courses taught by the same professor but without SI), earn higher mean final course grades (2.6 vs. 2.5, reduce failure rates (13.8% vs. 16.0%), and lower course withdrawal rates (6.1% vs. 6.9%).

Ochae, R. (1995). *Writers at risk: An experiment with Supplemental Instruction in freshman writing classrooms* *Black Hills State University Research and Scholarly Work Symposium Proceedings* (pp. 67-72). Spearfish, SD: Black Hills State University. Available online: ERIC database. (ED414830).

This book chapter describes the use of Supplemental Instruction (SI) during Fall 1994 at Black Hills State University (Spearfish, SD) with a beginning writing class (English 101). The institution has an open admission policy and high attrition and dropout rates in the first writing course. To measure effectiveness of SI, a diagnostic essay (EDE) was administered to the English 101 students, based on a common essay prompt and scored holistically by the entire English faculty. Results suggested that SI helped SI participants to improve writing skills (gain of 15.7% on the EDE vs. 14.0% for courses taught by the same professor but without SI), earn higher mean final course grades (2.6 vs. 2.5, reduce failure rates (13.8% vs. 16.0%), and lower course withdrawal rates (6.1% vs. 6.9%).

O'Donnell, L. E. (1995). *Inclusion for learning disabilities: Technology with learning variables research and Supplemental Instruction*. Conference Proceedings of the Empowering children with special needs: Practices around the world, Brighton, United Kingdom.

Learning Variables Research and Supplemental Instruction (LVR/SI) provide an innovative approach to inclusion for intellectually normal and gifted students with learning disabilities. The original Supplemental Instruction (SI) model is generally used with traditional college undergraduate and graduate students. Video-based Supplemental Instruction (VSI) allows enrolled high school or college students view the videotaped lectures of a college level course (e.g., Western Civilization, General Chemistry) and allow them opportunity to control the flow of information (e.g., stop, repeat, discuss material before proceeding). SI, and especially VSI, can be very helpful for students with learning disabilities since they can be served inside the same content class rather than requiring an additional class for the students to attend to deal with their specialized learning needs. The LVR/SI approach refines either the SI or VSI model with individualized learning variables and computer technology for application in junior high, senior high, and higher education. Rather than using video tape with VSI, computer technology might be substituted. In addition, the SI leader or VSI facilitator is provided critical information about students with disabilities. This technology-based program allows individuals with learning disabilities to succeed academically in integrated, inclusive classrooms.

O'Donnell, L. E. (1996). *Inclusion for learning disabilities: Technology with learning variables research and Supplemental Instruction*. *International Journal of Special Education*, 11(2), 27-32. Learning Variables Research and Supplemental Instruction (LVR/SI) provide an innovative approach to inclusion for intellectually normal and gifted students with learning disabilities. The

original Supplemental Instruction (SI) model is generally used with traditional college undergraduate and graduate students. Video-based Supplemental Instruction (VSI) allows enrolled high school or college students view the videotaped lectures of a college level course (e.g., Western Civilization, General Chemistry) and allow them opportunity to control the flow of information (e.g., stop, repeat, discuss material before proceeding). SI, and especially VSI, can be very helpful for students with learning disabilities since they can be served inside the same content class rather than requiring an additional class for the students to attend to deal with their specialized learning needs. The LVR/SI approach refines either the SI or VSI model with individualized learning variables and computer technology for application in junior high, senior high, and higher education. Rather than using video tape with VSI, computer technology might be substituted. In addition, the SI leader or VSI facilitator is provided critical information about students with disabilities. This technology-based program allows individuals with learning disabilities to succeed academically in integrated, inclusive classrooms.

O'Donnell, R. (2004). *Introducing peer-assisted learning in first year accounting in Australia*. Unpublished manuscript. Department of Economics, Macquarie University. Sydney, New South Wales, Australia. Available online:
http://www.econ.mq.edu.au/Econ_docs/research_papers2/2004_research_papers/PALDec04.pdf

At Macquarie University in Australia, Peer Assisted Learning (PAL) is an adaptation of the Supplemental Instruction (SI) model. PAL was piloted in an accounting course. The paper describes the pilot program regarding its design, outcomes, benefits, costs, and lessons learned. There was a positive correlation between higher grades and more frequent attendance in the PAL sessions. There were also benefits for the PAL facilitators: development of key skills such as leadership, communication, group management; deeper understanding of course content; valuable enhancement to employability; and financial payment.

Ody, M., & Carey, W. (2000). *Demystifying Peer Assisted Study Sessions (PASS): What...? How...? Who...? Why...?* Unpublished manuscript. The University of Manchester. Manchester, U.K. Available online: <http://documents.manchester.ac.uk/display.aspx?DocID=7418>
PASS offers benefits at several levels to various stakeholders. At an institutional level it provides an additional cost-effective method of student support, which has been highlighted as good practice by the Quality Assurance Agency in supporting the student experience. The impact of PASS on a student's employability is also recognized by employers and professional accreditation bodies; during a recent visit to the School of Chemical Engineering and Analytical Sciences the IChemE reported positively on the use of PASS and notably its impact on the transferable skills developed by PASS Leaders. Anecdotal feedback from a range of graduate employers recognizes that students who engage in voluntary roles, such as a PASS Leader, develop competencies and transferable skills that increase their employability prospects

Ody, M., & Carey, W. (2010). *Mid-term evaluation and feedback on the run...* PowerPoint Presentation. University of Manchester. Manchester, U.K. Available online:
<http://documents.manchester.ac.uk/display.aspx?DocID=7416>
These PowerPoint slides are from the authors' presentation at the 2010 Supplemental Conference in New Orleans. Topics include the real-time evaluation system used at the University of Manchester.

O'Flaherty, K., & Siera, M. (1985). The use of Supplemental Instruction in an Introduction to Sociology course. *ASA Teaching Newsletter*, 10(6), 13-16.
At Wichita State University (KS) the Supplemental Instruction (SI) model was used to help improve student academic performance in an Introduction to Sociology course. This Spring

1984 study suggested that SI attendance was positively correlated with higher mean final course grades. Of the SI participants, 75 percent received a final course grade of A or B while 59 percent of non-SI participants received a similar grade.

Ogden, P., Thompson, D., Russell, A., & Simons, C. (2003). Supplemental Instruction: Short- and long-term impact. *Journal of Developmental Education, 26*(3), 2-4. 6, 8.

The purpose of this study was to assess Supplemental Instruction (SI) for short- and long-term impact on college academic performance and retention at Georgia State University. Data were compiled for students registered in a political science course supported by SI. Four groups were identified according to their university entry status and SI participation: traditional (regularly admitted) SI participants, conditional (Learning Support Programs and/or English as a Second Language entry status) SI participants, traditional non-SI participants, and conditional non-SI participants. All SI participants volunteered for the program. There was no statistically significant differences between SI and non-SI participants in the two comparison groups when preentry attributes were analyzed. Conditional students participating in SI had significantly higher short- and long-term outcomes compared to conditional non-SI participants. Conditional SI participants reenrolled at a higher rate than did the other three student groups included in this study. Traditional SI participants earned higher final course grades than their non-SI counterparts, though the results were not statistically significant. The ESL students were equally distributed among the four comparison groups and did not serve as a statistically significant factor in outcomes studied.

Ogilvie, C. (1991). Supplemental Instruction: The California State University model. *Illinois Association for Personalized Learning Programs Newsletter, 4*-5.

This newsletter article provides an overview of the Supplemental Instruction (SI) program at California State University. To increase attendance at the SI sessions, students are required to register for a section of one credit and pay tuition to allow attendance at the SI sessions. SI is provided to 35 sections of courses.

Oja, M. (2012). Supplemental Instruction improves grades but not persistence. *College Student Journal, 46*(2), 344-349.

Supplemental Instruction (SI) is a growing student support service used to offer students peer-guided activities to improve course learning. The current research was conducted to answer two research questions: 1) Do those who participate in SI perform better in their courses than those who do not attend SI? 2) Are those who participate in SI more likely to persist at the college for another term, than those who do not attend SI? Performance was compared for students who did or did not attend a session of SI in course sections that offered SI. Participation in SI sessions predicted term GPA (grades in all course taken that term for each student) and pass rates, above and beyond prior GPA. SI did not seem to encourage persistence at the college to the following fall term. Overall, SI is a beneficial program and should be continued and/or expanded.

Okonkwo, Z. C., & Berry, E. (2013). An examination of the study table project and student achievement at a four-year college: Ramifications for retention, progression and graduation. . *International Journal of Research in the Academic Disciplines in Higher Education, 1*(1), 13-37. Available online: <http://www.zetric.com/firstedition/ijrdheFE2013.pdf#page=14>.

Traditionally, XYZ University had employed multifaceted approach to provide students out of class academic learning support which focused on enhancing student academic achievement, retention, progression, persistence, and graduation in their courses and programs. Over the years, retention, persistence, and graduation (RPG) have become essential attributes for gauging institutional effectiveness in the University System to which XYZ University belongs.

State funding of state Colleges and Universities are partially based on these delineated attributes. Support programs included peer tutoring in a variety of courses, sometimes housed in various academic units and departments, with supplemental instruction, mostly facilitated by instructors. Supplemental Instruction (SI) targeted gatekeeper courses such as College Algebra, Precalculus with Trigonometry, Calculus I, General Chemistry I, Introduction to Biology I, and Introductory Physics I. These courses have traditionally had very high Fail, "D grade, and withdrawal (FDW). In order to improve student success rate in foundation teacher certification exams, Praxis I (PreProfessional Skills Tests) review, encompassing of the quantitative and verbal sections, was introduced, this was later replaced by a state mandated Assessments for the Certification of Educators review. These academic support programs have achieved a reasonable level of success in the past, although no comprehensive assessment report has been written regarding overall accomplishments of these interventions. Guided by the zeal to continue to improve student retention, progression, and graduation at XYZ University, the Study Table Project was introduced in fall of 2011. In this paper therefore, the researchers compare student achievement within two subgroups in each category: participant and nonparticipant; the categories being freshman, sophomore, junior, senior, athlete, and the learning support cohort. Furthermore, participant survey results were used to gauge participant perception of the impact of the Study Table on their achievement.

Okun, A., Berlin, A., Hanrahan, J., Lewis, James, & Johnson, K. (2015). Reducing the grade disparities between American Indians and Euro-American students in introduction to psychology through small-group, peer-mentored, supplemental instruction. *Educational Psychology: An International Journal of Experimental Educational Psychology*, 35(2), 176-191. doi:10.1080/01443410.2013.849324.

Supplemental instruction (SI) is a small-group, peer-mentored programme which is compatible with the learning preferences of American Indian students. We tested the hypothesis that SI is a compensatory strategy that reduces the differences in the grades earned in introduction to psychology by Euro-American and American Indian students. The sample consisted of 129 American Indian students and 4588 Euro-American students enrolled in introduction to psychology at a US university. As hypothesised, a multi-level model yielded a significant ($p < .01$) interaction between SI and ethnicity on course grade. Whereas for non-SI users, the gap between Euro-American and American Indian students was .71 grade points, for SI users, it was only .15 grade points. Strategies should be devised for increasing SI visits by students enrolled in introduction to psychology, particularly those who belong to American Indian tribes.

Oliver, R. (1994, 1994, July 29). University of Port Elizabeth rector on the right road, *Eastern Province Herald Newspaper*, p. 11.

This newspaper article reports on the signing of an agreement between the University of Missouri-Kansas City and the University of Port Elizabeth in South Africa concerning Supplemental Instruction (SI). UPE is implementing the SI program to help bridge the gap caused by differences in the education systems in the country.

Oliver, S. (1995). Empowering student learning with Supplemental Instruction *Developing skill-based curricula through the disciplines: Case studies of good practice in geography*, SEDA Paper 89. Birmingham, England: Staff and Educational Development Association
This article describes the introduction of Supplemental Instruction (SI) to the United Kingdom in the 1990s. The author describes some of the issues associated with its implementation at his institution of Saint Mary's University College in London.

On-Thai, M. (2019). *Effectiveness of Supplemental Instruction on improving retention rate, success rate, and GPA for developmental math students*. (Ph.D. dissertation), University of Phoenix, Phoenix, AZ.

Developmental courses and services are created to provide academic tools and skills for students who are unprepared for higher education curriculum (Gordanier, Hauk & Sankaran, 2019, p. 24). Developmental education has grown into an essential part of higher education institutions with over 98% of community colleges providing developmental courses in 2000 (Williams & Siwatu, 2017, p. 24). Approximately 58% of students enrolling at community colleges are placed in developmental education, but only 44% complete the developmental English sequence compared to 31% for developmental math (Quarles & Davis, 2017, para. 4). The purpose of this quantitative comparative ex post facto study was to assess the effectiveness of an academic assistance program – Supplemental Instruction (SI) - on retention, success and GPA of developmental math students. Sample population for this study included 9,301 SI students and 14,597 Non-SI students enrolling in a total of 625 developmental math courses from summer 2013 to spring 2018. Aggregate data pertaining to the mean values of retention rates, success rates and GPAs of SI and Non-SI students enrolling in developmental math courses were used for comparative analysis. A one-way ANOVA and independent two-sample t-test with significance value p of less than 0.05 displayed a statistical significant difference between the retention rates, success rates and GPAs of SI and Non-SI students. Results from this research study call for continual supports and curriculum reforms to enhance learning outcome and success of developmental math students. Academic assistance programs are fundamental in helping students improve their retention and success.

Orr, M. K. (2010). *Comprehensive analysis of a student-centered active-learning integrated statics and dynamics course for mechanical engineers*. (Master of Science thesis), Clemson University, South Carolina - United States.

The Student-Centered Active Learning in Undergraduate Programs (SCALE-UP) approach to instructional design was adapted with the goal of delivering more effective statics, dynamics and multivariate calculus instruction and integrated course curricula. Inquiry-based learning exercises were designed, incorporating material from statics and dynamics into multivariable calculus, and vice-versa, as well as integrating statics and dynamics into one course. Analysis included an exploration of student study habits, multiple measures of course effectiveness, and an examination of curricular effects. Challenges of implementation are also discussed. Study habits of students in an integrated Statics and Dynamics course were assessed through a voluntary survey in order to determine which practices are the most helpful to the students. These data indicated that there are three distinct behavior patterns for these students (Help Seeker, Supplemental Instruction Dependent, and Minimalist), which lead to different levels of conceptual understanding of the material. The effectiveness of the revised course designs and activities were assessed using a mixed method approach. Student performance in these courses and in follow-on courses was used to measure improvements in concept retention. Conceptual tests (Statics and Dynamics Concept Inventories) were administered before and after semesters, and average normalized gains were compared with those for students in traditional learning environments. Open-ended questions on end-of-semester course evaluations assessed student perceptions of the course format. Results indicate increases in conceptual measures in statics with SCALE-UP, significant reductions in failure rates for students in the integrated statics/dynamics course, and reduction in time to completion of statics and dynamics courses. Survey data indicate positive effects on students' use of learning resources, and anecdotal evidence demonstrates that students are continuing the patterns of peer instruction and positive interdependence in follow-on courses. Based on these research findings, faculty development materials were generated that concisely state the pedagogical underpinnings of the method, provide evidence of success in our courses, and identify key

aspects of successful implementation of SCALE-UP in engineering courses. These include effective use of learning assistants, well-designed learning activities, and formative assessment questions that emphasize learning objectives and guided inquiry. Course materials have been published, and efforts are under way to promote this as a mainstream teaching resource. Mechanical Engineering students in both the old and new curricula (n= 316 and 366, respectively) were tracked to glean information about the paths students take as they progress through their degree program and the effects that the new integrated course has had on these paths. For each student, the number of attempts and grades for the courses of interest were recorded. Results indicate nearly the same proportion of students pass the integrated dynamics and statics course on their first attempt as pass both the separate courses on their first attempt at Clemson University. Students in the new curriculum are less likely to quit before completing the course sequence. As expected, it takes students less attempts to pass the new course than to pass both the old courses. Details regarding implementation of this course are discussed. Challenges to achieving success in this new course have been many and demanding. These include (1) development of a dedicated textbook, (2) development of learning exercises to foster student comprehension, (3) reorganization of topical content including topic deletion and added emphasis on certain topics, (4) preparing faculty for change, (5) accommodating limited student maturity, and (6) dealing with widespread misgivings about the project.

Osburne, J. D., Parlier, R., & Adams, T. (2019). Assessing impact of academic interventions through student perceptions of academic success. *The Learning Assistance Review, 24*(1), 9-26.

In Fall 2016, the Student Success Center at the University of Tennessee, Knoxville began a two-year study to assess participant impacts of three key academic success programs: academic coaching, tutoring, and Supplemental Instruction (SI). Survey results revealed that participants perceived academic impacts in all three programs and that students who attended more frequently had higher levels of perceived academic impact. The following article provides an overview of the study purpose, methodology, data collection, analysis and study findings. Study conclusions are presented along with implications and next steps for future research.

Outhred, T., & Chester, A. (2010). The experience of class tutors in a peer tutoring programme: A novel theoretical framework. *Journal of Peer Learning, 3*(1), 12-23. Available online: <http://ro.uow.edu.au/ajpl/vol3/iss1/3>.

This campus program called P2P is based on the PASS model which is based on Supplemental Instruction. Three female first-year class tutors provided insight into how they experienced a novel peer tutoring program embedded in their tutorials. Five themes emerged: role exploration and their professional identity, sharing responsibility, regulation of the peer tutored groups, harnessing the peer tutor role, and community.

Overly, C. (Writer). (1995). Supplemental Instruction overview [Videotape]. In C. Overly (Producer). Kalamazoo, MI: The University of Missouri-Kansas City
This ten minute videotape provides an overview of the Supplemental Instruction (SI) program. It includes brief interviews with SI leaders, SI supervisors and faculty members.

Owens, S. C., Rainey, Y., Tucker, P., & Edmunds, B. (2018). Effectiveness of a retention program to improve performance during the first semester of a Doctor of Physical Therapy Program *Journal of Health Care for the Poor and Underserved, 29*(1), 430-447. Available online: <https://muse.jhu.edu/article/686976/pdf>.

To meet the expanding need for physical therapists universities are under increasing pressure to enroll, educate, and train physical therapists. Poor academic performance can result in student dismissal from a physical therapy program. The purpose of this study is to determine if

implementation of a retention program would improve student academic performance in the foundational science curriculum in a physical therapy program. Methods. A prospective observational cohort design was used. The retention program centered on three approaches: 1. Early identification of at-risk students. 2. Supplemental instruction in Human Anatomy. 3. Offering peer tutoring for the foundational science courses. Results. A significant association existed between the implementation of the retention program and the reduction of dismissals from the Fall Semester of 2012 to the fall 2013 semesters. Conclusion. Implementation of a retention program had a beneficial effect on decreasing student dismissals in a physical therapy program.

Paabo, M., Brijmohan, A., Klubi, T., Evans-Tokaryk, T., & Childs, R. A. (2019). Participation in peer-led Supplemental Instruction Groups, Academic performance, and time to graduation. *Journal of College Student Retention Research Theory and Practice* doi: 10.1177/1521025119826287.

This study investigates the relationship of students' participation in peer-led Supplemental Instruction groups, called facilitated study groups (FSGs), with their academic performance and years to graduation. In 2017, the full academic records of about 2,400 students who started university between 2005 and 2007 and took Psychology 100 (PSY100) during their first year were analyzed. Students who attended two or more FSG sessions received about 5% higher marks in PSY100 than those who did not, after controlling for gender and tuition status (domestic or international). Students with higher PSY100 marks took less time to graduate and were more likely to have graduated by 2016. After controlling for gender, tuition status, and marks in PSY100, however, no relationship was found between FSG participation and degree completion time.

Packham, G., Cramphorn, C., & Miller, C. (2001). Module development through Peer-Assisted Student Support: An initial evaluation. *Mentoring & Tutoring*, 9(2), 113-124.

OPeer-Assisted Study Sessions (PASS), based upon the Supplemental Instruction (SI) model, are used with institutions within the United Kingdom for improvement of the course curriculum. Feedback is provided to the course instructors in such a way that is not easily obtainable through more traditional means. Data is collected through meeting logs, observations, interviews, and questionnaires. This article focused on the use of PASS for this purpose at the University of Glamorgan's Business School.

Packham, G., & Miller, C. (2000). Peer-Assisted Student Support: A new approach to learning. *Journal of Further and Higher Education*, 24(1), 55-65.

Peer-Assisted Student Support (PASS) is based upon Supplemental Instruction (SI) and is the predominate name used in the United Kingdom. This article provides an overview of PASS with specific information about its use at the University of Glamorgan during the 1997-98 academic year in the Business School. PASS is most popular with female students and those under 21 years of age. Evaluation of the positive impact of PASS participation is limited to the course in which the students attended PASS sessions. Higher rates of PASS attendance was correlated with higher final course grades.

Paideva, V., & Sookrah, R. (2014). Student engagement in chemistry Supplemental Instruction: Representations of learning spaces *South African Journal of Higher Education*, 28(4), 1344-1357.

The Faculty of Engineering at the University of KwaZulu-Natal (UKZN) has a rich diversity of first year students who present themselves as under-prepared for tertiary study. This is because many students have not yet developed the abstract reasoning skills that allow them to learn new ideas simply by either reading a text or listening to a lecture. Supplemental instruction (SI) was

thus introduced as an academic support programme for the first year students. The focus of this article is to theorise the engineering students' engagement within the SI learning space. This is done using the concepts of relate, create and reflect adapted from theories of engagement. The findings suggest that social learning spaces encourage explanations, conceptual understanding and reflective thinking. In theorising engineering students' engagement within the SI learning space, it is argued that the notion of engagement created representations of physical, cognitive and safe cultural spaces for learning chemistry.

Paideya, V. (2011). Engineering students' experiences of social learning spaces in chemistry Supplemental Instruction sessions. *Alternation*, 18(2), 82-95. Available online: <http://utlo.ukzn.ac.za/Files/Alternation%2018.2%20%282011%29.pdf>.

Students regarded their experiences of the social learning spaces created in the chemistry Supplemental Instruction (SI) sessions as inspiring because of the support they received from SI leaders and peers. SI has been introduced to the first hyear engineering and mainstream chemistry students at the University of KwaZulu-Natal as part of the "ThroughOut in Engineering Sciences (TIES) program. SI participants developed a better understanding of concepts through exposure to different points of view and different pedagogical activities offered. The findings indicate that the different pedagogical and learning techniques offered in the SI social learning spaces accommodated for the diversity of students' learning needs, encouraging students to take responsibility for their learning through feedback, motivation and support. Social spaces served for mini revision of concepts, explanations and discussions that improved understanding of concepts and collaboration amongst peers which increased students' confidence in answering questions. The findings from this study show that SI social learning spaces create opportunities for learning engagement that differ from lectures in many ways, particularly as they relate to: (a) offering more opportunities for practice and reflection; (b) access to a variety of questions; (c) access to support and immediate feedback; (d) opportunities for collaboration; (e) students taking responsibility for learning; and (f) motivation to learn. Students commented that student focused learning, which involved peer teaching and learning, encouraged them to: (a) develop thinking, reasoning and social skills which enabled them to engage with the problem solving activities more effectively; (b) develop confidence with respect to making appropriate choices in terms of chemistry concepts; and (c) explore, question and research other alternates as a fundamental component of their learning. It is evident from these responses that students who engaged in these social learning spaces developed a better understanding of concepts through collaboration. It is therefore argued that the social learning spaces created during the SI intervention session have the potential to develop independent lifelong learners in chemistry.

Paideya, V. (2014). Exploring students' experiences of chemistry SI with a vision to improve throughput and retention rates. *Supplemental Instruction Journal*, 1(1), 38-53. Available online: <http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVolumeOne.IssueOne.ConferenceProceedings.pdf>.

This paper reports on part of a longitudinal study conducted to track first-year, regular Supplemental Instruction (SI) attendees into their second and third years of study to determine progression and throughput rates. Surveys and focus group interviews were used to determine first year students' experiences of chemistry SI sessions. Data was analysed using an Interpretive methodology. Several themes emerged from the data with respect to students' attendance at SI sessions and their progression rates. It is therefore argued that SI sessions have the potential to support student retention and improve throughput in the School of Chemistry and Physics.

Paideya, V., & Sookrajh, R. (2010). Exploring the use of Supplemental Instruction: Supporting deep understanding and higher-order thinking in chemistry. *South African Journal of Higher Education*, 24(5), 758-770.

[Many under-prepared university students do not know how to study (Martin and Arendale 1993) because they have not yet developed the abstract reasoning skills that allow them to learn new ideas simply by reading a text or listening to a lecture. This article draws from selected findings from a PhD study currently being undertaken at a university in KwaZulu-Natal. This article explores the use of Supplemental Instruction (SI) in supporting deep understanding and higher-order thinking skills (HOTS) in stoichiometry in first year chemistry for engineers. The special focus of this article is to investigate whether the quality of teaching and learning in chemistry education is improved through SI and SI leader intervention. The central question guiding this article is: How does an interactive teaching and learning intervention programme (SI) facilitated by SI leaders potentially engage first year engineering students in deep understanding and HOTS in Chemistry? Since this article focuses on change or growth in natural settings, within stoichiometry in chemistry classrooms, it allowed for video-recordings, observations of SI sessions and focus group interviews which have been used in this study. Data analysis revealed that students preferred the more interactive engagement of SI sessions and discussion around chemistry concepts. Students found that having to explain concepts in their own words and being exposed to other students methods of answering questions greatly improved their understanding of stoichiometry. It was also found that SI leaders encouraged HOTS by asking higher-order questions, engaging in activities that required higher-order thinking as well as encouraged students to reflect on their thinking. It is therefore argued that teaching and learning strategies employed during the SI intervention session have the potential to promote deep understanding and higher-order thinking. (Contains 3 tables and 2 figures.)]

Painter, S. L., Bailey, R., Gilbert, M., & Prior, J. (2006). New directions for Supplemental Instruction. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 73-84). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter examines how SI can be implemented in university teaching-learning centers and in thematically based learning communities and with high school students, and with online academic support for distance learning students.

Paloy, A. R., Rogan, S., & Siminski, P. (2016). *The causal effects of the Peer Assisted Study Sessions (PASS) on educational outcomes*. Centre for Human and Social Capital Research, University of Wollongong. University of Wollongong, Australia. Available online: <http://www.uow.edu.au/~siminski/Final%20Report%20-%20Public%20Copy.pdf>

This report summarises the results of a HEPPP-funded research project on the effects of the Peer Assisted Study Sessions (PASS) on educational outcomes. The study used a randomised encouragement design (RED), which avoids the potential problem of selection bias that pervades non-experimental evaluations. Globally, this is the first large-scale experiment on the effectiveness of PASS or related Supplemental Instruction programmes. The study population consists of 6954 student subject observations from 14 first-year courses at the University of Wollongong in Australia in 2014 and 2015. Following the RED approach, a randomly selected sub-group was offered a large, near-cash incentive to participate in PASS. Whilst PASS participation is voluntary and unrestricted, participation was 0.47 sessions (19 percent) greater for the incentivised group compared to the non-incentivised group. This inducement effect is larger for students from low-SES areas (0.89 sessions). But the overall inducement effect is smaller than anticipated, which limits the statistical power of the main analysis, especially for subgroups. We also varied the size of the incentive greatly between semesters, but this did not meaningfully change the size of the inducement effect. The design of effective incentives for

student populations warrants further research. The experiment suggests that one hour of PASS improved grades by 0.065 standard deviations (1.26 marks on a raw 100-point scale), which is consistent with the non-experimental literature. However, this estimate is not statistically significant, reflecting limited statistical power. The estimated effect is largest and statistically significant for students in their first semester at university (0.153 standard deviations or almost 3 marks per hour of PASS). This particular sub-group analysis was not in our preanalysis plan, and so it should be treated as a suggestive—rather than a confirmatory—result. Nevertheless, it remains plausible given issues around transitioning into a university environment, including the more independent, self-directed study skills and time management required in tertiary study, as well as the need for structure and social support. We had intended to study heterogeneity of effects for a number of other subgroups (by socioeconomic status, rural and indigenous backgrounds, age, sex, domestic/international status, and high school grades), but this was not feasible because of limited statistical power.

Paloyo, A. R. (2015). A note on evaluating Supplemental Instruction. *Journal of Peer Learning*, 9(1), 1-4. Available online: <http://ro.uow.edu.au/ajpl/vol8/iss1/2/>.

Selection bias pervades the evaluation of Supplemental Instruction (SI) in non-experimental settings. This brief note provides a formal framework to understand this issue. The objective is to contribute to the accumulation of credible evidence on the impact of SI. The evaluation of PASS or SI based on experimentally-generated data is rare. The majority of the literature on the topic relies on evidence obtained from non-experimental approaches that fail to account for the presence of self-selection bias. This note discusses how this bias causes problems in impact evaluation. The hope is that education researchers, especially those who are interested in estimating the impact of SI, can use this note to justify the use of experimental or quasi-experimental methods and to enable them to be critical of weak evidence. Ultimately, this will enable education researchers to contribute to a larger body of credible evidence on the impact of SI on a number of interesting outcomes.

Paloyo, A. R., Rogan, S., & Siminski, P. (2016). *The effect of Supplemental Instruction on academic performance: An encouragement design experiment*. University of Wollongong, Wollongong, Australia. Available online:

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2728609

While randomized controlled trials (RCTs) are the "gold standard" for impact evaluation, they face numerous practical barriers to implementation. In some circumstances, a randomized-encouragement design (RED) is a viable alternative, but applications are surprisingly rare. We discuss the strengths and challenges of RED and apply it to evaluate a mature Supplemental Instruction (SI) or PASS (Peer Assisted Study Session) program at an Australian university. A randomly selected subgroup of students from first-year courses. A randomly selected subgroup of students from first-year course ($n = 6954$) was offered large incentives (worth AUD 55,000) to attend PASS, which increased attendance by an estimated 0.47 hours each. This first-stage (inducement) effect did not vary with the size of the incentive and was larger (0.89) for students from disadvantaged backgrounds. Instrumental variable estimates suggest that one hour of PASS improved grades by 0.065 standard deviations, which is consistent with the non-experimental literature. However, this estimate is not statistically significant, reflecting limited statistical power. The estimated effect is largest for students in their first semester at university.

Pappas, J. G. (1997, 1997, June 5). Pappas praises Supplemental Instruction program, *Central Washington University Observer*, p. 5.

This newspaper article by the Dean of Academic Services at Central Washington University describes the use of Supplemental Instruction (SI) program at the institution. The data from the

institution suggest that SI participants earn higher mean final course grades. A higher than estimated number of students (69 percent) participate in the program.

Paramore, T. L. (2007). *Developmental/remedial sciences at community colleges in five states in the central part of the United States*. (Ph.D. dissertation), University of Nebraska-Lincoln, Lincoln, NE.

This dissertation study investigated the use of remedial- and developmental-level academic support services for students enrolled in science courses at the community college level. Among the services noted was Supplemental Instruction (SI) which was offered for some science courses such as in introductory anatomy, chemistry, and physics courses.

Parkinson, N. (2009). The effect of peer assisted learning support (PALS) on performance in mathematics and chemistry. *Innovations in Education & Teaching International*, 46(4), 381-392. Supplemental Instruction has a long history of effective use in third level education in the United States. However, there are few rigorously controlled studies in which the potentially confounding effects of student aptitude and experience and of 'volunteer effects' have been controlled. Analysis of the effects of peer assisted learning in the context of the higher educational system of the UK and Ireland is relatively sparse, with few rigorously controlled studies, and it is therefore difficult to quantify its impact. The researcher carefully conducted a controlled study of the effects of peer assisted learning by second year students with first year students. Prior to tutoring, the tutored and non-tutored groups were very evenly matched. However, after one semester of tutoring there were substantial and significant differences between the tutored and non-tutored students. The tutored students progressively increased their performance at in-house tests in calculus compared to the untutored students, their examination marks in chemistry and calculus substantially improved (>13%) and failure rates were cut dramatically. Student progression was substantially improved.

Parsons, E. A. (2012). *What and how university student leaders learned in one peer education program*. (Master of Education thesis), Queen's University, Kingston, Ontario Canada. The purpose of the study was to explore what and how university students learned from their experiences working as peer educators. In my study, the researcher was only interested in investigating peer educators working in formal peer education programs within the post-secondary setting. Supplemental Instruction was the program identified for this study. Learning was defined as "a comprehensive, holistic, transformative activity that integrates academic learning and student development" (italics in original, ACPA & NASPA, 2004, p. 2). A modified version of the CAS 2009 learning outcomes framework was used to understand what peer educators learned. Those six CAS learning outcomes are: knowledge acquisition, construction, integration, and application; cognitive complexity; intrapersonal development; interpersonal competence; humanitarianism and civic engagement; and practical competence. The researcher used a qualitative, descriptive, exploratory approach to the study of the content and context of peer educators' learning. Selected participants for my study came from a pool of peer educators of a student affairs' learning assistance peer education program at a mid-sized Ontario university. Face-to-face, in-depth interviews were conducted with seven peer educators. The research revealed what peer educators in a single peer education program learned; it also provided insight into their experience of learning within the peer education program, i.e., how they learned. This study offers some insight into the potential for learning, as well as potential facilitators of learning, in the university peer educator role. The research findings indicate that the peer educators studied learned in each of the six CAS learning outcomes. The facilitators of learning that these peer educators described in their interviews include learning from experience, interactions with others, reflection, and training. The findings of the study suggest that further research could be conducted, at various institutions as well as within and across

peer education programs. SI leader reflections included: debrief with SI staff after observation of their SI session, periodic written reflections following writing prompts from the SI staff, and a detailed written reflection at the end of the academic term.

Parton, S., & Noad, V. (2013). PAL leader training at Bournemouth University: 12 years on and still evolving. *Journal of Pedagogic Development*, 3(2).

Peer Assisted Learning (PAL) at Bournemouth University in the United Kingdom has been operating for more than a decade. This journal article describes the history of the program with the majority of the text dedicated to a detailed overview of the training of the PAL leaders. The article finished with a report of the positive evaluation of the training program by the participants. PAL is a name used in the United Kingdom to describe similar programs that were based on the Supplemental Instruction (SI) model from the University of Missouri-Kansas City.

Pascarella, E. T., & Terenzini, P. T. (Eds.). (2005). *How college affects students: A third decade of research*. San Francisco: Jossey-Bass

On pages 106, 107, 399, and 400 the authors discuss the research studies that have analyzed the effectiveness of Supplemental Instruction (SI). Using published standard deviations from previous research studies, the authors conducted a rough meta analysis of SI. They found that the analysis suggested the effectiveness of SI.

PASS. (n.d.). PASS National Centre Web Site, Available online:

<http://www.pass.manchester.ac.uk/>

The National Centre for PASS (Peer Assisted Study Sessions)/SI (Supplemental Instruction) was established in April 2009 to support HEIs to further understand and develop programmes in the United Kingdom. PASS provides a facilitated, group learning opportunity that uses the experiences of higher year students to support the learning of lower year peers. This supplements existing activity (e.g. lectures and tutorials) and enables active learning in an informal, friendly and fun environment. Working with existing and previous PASS Leaders, the National Centre has produced a short clip to explain a bit more about PASS - let us know what you think.

Patt, G. R. (1996). The best way to learn is to teach. *Biosource*, 4(2).

This article describes the use of Supplemental Instruction (SI) as a form of peer-group instruction in biology at Southern Illinois University at Edwardsville. SI leaders report benefits for them since it helps them to prepare for comprehensive examinations such as MCAT or GRE as well as developing teaching skills. Data from Fall 1995 reports that those who attended SI session four or more times earned a mean final course grade of a low B, those who attended one to three times earned a C, and those who did not attend any SI sessions earned a high D grade.

Patterson, L. (2004). Worldwide success. *Perspectives News Magazine of the University of Missouri-Kansas City*, 12(1), 3-7.

This article provides a short overview of the Supplemental Instruction (SI) model and its dissemination to institutions throughout the U.S. and in other countries.

Payton, J., & Overly, C. (1994). Supplemental Instruction and physical geology. *Supplemental Instruction Update*, 1, 3.

This article provides an overview of the use of Supplemental Instruction (SI) in a Physical Geology course at Western Michigan University. This course has served as a "gatekeeper" course for students who are considering geology as a major. Frequently cited SI session activities included: vocabulary development/review; ask group to assist with generating SI

session agenda; create a visual matrix to help organize information; frequently use the "informal quiz" to check for comprehension level of SI participants; and create opportunities for students to connect lecture material to SI participants' lives.

Peacock, M. L. (2008). *A program evaluation of Supplemental Instruction for developmental mathematics at a community college in Virginia*. (Ph.D. dissertation), Old Dominion University, Norfolk, VA. Available online https://digitalcommons.odu.edu/efl_etds/184/

With the current emphasis on accountability and the importance of math skills in our present economy, the success of developmental mathematics students at community colleges is critical. How to improve the success of these developmental students has become the impetus for many educational initiatives. One educational innovation in tutoring, called Supplemental Instruction (SI), has been successfully applied to high-risk courses which are defined to have a failure rate in excess of 30%. Mid-Atlantic Community College, in its Title III grant which seeks to improve the success of developmental students, selected Supplemental Instruction (SI) as its initiative. This program evaluation investigated the effects of SI on the learning gains, persistence, course completion, metacognitive and study skills of the developmental math students at Mid-Atlantic Community College. Qualitative and quantitative methods were used in this research study. The researcher confirmed that the application of SI to developmental math at the community college did positively impact students' learning gains, persistence, and course completion when comparing SI classes to non-SI classes. The MSLQ revealed a positive impact in the areas of help-seeking and organization for SI students. The researcher also found a much larger withdrawal rate during the semester among non-SI students. The program evaluation revealed some aspects of the SI program that were not fully implemented. Near significance suggests that further investigations would be indicated in course completion rates and college persistence in a study with a larger sample size. Also, the MSLQ should be given as a pre-test with the students given feedback on how to improve their metacognitive and study strategies. Additionally, the effect on student performance of scheduling of a mandatory SI session each week should be investigated. While much of the research on SI has been performed at four year colleges and in non-developmental courses, this study confirmed that SI can make a difference in the lives of developmental students at the community college level. The leadership of the community college is interested in the success of their developmental students and their retention, as well as the impact that SI could have on many other high risk courses.

Pelaez, K., Levine, R. A., Fan, J., Guarcello, M. A., & Laumakis, M. A. (2019). Using a latent class forest to identify at-risk students in higher education. *Journal of Educational Data Mining*, 11(1), 18-46. Available online:

<https://jedm.educationaldatamining.org/index.php/JEDM/article/view/283>.

Higher education institutions often examine performance discrepancies of specific subgroups, such as students from underrepresented minority and first-generation backgrounds. An increase in educational technology and computational power has promoted research interest in using data mining tools to help identify groups of students who are academically at-risk. Institutions can then implement data-informed decisions to help promote student access, increase retention and graduation rates, and guide intervention programs. We introduce a latent class forest, a latent class analysis and a random forest ensemble that will recursively partition observations into groups to help identify at-risk students. The procedure is a form of model-based hierarchical clustering that relies on latent class trees to optimally identify subgroups. We motivate and apply our latent class forest method to identify key demographic and academic characteristics of at-risk students in a large enrollment, bottleneck introductory psychology course at San Diego State University (SDSU). A post hoc analysis is conducted to measure the efficacy of Supplemental Instruction (SI) across these groups. SI is a peer-led academic intervention that targets historically challenging courses and aims to increase student performance. In doing so,

we are able to identify populations that benefit most from SI to guide program recruitment and help increase the introductory psychology course success rate.

Peled, O. N., & Kim, A. C. (1995). *Supplemental Instruction in Biology at the college level*. Conference Proceedings of the 19th Annual Conference of the National Association for Developmental Education, Chicago, IL. Available online: ERIC database. (ED394414). Supplemental Instruction (SI) in 14 biology classes at National Louis University (Chicago, IL) was found to significantly increase student achievement (74.1 percentile vs. 67.6 percentile for non-SI participants). An additional analysis studied students with low grades (below the 60th percentile) and high grades (above the 80th percentile). SI attendance was positively correlated with higher grades. Many of the SI leaders in biology have been students intending to major in elementary education.

Peled, O. N., & Kim, A. C. (1996). Evaluation of Supplemental Instruction at the college level. *The Learning Assistance Review*, 1(2), 23-31. Available online: ERIC database. (ED410777). This article analyzed the Supplemental Instruction (SI) model as it was used in 14 sections of the same high-risk biology course between Winter 1990 through Winter 1993 at National-Louis University (Chicago, IL) which is a multicultural, multiethnic university campus. Rather than reviewing a comparison of SI and non-SI attendees within the same class, the comparison was the academic performance of students in classes that had SI available and classes that did not. The researchers believed that this was another way to help control for the possible effects of student motivation. Examination grades indicated that the average grade of students in classes that had SI sessions was significantly higher than that of students in classes where SI sessions were not offered (scale 0 to 100: SI classes, 74.1 percentile vs. 67.6 non-SI classes, $p < .05$). Within classes that had SI sessions offered for students, SI participants earned a final course grade 12 percent higher than non-SI participants. In classes in which an SI leader was available, the number of students receiving grades below 60 percent decreased; whereas, the number of students receiving grades above 80 percent increased.

Peoples, D. M. (1993). *Supplemental Instruction: Is it effective?* (Master of Arts thesis), Rowan College of New Jersey, Rowan, NJ. This Master of Arts Thesis studied the impact of Supplemental Instruction (SI) in 1991-1992 with fifteen 7th and 8th grade junior high school students with a disability enrolled in Overbrook Junior High School of the Lower Camden County Regional High School District Number 1 (NJ). The students were classified either Emotionally Disturbed, Perceptually Impaired or Neurologically Impaired. The students in the study were divided into three groups: those currently receiving SI (CSI) and are mainstreamed in all four of the core academic subject areas; those who previously received SI (PSI) and are mainstreamed in three of the subject areas and only receive resource room instruction; and those who never received SI (NSI) and are mainstreamed in two of the subject areas and only receive resource room instruction. The significance of this study is that SI provides another venue for students with a disability to be educated in the least restrictive environment and be mainstreamed with other students. Departing from the traditional SI model, the following modifications were made to the delivery of the SI program: (1) due to state regulations the SI leader in this study was a certified teacher of disabilities for grades N-12; (2) SI participants were limited to the "at-risk" students with a disability; and (3) due to state regulations the SI groups were limited to no larger than five students. The researcher noted that a common characteristic of SI for traditional college students and the high school students with a disability is that both populations had varying academic ability levels. The CSI students most of the time received higher final course grades than the PSI group, which in turn generally received higher grades than the NSI group. Interviews with parents suggested high satisfaction with the SI program and favored it over the

resource room instruction. Students also requested assistance more during the SI sessions than during the resource room instruction. The researcher suggested that the smaller size of the SI sessions in comparison with the resource room instruction was less threatening for students to reveal their needs.

Perrone-Saneski, C. (1984, 1984, May 13). Course sharpens freshmen's reasoning skills, *Troy Times Newspaper*, p. 1.

This newspaper article provides an overview of the Supplemental Instruction (SI) program. The article contains an interview with Deanna Martin, SI's creator. According to Martin, as many as 50 percent of college freshmen do not have the learning skills necessary to understand their coursework since they lack advanced reasoning skills. Martin was in Albany, NY presenting a seminar sponsored by the ACT National Center for the Advancement of Educational Practices concerning the use of SI in improving academic performance of students.

Peterfreund, A. R., Rath, K. A., Xenos, S. P., & Bayliss, F. (2008). The impact of Supplemental Instruction on students in STEM courses: Results from San Francisco State University. *Journal of College Student Retention*, 9(4), 487-503.

This article reports a research study concerning Supplemental Instruction (SI) at San Francisco State University. The focus was on students enrolled in science, technology, engineering, and mathematics (STEM) academic degree programs. Data was collected for these students who enrolled in General Chemistry 1, Introduction to Biology 1, introductory statistics, Calculus 1, and/or Calculus II. The study examined students over a six-year time period and found that SI participants earned higher grades and progressed through subsequent courses in an academic sequence more efficiently. High grades for STEM students is especially important since passing grades are insufficient to maintain standards for academic progress. These positive findings occurred despite the SI participants having an average lower academic profile than the nonparticipants. More females participated in SI than their proportion in the class. Male students and students from historically-underrepresented groups in college benefited the most, especially in introductory courses.

Peters, C. B. (1990). Rescue the perishing: A new approach to Supplemental Instruction *The Changing Face of College Teaching* (pp. 59-68). San Francisco, CA: Jossey-Bass, Inc. Available online: ERIC database. (ED344539).

This chapter describes an experiment of providing an a modified version of the Supplemental Instruction program at the University of Rhode Island (Kingston, RI). The author is an associate professor of sociology and anthropology. Rather than hiring student SI leaders to facilitate the SI sessions, the course professor performs the task. According to the author, these out-of-class sessions appear similar to ones facilitated by student leaders. Participating students report satisfaction with the sessions.

Phelps, J. M. (2005). *Supplemental Instruction in a community college developmental mathematics curriculum: A phenomenological study of learning experiences*. (Ph.D. dissertation), University of Central Florida, Orlando, FL.

This research study used a phenomenological approach at a community college to identify factors that motivated students' attendance and subsequent learning experiences in Supplemental Instruction (SI) sessions that supported developmental mathematics courses. Interviews were held with both SI participants and the SI leaders. Additional data was gathered through a Multiple Intelligence Inventory. The data suggested eight themes of motivation for students participating in the voluntary SI sessions and nine themes characterized the types of learning experiences that occurred in the SI session. SI was found to be a significant factor in academic achievement in the developmental mathematics courses. Findings suggest that SI

helps create a climate of achievement for learners taking developmental mathematics in a community college setting.

Phelps, J. M. (2007). *A key strategy for Achieving the Dream (AtD): Adapting Supplemental Instruction (SI) to the developmental mathematics setting*. Unpublished manuscript. Valencia Community College. Florida.

This PowerPoint presentation describes how the Supplemental Instruction (SI) model has been incorporated with the Achieving the Dream program at Valencia Community College (FL) to increase success of students in developmental mathematics.

Phelps, J. M., & Evans, R. (2006). Supplemental Instruction in developmental mathematics. *The Community College Enterprise (formerly Michigan Community College Journal)*, 4(6).

After an extensive review of the professional literature concerning Supplemental Instruction (SI), especially among community colleges, the article focuses on its use at Valencia Community College in Orlando, FL during 2003 and 2004. Results included: increase in completion rate of the course (52% vs. 35%); higher final course grade (2.57 vs. 2.22; SI participants reported a lower level of test anxiety; and SI participants reported a higher level of confidence in their abilities. The article concludes with identifying new avenues for investigation of the SI model, especially with a deeper understanding of student motivation.

Phillips, K. (1995). *Supplemental Instruction in Australia*. Unpublished manuscript. The University of Missouri-Kansas City. Kansas City, MO.

This report records the observations by a staff member from the National Center for Supplemental Instruction (SI) located in Kansas City, MO during her professional development leave in Australia in the first half of 1997. The author records her observations concerning the SI programs operating at Queensland University of Technology, University of Southern Queensland, and the University of Western Sydney-Nepean. Some of the adaptations of the SI model frequently used with Australian higher education include: use of multiple SI leaders in a single class, SI leaders work in pairs during SI sessions, and the SI program is usually decentralized on campus. Often the course lecturer selects, hires, trains, evaluates, and supervises the SI leader. This administrative procedure encourages higher involvement of the lecturer in the SI program. A drawback mentioned by the author is that this responsibility is added due to heavy work demands placed upon the lecturer for other responsibilities. There is continuing discussion with Australian educators regarding the strengths and challenges with a decentralized SI administrative structure.

Phillips, K. (1999). *Proceedings of the First National Conference on Supplemental Instruction/VSI*. Kansas City, MO: Center for Academic Development, University of Missouri-Kansas City.

This set of conference proceedings provides an overview to the First National Conference on Supplemental Instruction/VSI here in Kansas City, MO in May 1999. Articles include: SI, an effective program within student affairs, Edit Kochenour and Kenneth Roach; Get creative, working with SI data, Jeanne Wiatr and Barbara Stout; SI supporting quality in higher education in the United Kingdom, Jenni Wallace; Managing an expanding program or SI empire, Valeric Merriwether; Supplemental Instruction with math study skills templates, Paul Nolting and Kimberly Ruble; SI down under, Australian innovations, Martin Murray; Distance PALS in real and virtual classes, Judith Couchman; SI leadership and personal growth, a South African perspective, Linda Smith; Discipline-specific SI strategies for writing, Sandra Zerger; VSI, partnerships, and the transformation of education in South Africa, Paul Du Plooy and Cathy Clark; and SI leaders, the real winners, Maureen Donelan.

Po, Y. K. (2004). *An evaluation of a Supplemental Instruction program*. (Master's of Arts thesis), University of Hong Kong, Hong Kong. Available online: <http://hub.hku.hk/handle/10722/31605> Supplemental Instruction (SI) has been introduced at the University of Hong Kong. The focus for this masters' thesis was on the usefulness of SI with a business statistics course during 2003 and 2004. The study involved both a comparison of SI and non-SI participant grades as well as semi-structured interviews and observations to further evaluate the utility of SI. While there was no improvement in final course grades, interviews with the SI participants revealed the following themes: more opportunities to discuss the course, increased confidence in the subject matter, and reduced test anxiety.

Podolsky, T. (2017). Building leadership skills: A small cohort study of the associated benefits of being an SI leader. *Supplemental Instruction Journal*, 3(1), 6-23. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

Since the inception of Supplemental Instruction study groups in 1973, the benefits for student participants have been thoroughly studied and reported. There have also been reports about the associated benefits that SI Leaders can acquire from being involved with the program as peer mentors; however, these claims remain primarily anecdotal, and there has been a minimal amount of research conducted on the actual nature of the benefits for SI facilitators (Couchman, 2009). This research project aims to discover the specific nature of the benefits to SI Leaders who have moved on to other academic programs or professional careers. The research was conducted by surveying 24 former SI Leaders and through two focus groups consisting of 5 former Leaders in total. The results indicate that the SI Leaders benefitted by improving their own study skills in a variety of ways, improving their communication skills, increasing their self-confidence when public speaking, developing both their appreciation of and their ability to work in group situations, increasing their capacity to be flexible and adaptable, and improving their teaching abilities. Although these skills are not necessarily taught or learned through typical course work, they are highly valuable in graduate and professional programs, and workplaces often covet employees who already have many of these "leadership" skills. By placing a greater focus on the leadership development aspects of SI programming, this research study provides concrete evidence that there are tangible benefits for SI Leaders themselves, which confirms the value of SI programming beyond the more established benefits for student participants.

Podolsky, T. (2018). Building leadership skills: A small cohort study of the associated benefits of being an SI leader. *Supplemental Instruction Journal*, 3(1), 6-23. Available online: <https://info.umkc.edu/si/wp-content/uploads/2017/12/Compressed-siJ-Volume-Three-Issue-One.pdf>.

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often covet employees who already have many of these “leadership” skills. By placing a greater focus on the leadership development aspects of SI programming, this research study provides concrete evidence that there are tangible benefits for SI Leaders themselves, which confirms the value of SI programming beyond the more established benefits for student participants.

Pollock, K. (2005). Tracking D, F, and W students could bring at-risk students, classes to light. *Enrollment Management Report*.

Supplemental Instruction (SI) is identified as an effective program for increasing academic success of at-risk students.

Porter, R. C. (2010). The effects of supplemental instruction on student achievement in College Algebra. *Georgia Journal of Science*, 68(3), 124-131. Available online:

<http://www.freepatentsonline.com/article/Georgia-Journal-Science/236983055.html>.

College Algebra consistently has a very high number of students performing poorly. An experimental study addressing student performance was conducted. Two College Algebra classes each with 25 students and with the same teacher were used, one as the control group and the other as the experimental group. The experimental class included mandatory Supplemental instruction (SI) for an extra class period per week. T-tests were used to compare performances on each test and homework. A Repeated Measures 2x2 ANOVA was used to compare the students' performance on a pre-test and a post-test between each class. The Mann-Whitney U-test was used to compare final grade distributions. The results of the T-tests were not significantly different. The results of Repeated Measures 2x2 ANOVA indicate that there was not a significant difference between the two classes' performance. Finally, the Mann-Whitney U-test showed that there was not a significant difference between the final grade distributions.

Porter, R. C., Ofodile, C., & Carthon, J. (2015). Redesigning college algebra for success: An analysis of student performance. *Georgia Journal of Science*, 73(2), Article 5. Available online: <http://digitalcommons.gaacademy.org/cgi/viewcontent.cgi?article=1168&context=gjs>.

A section of College Algebra was redesigned to consist of best practices in instruction and assessment, a lower enrollment, and a required lab component in an effort to improve student performance. This pilot course consisted of instructional methods such as whole class instruction, small group instruction, and student presentations. Additional course revisions included a writing component using personal reflections, an additional lab component, a software package aligned with the adopted textbook, and bi-weekly progress reports. There was a statistically significant increase from pretest to posttest, as determined by a T-test. Other comparative analyses showed the course had the highest passing rate in the department. This class had the highest average on the departmental final exam. The faculty member teaching the course also had a higher passing rate when compared to courses she taught during previous semesters. According to these results based on student performance, this course was deemed successful.

Potts, S. A. K. (1998). Impact of mixed method designs on knowledge gain, credibility, and utility of program evaluation findings [Dissertation, Arizona State University, 1998]. *Dissertation Abstracts International*, 59(06), 1942A.

This dissertation study attempted to understand the relationship between evaluation approach and the perceived knowledge gain, credibility, and utility of findings. Specifically, the researcher investigated whether or not quantitative, qualitative, and mixed-method evaluations produced different kinds and amounts of knowledge gain, different levels of credibility, or suggested different types of use. To investigate this question, the researcher selected a group of consumers of evaluations, presented them with three simulated evaluation case summaries,

and interviewed them for their reactions. Participants included ten administrators from academic success and student service programs at Arizona State University. The evaluation case summaries were of a study counseling center, a summer transition program, and a Supplemental Instruction (SI) program. Each summary highlighted the evaluation's purposes, research questions, data collection methods, findings, conclusions, and recommendations. Participants ranked the mixed-method summary the highest in knowledge gain because it portrayed the most comprehensive picture of program participants, processes, and outcomes. The mixed-method summary was ranked the highest in credibility because it allowed participants to experience the program through the eyes and voices of the students. Participants also ranked the mixed-method summary the highest in utility since it prepared them for such internal administrative responsibilities such as strategic planning, high stakes decision-making, and programmatic improvement. Even though SI was not the primary focus of this study, the findings illustrate the need for careful evaluation of SI programs. The research suggests that SI program administrators should use the mixed-method evaluation system to provide the most helpful and convincing data for policy makers.

Power, C. (2010). Peer Assisted Study Sessions (PASS) through a complexity lens. *Australasian Journal of Peer Learning*, 3(1), 1-11. Available online: <http://ro.uow.edu.au/ajpl/vol3/iss1/2>.

This study investigates Peer Assisted Study Sessions (PASS), a commonly used term when describing implementation of Supplemental Instruction (SI) in Australia. This paper suggests complexity theory provides a useful conceptual lens for analyzing this multifaceted peer learning program. Dimensions of complexity such as self-organization, fractality, dynamism and emergence offer ways of deeper understanding of the SI/PASS model. The author argues that deeper understanding of the underlying theory and essential components of SI/PASS help when making adaptations of the model to meet needs.

Prendi, L. (2011). Strategic priority funding: Foundational Mathematics Instruction (62-140), Available online: [http://web4.uwindsor.ca/units/researchEthicsBoard/studyresultforms.nsf/b16c81cd4c873b9085256f31005fff04/e3ea0dc1d2041237852579650076f8a2/\\$FILE/Report_23Sept2011.pdf](http://web4.uwindsor.ca/units/researchEthicsBoard/studyresultforms.nsf/b16c81cd4c873b9085256f31005fff04/e3ea0dc1d2041237852579650076f8a2/$FILE/Report_23Sept2011.pdf)

The paper describes the use of Supplemental Instruction at the University of Windsor in Canada in a math course. It can be concluded that the historical trends indicate an increase in student performance and drop in failure rates on the first semester of SPF implementation. However, the results were not maintained in the second semester. It is not clear at this point which factors affected the trend of the results in the second semester. Pre and post-survey results indicate an increase in computational and calculus skills. The increase was statistically significant overall and specifically for the group of students that participated in both pre and post-surveys. However, the majority of those students got A's and B's and this fact should be considered in the analysis and when planning future surveys. If only good students participate in the survey than the data are not representative of the whole group. In general the results are very promising and indicate the potential that this project has in improving the students' success in foundational mathematics course.

Preszler, R. W. (2005). *Improving student's performance in a challenging biology course: Assessing specific components of Supplemental Instruction*. Unpublished manuscript. New Mexico State University. Las Cruces, NM.

This report describes the use of Supplemental Instruction (SI) in a biology course at New Mexico State University (Las Cruces, NM). The students enrolled in the course were provided SI sessions outside of class. In some of these sessions, a traditional SI model was used with it being a student-directed session. Another session was more teacher-driven. Another session

used a combination of both student- and faculty-driven sessions. The results for the students depended upon their academic preparation level. Students who were most underprepared did not benefit much from the SI experience, regardless of the orientation of the session. Students who had modest preparation benefited the most from the student-centered sessions. The sessions with students who had the most preparation benefited regardless of whether it was student- or teacher-centered.

Preszler, R. W. (2006). Student- and teacher-centered learning in a supplemental learning biology course. *Bioscene: Journal of College Biology Teaching*, 32(2), 21-25.

This article describes the use of an adapted version of Supplemental Instruction (SI) in a large biology lecture. With this experiment, students in the large biology course participated in one of several supplemental learning groups outside of the lecture sessions: (a) teacher driven sessions; (2) student driven sessions similar to SI; and (c) sessions that alternated the learning environment between teacher and student driven discussions. Students could voluntarily choose to enroll in a "Learning Biology" course that used one of the three previously described learning environments. The results were mixed for which of the three was best, however, it appears that this model with an optional course enrollment for the Learning Biology course yielded higher academic achievement for the participating students than a purely voluntary model which generally yields lower outcomes for the students. The researcher recommends further investigations with these models.

Price, J., Lumpkin, A. G., Seemann, E. A., & Bell, D. C. (2012). Evaluating the impact of Supplemental Instruction on short- and long-term retention of course content. *College Reading and Learning*, 42(2), 8-26.

At the University of Alabama at Huntsville a team evaluated the effectiveness of Supplemental Instruction with short- and long-term retention of course content. The researches tracked 75 students enrolled in an introductory psychology course. Results indicated the SI participants improved both types of retention of course content measured through course quizzes and major exams.

Price, M., & Rust, C. (1994). Introducing Supplemental Instruction in business courses in a modular programme. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 31-36). Birmingham, England: Staff and Educational Development Association

Oxford Brookes University in the United Kingdom is using the Supplemental Instruction program in the School of Business. SI was implemented with larger business courses (400 to 500 students) to enhance the learning environment for the students enrolled in these elective courses that are outside their field of study. Rather than paying the SI leaders, they were given academic credit for the experience. The research studies of students enrolled in the targeted courses suggested a positive correlation ($p < .05$) between SI participation (two or more times) and higher final course grades (Introduction to Business, 61.4 percentile vs. 56.2 percentile for non-SI participants; Managing Concepts, 60.7 vs. 54.6; and Changing Environment of Business, 56.6 vs. 46.2). The SI participants attracted a higher percentage of female and older students than represented in the total class.

Price, M., & Rust, C. (1995). Laying firm foundations: The long-term benefits of Supplemental Instruction for students in large introductory courses. *Innovations in Education and Training International*, 32(2), 123-130.

This article contains the results of the use of Supplemental Instruction (SI) to support student learning in business modules at Oxford Brookes University in the United Kingdom. The courses were selected due to their large size and the need to ensure mastery of course material that

was prerequisite for the next course in the sequence. Quantitative and qualitative studies in 1993-94 suggest that SI was beneficial in increasing mean final course grades in the courses supported by SI (Introduction to Business: 61.4 percentile for SI participants vs. 56.2 percentile for non-SI; Managing Concepts: 60.7 vs. 54.6; Changing Environment of Business: 59.6 vs. 46.4). Further analysis showed that there was no correlation between entry qualifications and performance in the classes. In comparison with non-SI participants, former SI participants earned mean final course grades that were higher in subsequent courses in the business sequence that did not have SI support provided (54.9 percentile for former SI participants vs. 48.8 percentile for former non-SI). This finding was confirmed through interviews with students who reported using learning strategies from SI sessions in other classes. This suggests that SI provided transferable benefits for additional courses in the sequence.

Priem, B. J., Chio, C., Boyce, H., Morris, S. A., Kaeli, E., Cole, T. B., . . . Reisberg, R. (2019). *A longitudinal study of the effects of pre-college preparation and use of Supplemental Instruction during the first year GPA and retention for women in engineering*. Conference Proceedings of the 126th Annual Conference and Exposition American Society for Engineering Education. Available online: <https://peer.asee.org/31969.pdf>

The purpose of this study was to evaluate the impact of factors including self-reported gender, first semester GPA, college credit earned in high school, participation in study abroad, major, and use of supplemental instruction (SI) on retention and academic success of 719 undergraduate students who enrolled in engineering during the fall of 2013 at Northeastern University. Our previous research has shown that use of SI in high school resulted in higher course grades and higher GPAs through a student's fourth semester. This study was undertaken to evaluate the impact of SI and other factors on retention and academic performance over a five-year period. Data for gender, pre-matriculation college credit, cumulative GPA, major, and registration status at the end of each semester from Fall 2013 through Summer 2018 were obtained from the University for 211 female and 508 male engineering students who entered at the start of the Fall 2013 semester. Data for participation in group and one-on-one tutoring was available from attendance logs for these forms of SI offered to first-year students. This information was analyzed for the effects of gender, number of college credits earned in high school, and participation in first-year SI on retention, graduation rate, GPA, and frequency of both change-in-major and study abroad after each semester. We found that male and female students' GPAs at the end of their first semester at Northeastern University correlated positively with not only their fourth semester GPAs, but also their graduation GPAs. Females had higher five-year rates of graduation, as well as higher mean GPAs at graduation compared to males. The amount of college credit earned in high school influenced students' academic performance in college. A lack of pre-matriculation college credit had a significant negative effect on males, with males without pre-college credit having lower retention and graduation rates and lower GPAs at every time point compared to their male peers who entered with college credit. In contrast, the retention and graduation rates, as well as GPAs of females without pre-enrollment college credit did not differ significantly from their female peers with credits. Overall, females used SI at higher rates than their male counterparts. Furthermore, females entering without college credit used first-year SI at markedly higher rates than their female peers who entered with college credit and male counterparts who entered with and without college credit. In summary, these results show a link between first semester GPA and graduation rates, demonstrate that college-level coursework taken during high school is correlated to college graduation GPA for males, and suggest that SI usage during the first semester of college by females without college credit may explain why females achieve higher levels of academic success throughout their undergraduate careers.

Prior, J. (2004). *Development of PAL Online: An analysis of the first part of a two-stage trial*. Unpublished manuscript. Oxford Brookes University.

This report abstract describes the use of Peer Assisted Learning (PAL) at Oxford Brookes University (England) in the Business School. PAL is an adaption of the Supplemental Instruction (SI) program. The researcher are studying the impact with online academic support though the use of PAL leaders. Their role would be slightly different with a shift towards being more interventionist and less of a facilitator. This trial will form the first stage of a two stage trial. Stage two will be the implementation of online discussion on a large core module next term. The ultimate aim of the research is to develop a model for PAL online that covers areas such as site design, PAL leader training and support, the needs of both participant and leaders and the potential benefits for both groups.

Pryor, S. A. (1990). The relationship of Supplemental Instruction and final grades of students enrolled in high-risk courses [Dissertation, Western Michigan University, 1989]. *Dissertation Abstracts International*, 50(07), 1963A. (University Microfilms, No. 8923554).

The purpose of this doctoral dissertation research study was to determine if there was a significant relationship between attendance at Supplemental Instruction (SI) and final course grades. Unlike some other studies that included SI leaders who were graduate students, community persons, or faculty members, this study only examined SI sessions that were facilitated by undergraduate students. The three science courses at Western Michigan University studied were Animal Biology, Plant Biology, and Introduction to Physics. Attendance at SI was significantly related to final course grades (4.0 grade point scale: 2.64 for SI participants vs. 2.27 for non-SI participants, $p < .002$), and students who attended SI earned significantly higher final course grades than students who did not attend SI. Even when final course grades were adjusted for composite ACT score, the SI group maintained the half letter grade positive difference. There was also a significant difference in the grade distribution of students who attended SI and students who did not attend SI. The rate of D, F and course withdrawals much significantly lower for the SI group (25% vs. 39%, $p < .05$). There was a positive correlation between higher levels of SI attendance and higher mean final course grades. Students who attended three or more SI sessions earned a full letter grade higher than the non-SI group (adjusted mean final course grades: zero SI attendance, 2.27; attended SI once or twice, 2.45; attended three to six SI sessions, 3.07; and attended SI sessions seven or more times, 3.10)

Quinn, K. B. (1990). *Retaining undergraduates and training graduates: A variation on Supplemental Instruction in a College Biology class*. Conference Proceedings of the 14th Annual Conference of the National Association for Developmental Education, Boston, MA.

This article described a retention program based on a variation of the Supplemental Instruction (SI) model piloted in the Academic Skills Program at the University of Illinois at Chicago. SI leaders were graduate students enrolled in the Masters of Teaching Science program at the university. The intent of the pilot program was not only to increase the academic performance of students and the number of students who completed Biology 102 -- one of the most difficult courses for non-majors at the university -- but also to provide a training experience for graduate students who were going into teaching science in the public schools and the community colleges. Research suggests that freshmen SI participants earned higher mean final course grades (3.23 vs. 2.90). Students who attended SI six or more times during the academic term received no lower than a final course grade of B. There was a positive correlation between SI attendance and higher grades (zero to five point scale): attended one SI session, mean final course grade of 3.16; attended two to five, 3.56; attended six to ten, 4.50; attended eleven to twenty-seven, 4.00.

Rabitory, E. R., Hoffman, J. L., & Person, D. R. (2015). Supplemental Instruction: The effect of demographic and academic preparation variables on community college student academic achievement in STEM-related fields. *Journal of Hispanic Higher Education*, 14(3). doi:10.1177/1538192714568808.

This study evaluated variables associated with academic preparation and student demographics as predictors of academic achievement through participation in supplemental instruction (SI) programs for community college students in Science, Technology, Engineering, and Math (STEM) fields. The findings suggest a differential impact of SI outcome for students based on gender and ethnicity. Furthermore, the study underscores the importance of evaluating the influence of academic achievement and student demographic variables when considering the development of SI programs on community college campuses.

Rabito, E. R., Hoffman, J. L., & Person, D. R. (2005). Supplemental Instruction: The effect of demographic and academic preparation variables on community college student academic achievement in STEM-related fields. *Journal of Hispanic Higher Education*. doi:10.1177/1538192714568808.

This study evaluated variables associated with academic preparation and student demographics as predictors of academic achievement through participation in supplemental instruction (SI) programs for community college students in Science, Technology, Engineering, and Math (STEM) fields. The findings suggest a differential impact of SI outcome for students based on gender and ethnicity. Furthermore, the study underscores the importance of evaluating the influence of academic achievement and student demographic variables when considering the development of SI programs on community college campuses.

Rabito, E. (2011). *Supplemental Instruction in STEM-related disciplines on a community college campus: A multivariate path-analytic approach*. (Ed.D dissertation), California State University, Fullerton.

This study evaluated the impact of a community college Supplemental Instruction (SI) program on academic achievement. The research assessed the relationship between student demographics and academic preparation to factors related to student participation in SI and academic achievement in Science, Technology, Engineering, and Mathematics (STEM)-related curriculum. The study evaluated an a priori model based on Astin's input, environment, outcome college impact model, utilizing a multivariate path analytic approach. Several input variables directly predicted academic success. Female students of color earned significantly lower final course grades and cumulative GPAs than did students not classified within this demographic. Both prior GPA and Math placement score predicted final course grade and final cumulative GPA for all students. Female students attended more SI sessions than did male students, and high GPA predicted increased SI attendance for all participants. Higher scores on the Math placement exam predicted decreased SI attendance. Several statistically significant relationships existed between environment variables and academic achievement. For students of color, enrollment in a class section with an SI leader of color and or a faculty member of color predicted increased academic achievement. White students enrolled in a course section with a faculty member of color experienced increased SI attendance and a small increase in academic achievement. With the exception of White students, enrollment in a class section with a female SI leader predicted increased SI attendance. With the exception of male students, students enrolled in a course section with a White SI leader experienced increased SI attendance. Increased SI attendance positively predicted academic achievement for all participant groups but particularly so for students of color. The results of the study provide researchers and practitioners with insight into the effective design, implementation, and evaluation of SI programs on community college campuses. These findings suggest that the gender and ethnicity of the student, faculty member, and SI leader have an impact on the SI environment for

community college students enrolled in STEM curriculum. More importantly, the findings imply that the establishment of a diverse SI environment is critical to the success of the diversified student body that characterizes the community college system of today.

Rachal, K. (2006). *The past, present, and future of Supplemental Instruction at Southeastern Louisiana University*. (Ph.D. dissertation), Southeastern Louisiana University, Hammond, LA. This thesis provides an in-depth look into the development and structure of the Supplemental Instruction (SI) program at Southeastern Louisiana University. The author had four years of experience as an SI leader, SI graduate assistant, and the current campus SI Coordinator.

Rafi, F., & Karagiannis, N. (2014). A comparative study of African-American males vs females at a minority institute of higher learning and the role of Supplemental Instruction. *Journal of Peer Learning*, 6(1), 76-85. Available online: <http://ro.uow.edu.au/ajpl/vol6/iss1/7>.

The purpose of this paper is to draw a comparison of high attrition rates among African-American males versus African-American females in higher education and examine the role of Supplemental Instruction (SI). The study was conducted at a minority institution (Winston-Salem State University) where African-American students are in the majority. For this study, data was utilised from Cooperative Institutional Research Program (CIRP) surveys, Accuplacer placement test scores of incoming freshmen populations, and academic assistance pursued through the SI Program by African-American male and African-American female students. Primary sources and available statistical information were also used. Comparisons were made between the study habits of African-American male and African-American female students and their implications for the retention rates of these students. These comparisons are presented in the findings section of the paper. Brief conclusions end the paper.

Ramirez, G. M. (1997). Supplemental Instruction: The long-term impact. *Journal of Developmental Education*, 21(1), 2-4, 6, 8, 10, 28.

This study addresses two questions about the impact of Supplemental Instruction (SI) on students in a large urban university (California State University, Long Beach): what academic performance benefit is realized beyond the target course supported by SI, and whether SI participation strengthens the persistence patterns of particular student populations. A unique feature of the SI program at Long Beach is that students enroll for a one-unit prebaccalaureate class to gain admission to SI sessions. In this way SI becomes a part of the student's weekly schedule and student participation is higher than programs where SI attendance is voluntary. Participants from various student groups were tracked for a period of 8 semesters beginning in Fall 91, and their performance and retention patterns were compared with those of control peer groups of nonparticipants. SI was found to have essentially an immediate impact (grade range: 4.0 to 0.0; target course: 2.86 vs. 2.27 and semester GPA: 2.77 vs. 2.49) on traditional students; however, it has a substantial impact on performance [2.52 vs. 1.82] and retention [70% vs. 51%] for special-admit students and a definite benefit for underrepresented or underprepared students. Low motivated students, as evidenced by their prior college performance, maintained consistent improvement after SI participation.

Ramirez, G. M. (1997). *Supplemental Instruction*. Conference Proceedings of the Proceedings of the 13th and 14th Annual Institutes for Learning Assistance Professionals: 1992 and 1993. Available online: http://www.lsche.net/?page_id=1201

This article provides a basic overview of Supplemental Instruction (SI). Data is reprinted from a 1983 research study by Drs. Martin and Blanc on the effectiveness of SI. The SI program was customized at California State University, Long Beach to more effectively target first-generation and economically-disadvantaged students for service. Participating students attended SI sessions on a weekly basis and received academic credit. Research studies from 1990 suggest

that students from less academically-prepared backgrounds benefitted twice as much as traditional students who attended SI. Results were highest in SI sessions where the SI leader emphasizes both content mastery and development of critical thinking/study skills in comparison with SI leaders who focused primarily on mastery of the academic course material.

Ramming, V. (1989). Supplemental Instruction: A proactive front loading model. *New Jersey Association of Developmental Educators Newsletter*, 1.

This newsletter article provides an overview of the Supplemental Instruction (SI) program.

Rapley, E. (2015). Reaping what you sow: How the University of Bedfordshire uses experienced Peer Assisted Learning (PAL) students to inspire and nurture future generations of PAL leaders. *Journal of Pedagogic Development*, 5(2). Available online:

<https://journals.beds.ac.uk/ojs/index.php/jpd/article/view/172/266>.

As staff awareness and understanding of Peer Assisted Learning (PAL) has continued to develop, a conscious decision has been made to hand over greater responsibility and ownership of PAL to the PAL Leader student team. PAL is based on the Supplemental Instruction (SI) model with a broader interest in holistic development of the students beyond just subject course competence. The success of any PAL initiative rests upon the quality of the PAL Leaders who facilitate the sessions. Motivated, committed and enthusiastic PAL Leaders are key to ensuring that engaging and meaningful sessions are provided for first year students. With our mission to ensure PAL Leaders truly benefit and develop themselves during their tenure, it was felt that this transformation could only take place if PAL Leaders really had opportunities to step up and take ownership of PAL.

Rath, K. A., Peterfreund, A. R., Xenos, S. P., Bayliss, F., & Carnal, N. (2007). Supplemental Instruction in Introductory Biology I: Enhancing the performance and retention of underrepresented minority students. *CBE-Life Sciences Education*, 6, 203-216.

Supplemental Instruction (SI) was used at San Francisco State University in an Introductory Biology I class. Participation in the voluntary SI program was beneficial and especially so for students who are underrepresented minority students in the sciences. Data was analyzed between 1999 and 2005 consisting of a pool of approximately 1,500 students in the classes where SI was offered. Following national averages, about one-third of the students participated in SI. The SI participants had higher outcomes in comparison with the non-SI participants: (a) proportion receiving a "C-" final courses or higher, 82% vs. 72%; (b) average final course grade, 2.29 vs. 1.99; (c) proportion ultimately graduating from SFSU, 67% vs. 59%. The SI participants reenrolled in the class multiple times by a slightly higher rate, 19% vs. 16%. In comparing the SI and non-SI participants, the SI participants had lower college entrance scores, lower high school graduation rank percentile, and higher rate of underrepresented student population in science majors. When comparing only the underrepresented students in the class, the results favored even more dramatically the SI participants: (a) earned final course grade of C- or higher, 80% vs. 55%; (b) average final course grade, 2.22 vs. 1.49; (c) proportion ultimately graduating from SFSU, 73% vs. 50%. The authors share several theories as to why SI was more beneficial to the underrepresented minority students including that they benefited the most since they had the most disadvantages to overcome in college due to their academic preparation in high school.

Rath, K. A., Peterfreundt, A., Baylisst, F., Runquist, E., & Simmonis, U. (2012). Impact of Supplemental Instruction in entry-level chemistry courses at a mid-sized public university. *Chemistry Education*, 89(4), 449-455.

This paper examines the impact of supplemental instruction (SI)—nonremedial workshops that support regularly scheduled courses—on four different chemistry courses: General Chemistry I

and II, and Organic Chemistry I and II. Differences in how SI impacts student performance in these courses are discussed, particularly in terms of whether students from underrepresented minority groups are affected differently from their peers. We found that SI appears to be most effective in courses at the beginning of the chemistry sequence and least effective in those in which students have already had to demonstrate effectiveness with the material in order to succeed in the course; its impact on performance in General Chemistry I appears to be quite high compared to a negligible impact in Organic Chemistry II. Impacts appear to be due to SI itself rather than the academic fitness of the students who opt to enroll in it. In the four courses examined, SI did not appear to have a different impact on students from underrepresented minority groups than it did on their peers.

Rath, K. A., Peterfreundt, A. R., Xenox, S. P., Baylisst, F., & Carnal, N. (2017). Supplemental Instruction in Introductory Biology I: Enhancing the performance and retention of underrepresented minority students. *CBE-Life Education*, 6(3). Available online: <https://www.lifescied.org/doi/full/10.1187/cbe.06-10-0198>.

Supplemental instruction classes have been shown in many studies to enhance performance in the supported courses and even to improve graduation rates. Generally, there has been little evidence of a differential impact on students from different ethnic/racial backgrounds. At San Francisco State University, however, supplemental instruction in the Introductory Biology I class is associated with even more dramatic gains among students from underrepresented minority populations than the gains found among their peers. These gains do not seem to be the product of better students availing themselves of supplemental instruction or other outside factors. The Introductory Biology I class consists of a team-taught lecture component, taught in a large lecture classroom, and a laboratory component where students participate in smaller lab sections. Students are expected to master an understanding of basic concepts, content, and vocabulary in biology as well as gain laboratory investigation skills and experience applying scientific methodology. In this context, Supplemental instruction classes are cooperative learning environments where students participate in learning activities that complement the course material, focusing on student misconceptions and difficulties, construction of a scaffolded knowledge base, applications involving problem solving, and articulation of constructs with peers.

Reck, L. (2019). *Neural networks for estimating individualized treatment effects in observational studies*. (M.S. thesis), San Diego State University, San Diego, CA.

The main goal of this thesis is to evaluate individualized treatment effects (ITE) using neural networks. The individuals are university students and treatment is defined as attendance in Supplemental Instruction (SI). The variable of interest is given by the grade at the end of the semester. So the main question of this thesis is, how much each individual student would improve by attending SI. Even though past data is available, each student can either attend SI, or not. Hence only the grade at the end of the semester for one of the two scenarios is known, such that the true ITE will always be unknown. Therefore statistical methods need to be implemented in order to estimate the ITE. While we consider several methods, the main focus lies on neural networks. A simulation study is used to evaluate the accuracy of the statistical methods developed. The methods are applied on artificially generated data, where the true relationship between the variables is known and the true ITE can be calculated. The simulation study showed that neural networks, along with random forest, performed best in estimating the ITE. Since individual neural networks showed quite a bit of variation, we used an averaging method to derive the final prediction model. The application data for this analysis contains several thousand observations, each describing one student. For each student, more than 20 covariates are available with both university related information, such as major or term GPA and personal information, such as gender and age. The main finding in this analysis is that students

with weaker academic background benefit more by services like SI. Furthermore, we may use pre-semester data such as high school GPA, campus GPA, and academic status to create an early warning system to encourage students into the SI program.

Reed, A. K. (2016). *Evaluating the effects of instructor-led mandatory Supplemental Instruction on student achievement in developmental algebra: A comparative study*. (Ph.D. dissertation), Northcentral University, San Diego, CA.

Students entering college often lack the prerequisite skills necessary for successful completion of the mathematics requirements for graduation and are frequently placed in developmental mathematics courses that do not receive college credit toward degree completion. High failure rates in introductory college mathematics courses across the US have been problematic for underprepared college students as well as for degree-granting higher education institutions. Recent budget cuts to education and the growing emphasis for increased graduation rates have made it necessary for college mathematics instructors to cover more content at a faster pace to allow students to complete the mathematics requirements needed for graduation in a timely manner. In an effort to help students cope with the rigors of higher education and complete their college degree program on time, college educators have focused on a variety of new teaching methods and support programs. Supplemental instruction (SI) is one academic support program for high-risk courses that has led to increased student performance, retention, and graduation rates. In traditional SI programs, students self-select to enroll in SI sessions that are led by one of their peers. While there are indications that more students succeed in courses that offer SI than those without SI, there is a marked lack of attendance and enrollment in the traditional voluntary peer-led SI programs. The purpose of this quantitative ex post facto two group comparative study was to determine if there was a significant difference in student achievement in developmental intermediate algebra courses who received no supplemental instruction (NonSI) and developmental intermediate algebra (Math 106) courses that had instructor-led mandatory Supplemental Instruction (ManSI) built into the course. The targeted population for this study was students placed in developmental intermediate algebra courses during the fall 2009 (NonSI) semester and the fall 2011 (ManSI) semester at State University of New York (SUNY) Canton, a small, rural state university in the northern part of New York State.

Reeve, A. (1989). Different approach to tutoring: Supplemental Instruction. *Aspirations: Association of Special Programs in Region Eight Newsletter*, 2, 1.

This newsletter article provides an overview of the Supplemental Instruction (SI) program with advantages of the SI model in comparison with traditional tutoring.

Reitinger, D. L., & Palmer, T. M. (1996). Lessons learned from using Supplemental Instruction: Adapting instructional models for practical application. *Research and Teaching in Developmental Education*, 13(1), 57-68.

This article describes the use of Supplemental Instruction to increase student academic achievement. A research study suggests that SI contributed to higher mean final course grades in an introductory psychology course (Psychology 110) over five semesters in seven sections. Several lessons learned included: SI provides professional development opportunities for the SI leader; SI attend may be negatively affected if the SI leader quits attending the class lecture sessions; students will not attend SI if the scheduled times are inconvenient; and requiring students to attend 90 percent of the SI sessions to receive extra academic credit from the course instructor results in less than ten percent of the students choosing to attend at that level.

Ribera, A. K., BrckaLorenz, A., & Ribera, T. (2012). *Exploring the fringe benefits of Supplemental Instruction*. Paper presented at the Association for Institutional Research Annual

Forum, New Orleans, LA. Available online:

<http://cpr.iub.edu/uploads/AIR%202012%20%28SI%20Final%29.pdf>.

Supplemental Instruction (SI) is an academic support program geared toward promoting engagement and effective study skills among students in “high-risk” courses. Despite knowledge of the positive relationship between SI and student achievement and retention, little is known about how SI relates to other forms of effective educational practices and what type of student populations are more or less likely to engage in SI. Using data from the 2011 NSSE, students that participated in SI experiences had significantly ($p < .001$) higher engagement, deep approaches to learning, and self-reported gains scores than students that had not participated in SI experiences. Effect sizes for these differences were noticeable, particularly for senior students. These findings suggest that SI experiences may contribute to important outcomes such as other forms of engagement and students’ perceptions of gains while in college.

Ricardo, J., Guide, V. G., Hanson, A., Auzenne, M., & Williamson, S. (2007). *Enhancing critical thinking skills of civil engineering students through Supplemental Instruction*. Paper presented at the American Society for Engineering Education Annual Conference, Honolulu, Hawaii.

Available online:

http://icee.usm.edu/icee/conferences/asee2007/papers/907_ENHANCING_CRITICAL_THINKING_SKILLS_OF_CI.pdf.

Supplemental instruction in civil engineering curriculum has been conducted at New Mexico State University since spring 2003. The SI session is designed to develop critical thinking skills of the students by applying collaborative learning methods. The SI session meets once per week to resolve student’s questions in the topics of domestic water and wastewater treatment. Prior to meeting in the SI session, students submit questions on the engineering and design concepts discussed within the previous week of class. Active learning in the classroom and self-directed learning outside of class create opportunities for the students to identify questions which can be resolved in the SI session. Students follow a set of steps to develop proper questions and find solutions to their own questions by applying critical thinking skills. The course also requires the students to exercise critical thinking skills as it involves design oriented open-ended problem solving. The student improvement through the SI sessions has been monitored for three consecutive semesters. Comparisons have been made between the SI group and non-SI group students in terms of academic performance throughout the semester. Bloom’s levels of learning have been considered to measure the student learning through critical thinking exercises. It has been observed that SI participants have performed better than others in monitoring work examples. Also the SI group earned better grades than the non-SI group in the class.

Rich, C. E., Williford, A. M., & Kousaleous, S. L. (1997). Supplemental Instruction at Ohio University: Improving student performance. In P. L. Dwinell & J. L. Higbee (Eds.), *Developmental Education: Enhancing student retention* (pp. 37-44). Carol Stream, IL: National Association for Developmental Education

This study of student performance compared final course grades of students who attended Supplemental Instruction (SI) study sessions with grades of those who did not attend SI study sessions during the period of Fall 1993 through Spring 1995. Results indicated that, with gender and aptitude controlled, students who attended SI study sessions generally finished the targeted course with higher grades than students who did not attend, and that frequent attendees completed courses with final course grades that were generally higher than infrequent or non-attenders. Students who most need academic support, as identified by lower aptitude scores, comprised a majority of attenders. Poor performance, early withdrawal, and failure rates were lower among SI attenders than among non-attenders for most courses in which SI was offered.

Richardson, S. (1994). How Supplemental Instruction came to Britain. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 15-16). Birmingham, England: Staff and Educational Development Association
The author describes the role of Dennis Congos -- a Certified SI Trainer -- in introducing the Supplemental Instruction model at Kingston University in the United Kingdom.

Richter, A. M., & Augdahl, J. (2003). *Supplemental Instruction for introductory chemistry courses at North Dakota State University*. Conference Proceedings of the 225th American Chemical Society National Meeting, New Orleans, LA. For more information, contact the authors at the Department of Chemistry, North Dakota State University, Fargo, ND 58105, amy.richter@nodak.edu

Supplemental Instruction (SI) is used at North Dakota State University to support students enrolled in challenging introductory chemistry courses.

Rizvi, T. (1988, 1988, September 23). Study with a buddy: Supplemental Instruction fills the learning gap, *Campus Report: The University of Dayton Newspaper*, p. 1.

This newspaper article describes the use of Supplemental Instruction (SI) in ECO 203 Microeconomics and ECO 204 Macroeconomics at the University of Dayton (OH).

Rizvi, T. (1997, 1997, June 16). Law students give each other help, reduce failure rate, *Campus Report: The University of Dayton Newspaper*, p. 1.

This newspaper article describes the use of an academic support program modeled after Supplemental Instruction (SI) with first-year law students at the University of Dayton (OH). Interviews with faculty members and students emphasized that the program was not about students being underprepared, rather it was to help students bridge into a different learning style. The failure rate for students of color involved in the program have dropped from 30 percent three years ago to 6.5 percent last year. The article also contains an interview with David Arendale from the University of Missouri-Kansas City where the SI program has been used for five years in the UMKC School of Law with similar positive results.

Rockefeller, D. J. (2003). An online academic support model for students enrolled in Internet-based classes [Dissertation, University of North Texas, 2000]. *Dissertation Abstracts International*, 63(09), 3095.

This doctoral dissertation from the University of North Texas describes a research study that examined the effectiveness of an experimental Supplemental Instruction (SI) program that utilized computer-mediated communication (CMC) rather than traditional SI review sessions. During the Spring 1999 semester, six sections of an introductory computer course were offered via the Internet by a suburban community college district in Texas. Using Campbell and Stanley's Nonequivalent Control Group model, the online SI program was randomly assigned to four of the course sections with the two remaining sections serving as the control group. The students hired to lead the online review sessions participated in the traditional SI training programs at their colleges, and received training conducted by the researcher related to their roles as online discussion moderators. Following recommendations from Congos and Schoeps, the internal validity of the groups was confirmed by conducting independent t-tests comparing the students' cumulative credit hours, grade point averages, college entrance test scores, and first exam scores. The study's four null hypotheses were tested using multiple linear regression equations with alpha levels set at .01. Results indicated that the SI participants earned better course grades even though they had acquired fewer academic credits and had, on average, scored lower on their first course exams. Both the control group and the non-SI participants had average course grades of 2.0 on a 4.0 scale. The students who participated in at least one SI

session had an average final course grade of 2.5, exceeding their previous grade point average of 2.15. Participation in one SI session using CMC was linked to a one-fourth letter grade improvement in students' final course grades. Although not statistically significant, on the average, SI participants had slightly better course retention, marginally increased course satisfaction, and fewer student-initiated contacts with their instructors.

Rodriguez, C. (2001, 2001, September 20). Southern Illinois University hopes new kind of teaching will make more students stay, *Daily Egyptian*.

This newspaper story describes the use of Supplemental Instruction (SI) at Southern Illinois University-Carbondale. Several students are interviewed for the story about the positive benefits of attending SI sessions.

Romoser, M. A., Rich, C. E., Williford, A. M., & Kousaleous, S. L. (1997). Supplemental Instruction at Ohio University: Improving student performance. In P. L. Dwinell & J. L. Higbee (Eds.), *Developmental Education: Enhancing student retention* (pp. 37-44). Carol Stream, IL: National Association for Developmental Education

This study of student performance compared final course grades of students who attended Supplemental Instruction (SI) study sessions with grades of those who did not attend SI study sessions during the period of Fall 1993 through Spring 1995 at Ohio University (Athens, OH). Results suggested that, with gender and aptitude controlled, students who attended SI study sessions generally finished the targeted course with higher grades and lower rates of withdrawal than students who did not attend, and that frequent attenders (five or more times per academic term in one course) completed courses with final course grades that were generally higher than moderate (two to four times) infrequent (one time only) or non-attenders. For example, during Fall 1994 the following results occurred for higher aptitude students: non SI, 2.55; infrequent, 2.55; moderate, 2.73; and frequent, 2.95. For lower aptitude students for the same academic term: non SI, 1.94; infrequent, 2.09; moderate, 2.27; and frequent, 2.41. Through student evaluations three factors emerged that influenced student attendance: (1) course content must be perceived as challenging, but manageable; (2) cooperating faculty member must endorse both the SI program, SI leader, and encourage students to attend SI; and (3) students must have some understanding of what SI is and what to expect at a study session. A locally-produced SI introductory video has been a helpful promotional tool, second only to participant endorsements.

Ross, T. (1995). *Report on Peer Assisted Study Sessions conducted in visual arts, second semester 1995: AASB726, Introduction to Art History*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This report discusses the use of Peer Assisted Study Sessions (PASS), the local institutional name for the Supplemental Instruction (SI) program with students enrolled in an Introduction to Art History course (AAB726). For several reasons, the grades of PASS and non-PASS students were nearly the same. The author suggests that part of the difficulty for the PASS program was that the PASS leaders did not attend class along with the other students. The course curriculum had undergone a significant change between when the PASS leaders attended the same class and when they attempted to provide academic assistance to the students. However, surveys found that PASS leaders found the experience very helpful: improved interpersonal skills (100%); improved learning skills (100%); developed facilitating skills (100%); and developed leadership skills (100%).

Rowe, J. A. (2019). *Synchronous and asynchronous learning: How online Supplemental Instruction influences academic performance and predicts persistence*. (Ph.D. dissertation), Capella University.

While supplemental instruction (SI) programs have garnered wide support in educational research literature and adoption in higher education, the impact of online Supplemental Instruction (OSI) remains unknown. Using the theoretical framework of social cognitive theory, this study compared the impact of synchronous OSI and asynchronous OSI on academic performance, and in terms of how OSI predicts persistence. The goal was two-fold: to consider if similar academic and persistence benefits predicted from SI extend to OSI, and to investigate how academic performance and persistence of students listening to asynchronous recordings might differ from students attending live synchronous OSI sessions. An ANOVA procedure was used to investigate academic performance, and a logistic regression procedure was used to investigate persistence to test two hypotheses with a sample of 1727 (N = 1727) online graduate students. Results were significant for both synchronous and asynchronous groups, indicating that OSI is comparable to SI in terms of having a positive impact on academic performance when compared to students with no OSI exposure. Persistence results were significant for OSI as a whole and specifically for students who attended synchronous OSI.

Rust, C., & Price, M. (1994). *Improving students' skills through Supplemental Instruction*. Conference Proceedings of the 2nd International Symposium on Improving Student Learning, Oxford, England.

Oxford Brookes University in the United Kingdom is using the Supplemental Instruction program in the School of Business. SI was implemented with larger business courses (400 to 500 students) to enhance the learning environment for the students enrolled in these elective courses that are outside their field of study. Rather than paying the SI leaders, they were given academic credit for the experience. The research studies of students enrolled in the targeted courses suggested a positive correlation ($p < .05$) between SI participation (two or more times) and higher final course grades (Introduction to Business, 61.4 percentile vs. 56.2 percentile for non-SI participants; Managing Concepts, 60.7 vs. 54.6; and Changing Environment of Business, 56.6 vs. 46.2).

Rust, C., & Wallace, J. (Eds.). (1994). *Helping students to learn from each other: Supplemental Instruction*. Birmingham, England: Staff and Educational Development Association
This monograph provides a comprehensive review of Supplemental Instruction in the United Kingdom: overview of SI; background of introduction of SI; use of SI for staff and faculty development; benefits of SI for both the students and the SI leaders; statistical research reports; and eight case studies illustrating the experience of implementing SI into British higher education courses.

Ruth, D. (1987, 1987, March 7). Education bill helped economy, *The Times Picayune*, pp. A-18. This newspaper article mentions that Supplemental Instruction (SI) is being used at the University of New Orleans with introductory courses in business administration, sociology and Afro-American culture. In these classes students are passing the courses at a rate of 73 percent. Before introduction of SI the pass rate was less than 50 percent.

Rye, P. D., & Wallace, J. (1994). Helping students to learn: Supplemental Instruction. *Student British Medical Journal*, 2, 79-80.

This short article provides an overview of Supplemental Instruction and its use with medical students.

Rye, P. D., & Wallace, J. (1994). Supplemental Instruction: A peer-group learning program for medical undergraduates. *Nordisk Medicin*, 109(11), 307.

This article describes the use of Supplemental Instruction (SI) with Norwegian undergraduate medical students. Various benefits of SI are described for the session participants: study strategies, life-long learning skills, and working in learning teams with other students.

Rye, P. D., Wallace, J., & Bidgood, P. (1993). Instructions in learning skills: An integrated approach. *Medical Education*, 27(6), 470-473.

The transition from school to university education and a medical school environment can be difficult for even the very best students. The article suggests that Supplemental Instruction (SI) would be useful to improvement academic performance of these students. Research studies from Kingston University (Surrey, England) in Computer Science, Electronics and Engineering are cited to suggest the Supplemental Instruction would also be helpful for medical students (62.3 percentile vs. 54.2 percentile for non-SI participants).

Sacdalam, N. (2017). Peer Assisted Study Sessions (PASS) benefit students in anatomy and physiology classes at Southern Adventist University. *Journal of Interdisciplinary Undergraduate Research*, 9, Article 3. Available online:

<http://knowledge.e.southern.edu/cgi/viewcontent.cgi?article=1057&context=jiur>.

Peer Assisted Study Sessions (PASS) is a program implemented at Southern Adventist University to lower drop, withdrawal, and fail rates. In these sessions, a student leader, who has excelled in previous sections of a particular class, help reinforce difficult concepts in hour-long meetings with currently enrolled students. Activities during PASS include worksheets, pretests and quizzes, games, and videos. In this paper, we discuss the methods used during PASS sessions within anatomy and physiology classes and present an analysis of the effect of PASS on academic performance in entry-level anatomy and physiology classes over two semesters (winter and fall of 2015) at Southern Adventist University. Our analysis showed that greater student attendance at PASS sessions predicted higher final grades while controlling for two other potentially confounding predictors of students success: high school GPA and ACT score.

Sagna, B. (2019). *Effectiveness of remedial mathematics Supplemental Instruction: A community college study*. (Ph.D. dissertation), Teachers College Columbia University, New York, NY.

The purpose of this mixed method study was to determine if there is a relationship between characteristics of supplemental instructors' personal traits, teaching skills, subject matter, constructive/active, collaborative learning, effective communication, and their practices (as judged by students) and student success in their remedial mathematics course. The college Provost was contacted by email to request an authorization to conduct this study in his college. Once approved, the investigator contacted face to face his colleagues to ask their students to participate in the study because they enrolled in a remedial algebra class where the instructor is assisted by a supplemental instructor (SI leader). Sixteen algebra classes were selected, and each were assisted by supplemental instructors. Students' scores on the pre-test (at beginning of the semester) and post-test (at the end of the semester) were collected to gauge their achievement on both tests. Students completed a questionnaire that asked about their perceptions about their Supplemental Instructors' personal traits, teaching skills, subject matter, constructive/active, collaborative learning, effective communication, and their practices throughout the semester. Students' mean scores difference on the post-test were higher in 62.5% of the sections than on the pre-test. The evaluation of achievement on both tests, the responses to the questionnaire and comments from students showed that SI leader's characteristics associated to effective communication/active learning, teaching skills, and personal traits could be contributor to score achievements. The linear regression in the study shows that the three factors did not significantly predict the post-test score. However, the pre-test did significantly predict the post-test score in a remedial Math 20 at the end of the semester

(Beta = .47, $t(197) = 6.56$, $p < .05$). In addition, the comments in the questionnaire found that students acknowledged their supplemental instructor role in the classroom and during the SI's weekly sessions.

Salame, I., & Nazir, S. (2019). The impact of Supplemental Instruction on the performance and attitudes of general chemistry students. *International Journal of Chemistry Education Research*, 3(2). Available online: <https://journal.uui.ac.id/IJCER/article/view/12570>.

Supplemental Instruction (SI) has been a successful implementation into institutions worldwide. It serves as a means of reducing attrition and increasing the overall learning of course material. The City College of New York (CCNY) has recently implemented SI to General Chemistry I courses to examine whether or not SI would help students succeed in the course and understand and grasp the course material better. SI was made available several times a week during flexible times to students who are struggling in the course. Our method of data collection is a Likert-type and open-ended questionnaire that was distributed at the end of each of the semesters to SI participants in an anonymous fashion. Furthermore, we compared the grades and performance of students participating in SI with those who did not. The collected data enabled us to examine the impact of implementing Supplemental Instruction (SI) in General Chemistry I at CCNY. Our data show that SI was beneficial, contributed to improving students' understanding of course material, and increased their success rate. About 80 percent of students who failed the first exam and participated in SI obtained a passing grade compared to 11 percent of those who did not.

Sandmann, B. J., & Kelly, B. K. W. (1979). *Effect of Supplemental Instruction on student performance in a pharmaceuticals course*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO.

This investigation sought to determine if Supplemental Instruction (S) would effect student performance in a physical pharmacy course at the University of Missouri-Kansas City. Mean scores on pretest, quizzes, first, second, and final examinations for the two groups (SI and non-SI participants) were compared by conducting a t-test. While scores for the non-SI group remained relatively constant, the SI participant group's academic performance improved throughout the academic term.

Saunders, D. (1992). Peer tutoring in higher education. *Studies in Higher Education*, 17(2), 211-218.

This article describes the development of peer tutoring programs at many institutions in the United Kingdom. Supplemental Instruction (SI) is one of the programs that is being implemented in higher education institutions. Lecturers are being asked to experiment with a greater variety of teaching and learning strategies which complement the lecture tradition. The use of SI at Kingston Polytechnic is mentioned. The benefits of tutoring programs for the tutors are described.

Saunders, D., & Gibbon, M. (1998). Peer tutoring and peer-assisted student support: Five models within a new university. *Mentoring & Tutoring*, 5(3), 3-13.

This article describes the use of Supplemental Instruction (SI) -- called Peer Assisted Student Support (PASS) by the local institution -- in the Business School at the University of Glamorgan in Glamorgan, Wales, United Kingdom. SI has been offered in the School of Applied Sciences since 1991. It is called PASS within the Business School. Most of the PASS group facilitators are volunteers and have previously been participants in groups when they were first year students. Positive reports from facilitators included: satisfaction gained from being able to positively help their peers, improved self-confidence, better communication and oral presentation skills as a result of running sessions, and being able to strengthen their job

resume. The author identified several challenges with the PASS scheme: student attendance was erratic due to perceived time conflicts of students; difficulty to maintain the voluntary program as committed PASS facilitators graduated and new leaders needed to be recruited to take over responsibilities.

Sawyer, J. (1990, 1990, October 26). University of Missouri involved in project with South Africans, *St. Louis Post-Dispatch*, p. 15.

This newspaper article provides an overview of the Supplemental Instruction (SI) program as it is being implemented at the University of the Western Cape (UWC) in Cape Town, South Africa. The article reports on trips by UMKC's Larry De Buhr who went to UWC in 1987 and 1989 to help introduce the SI program.

Sawyer, S. J., Sylvestre, P. B., Girard, R. A., & Snow, M. H. (1996). Effects of Supplemental Instruction on mean test scores and failure rates in medical school courses. *Academic Medicine: Journal of the Association of American Medical Colleges*, 71(12), 1357-1359. Correspondence and requests for reprints should be addressed to Dr. Snow, University of Wisconsin Medical School, Dean's Office, 1142 Medical Sciences Center, 1300 University Avenue, Madison, WI 53706-1532.

The purpose of the research study was to determine whether Supplemental Instruction (SI) offered to first-year medical students reduces the number of examination failures. The SI program -- locally called the Medical Scholars Program (MSP) -- was offered at not cost to all first-year students at the University of Southern California School of Medicine in 1994-95. SI sessions were offered in biochemistry, gross anatomy, micro anatomy, and physiology. Mean test scores and failure rates for students considered academically at risk and those not at risk were compared between the class entering in 1994 and the classes matriculating during the preceding three years. Since 85% of students elected to participate in the SI program, it was necessary to compare performance to previous academic terms rather than the non-SI group which was so small as to make same academic term comparisons difficult. At-risk students were defined as those with a total Medical College Admission Test score below 26 and a science grade-point average below 3.0. Comparisons were performed using two-tailed t-tests and chi-square tests. Statistically significant increases in mean test scores were achieved on most examinations by the class exposed to SI. Failure rates for at-risk students decreased by 46% during the year the SI program was offered. The authors listed other outcomes from the SI program: strengthened study strategies that could be used in other courses; students identified gaps in his or her knowledge in advance of examinations; enhanced cooperative rather than competitive interaction with colleagues; hastened development of class camaraderie by broadening the student's circle of friends since they were randomly assigned to the SI groups; and increased student morale and self-esteem since the students experienced less academic failure. SI leaders reported the following benefits of the SI program for themselves: reviewed first-year material in the SI courses which helped them prepare for both the second-year courses and for Step 1 of the United States Medical Licensing Examination.

Schaefer, S., & Hopper, J. (1991). Successful funding and implementation of a biology adjunct. *Journal of College Reading and Learning*, 24(1), 55-62.

This article describes the use of Supplemental Instruction (SI) in an introductory course in biology -- BIO 90, Diversity of Life -- at the University of California, Irvine. SI is offered as a non-credit class that accompanies a specific course. The authors describe the process for gaining support to provide the program: contact with counselors, administrators, and faculty; identified the historically difficult course that needed assistance; wrote a grant proposal; and conducted a pilot test of SI with a limited number of students. Results of the program included: positive relationship between attendance in SI and final course grade; statistically significant positive

change ($p < .01$) from pre- to post-test performance on the Nelson Denny Reading Comprehension Subtest; post-tests in writing showed that students were more likely to answer essay questions with correct answers in complete sentences; and for all the items on the self-assessment of reading, writing, and thinking skills there was a positive, and statistically significant change.

Schecker, F. (1982, 1982, March 29). Program gives boost to students, *The Kansas City Star Newspaper*, p. 3A.

This newspaper article provides an overview of the Supplemental Instruction program at the University of Missouri-Kansas City

Schuldt, G. (1991, 1991, May 15). Group tutoring program a success, *Milwaukee Sentinel Newspaper*, p. 10.

This newspaper article describes the use of Supplemental Instruction (SI) at Milwaukee Area Technical College (WI). Some of the courses that SI is offered include Intermediate Algebra, Introduction to Human Services, Oral Anatomy, Introduction to Occupational Therapy and nine other courses. Data from two courses was reported in the newspaper article. SI participants earned higher mean final course grades than non-SI participants: Oral Anatomy (3.0 vs. 2.2) and Introduction to Occupational Therapy (3.5 vs. 2.3).

Schuss, D. G. (1999, 1999, May 30). Many top college students use tutors to keep an edge: Study sessions aren't just for catching up, *The Boston Globe*, p. D5.

This newspaper article describes the use of Supplemental Instruction (SI) and other forms of academic assistance at highly-selected postsecondary institutions such as Worcester Polytechnic Institute, Harvard University, Wellesley College, Dartmouth College, Salem State College, and University of Massachusetts/Amherst. Interviews with campus administrators and students suggested the following reasons for interest in SI and other forms of academic enrichment: maintain top class rankings, improve study strategies, understand class lectures from another perspective, and to improve student persistence towards graduation.

Schuster, E. (2018). Supplemental Instruction: Leading to success. *Journal of Computing Sciences in Colleges*, 43(6), 143-147.

This paper addresses the role of Supplemental Instruction (SI) in our Computer Science courses. SI is a free, voluntary academic development program aimed at increasing students' retention and success in their academic careers. The program is offered to all students in various historically-difficult subjects. SI is led by upper-level students ("SI Leaders") who have successfully taken these courses during previous semesters. The SI leaders are embedded in the classroom in order to help the students along with the instructors. They facilitate regularly-scheduled out-of-class sessions, which are structured group study sessions to support students so they can master the course's content and learn effective study skills. We discuss the advantages and positive results we have seen in our Computer Science courses as a result of incorporating SI.

Schwartz, E. B. (1997). Program helps students make the grade. *Key Magazine*.

This short article provides an overview of the Supplemental Instruction (SI) program. The author is the Chancellor the University of Missouri-Kansas City, home of the SI program.

Schwartz, M. D. (1992). Study sessions and higher grades: Questioning the causal link. *College Student Journal*, 26(3), 292-299.

This article contains a data study of the use of Supplemental Instruction (SI) in a large sociology course at Ohio University (Athens, OH). While the study did not reveal statistical significance

between SI attendance and final course grade, the students who attended the SI sessions tended to have fewer unexcused absences in the course. In turn, a higher number of unexcused absences was associated with lower course grades.

Scott, C. A., McLean, A., & Golding, C. (2019). How peer mentoring fosters graduate attributes. *Journal of Peer Learning*, 12(1), 29-44. Available online: <https://ro.uow.edu.au/ajpl/vol12/iss1/3>.

The most common approach to foster graduate attributes is to teach them in the curriculum of a bachelor's degree. However, it is difficult to include every graduate attribute in every degree. In this article we consider how co-curricular peer mentoring might provide an additional approach. We examine a case study of the mentors of the Peer Assisted Study Sessions (PASS) programme at a research-intensive university in New Zealand, and we examine the process by which they developed graduate attributes. PASS mentors reported that they developed a range of graduate attributes such as communication, critical thinking, and ethical responsibility, due to the extra responsibility and leadership involved in being a mentor in an authentic work environment. We argue that co-curricular programmes such as PASS can provide useful additional opportunities for students to acquire and develop graduate attributes. While not all students will be able to participate as PASS mentors, we also argue that our findings can inform other programmes for fostering graduate attributes. If these programmes offer authentic responsibilities to participating students, they may be more effective at fostering graduate attributes.

Scriver, S., Olesen, A. W., & Clifford, E. (2015). From students to leaders: evaluating the impact on academic performance, satisfaction and student empowerment of a pilot PAL programme among first year students and second year leaders. *Journal of Learning Development in Higher Education: Special Edition: Academic Peer Learning*(November). Available online: <http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path%5B%5D=359&path%5B%5D=pdf>.

This paper evaluates the pilot year of the CÉIM PAL initiative at the National University of Ireland Galway through analysis of examination results, student surveys and the reflections of two students who participated as first year students in the pilot year and subsequently as student leaders in year two. The paper considers the impact of attendance at sessions on academic performance, student satisfaction with the programme, and evaluates the extent to which the initiative has assisted students to become more empowered learners as expressed through the development of self-directed learning, growth in educational self-efficacy, and confidence in navigating the learning environment. Recommendations are also made for developing the CÉIM initiative, which may be relevant to other PAL programmes and for determining the direction of future research.

Selsby, J., Sterle, J., & Zywicki, C. (2014). Participation in Supplemental Instruction improves students' academic performance in a physiology course. *The FASEB Journal*, 28(1), 531-551. Student perception of the difficulty of AnS 214, Domestic Animal Physiology, is supported by comparing mean grade in AnS 214 (2.23/4.0) to that of all 100 and 200 level classes at Iowa State University (ISU; 2.86/4.0). To address student need for academic support, Supplemental Instruction (SI) has been offered for this course since the spring 2009 semester. SI consists of peer-assisted group study sessions, facilitated by a peer student (the SI Leader) who successfully completed the course. The Leader attends classes with students and plans SI session content based on recent coursework, emphasizing what to learn and how to learn. The purpose of this investigation was to determine the extent to which student participation in SI improved academic performance in AnS 214. SI participants earned an average grade of 2.73 ± 1.05 while non-participants earned an average grade of 2.23 ± 1.23 (p<0.05). Of the subgroup

of students that were deemed regular participants (>9 sessions) the average grade improved more substantially to 3.07 ± 0.86 ($p < 0.05$ v non-participants; $p < 0.05$ v all participants). When each of the four exams given throughout the semester were considered, SI participation improved exam performance by 11-19% for all exams compared to non-participants ($p < 0.05$ for all exams). Regular attendance improved exam performance by 17-28% compared to non-participants ($p < 0.05$ for all exams) and was also significantly greater than participants attending 1-9 sessions ($p < 0.05$ for 1-9 participants). These data indicate that participation in SI improved student academic performance, however, regular participation led to further benefits.

Sevos, S. (1991). *The effects of Supplemental Instruction on a developmental mathematics course*. (Master's of Science thesis), Kean College of New Jersey.

Shaw, C. S., & Holmes, K. E. (2014). Critical thinking and online Supplemental Instruction: A case study. *The Learning Assistance Review*, 19(1), 99-119.

A wealth of research is available regarding Supplemental Instruction; however, a dearth exists regarding online Supplemental Instruction and critical thinking. This case study explored what was assumed to be known of critical thinking and investigated the extent to which critical thought was promoted within a university's online supplemental instruction program. Survey and persistence data indicated the university's online SI program was successfully facilitating critical thinking. However, after conducting online session observations, based upon the Paulian critical thinking theory and the adoption of Bloom's taxonomy as a critical thinking model, the case investigation revealed the initial assumption was flawed

Shaya, S. B., Petty, H. R., & Petty, L. I. (1993). A case study of Supplemental Instruction in biology focused on at-risk students. *BioScience*, 43(10), 709-711.

The effects of Supplemental Instruction (SI) in Basic Biology I course at Wayne State University (MI) is examined by studying the academic performance of academically at-risk students (low high school grade-point average, low ACT standardized test scores). The SI sessions were open to all students in the course. About 25 percent of the traditional admit students and 40 percent of the at-risk students voluntarily participated in SI sessions during the academic term. The data suggests that SI contributed to higher mean final course grades for SI participants (2.9) vs. nonparticipants (2.4). A separate analysis was conducted to compare the academic performance of at-risk students. At-risk SI participants received higher mean final course grades (2.65 vs. 1.31) and had a higher course completion rate (90 percent vs. 32 percent). To attempt to control for student motivation level, an analysis was conducted of high school grade point averages and ACT scores for SI and non-SI participants among the at-risk students. No significant differences were found. A second analysis for student motivation considered intrasemester SI entry. At-risk students who began to attend SI later in the academic term earned higher mean final course grades than at-risk students who chose not to attend SI. The data suggests that SI participation contributed to the majority of the variance concerning higher mean final course grades.

Sherman, D. (2015). *Why do I need to know math? The impact of Supplemental Instruction from the student's perspective*. (Ph.D. dissertation), Northeastern University, Boston, MA.

Many students enter college unprepared for the study of mathematics and other subjects that require a strong math background. As a result, students have difficulty applying math concepts in non-math courses and frequently ask the question "Why do I need to know math?" Institutions of higher education must find ways to support these students in order to improve retention and graduation rates. In this study, an instructional intervention called Supplemental Instruction (SI) is used to help students to link the application of math concepts to their chosen discipline of study. SI is a tutoring approach that targets at-risk courses versus at-risk students; removing the

remedial stigma experienced by many at-risk students. SI programs consist of voluntary tutoring sessions that occur weekly throughout an academic term and are facilitated by an SI Leader. This SI Leader is an expert in the topic area covered by the SI program and also attends all classes with the enrolled students. This study employed a qualitative research approach designed to capture an understanding of the lived experiences of engineering technology students who participate in a SI program focused on connecting important math concepts to complex engineering applications. This Interpretive Phenomenological Analysis study incorporated the use of individual interviews to collect rich data capturing the lived experiences of the participants. The qualitative data collected and analyzed sheds light on the experiences of students who have participated in this SI program.

PREVIEW

Shook, J. L. (2012). *An analysis of academic peer leaders' perceptions of academic skills and performance*. (Ph.D. dissertation), University of South Carolina.

This research study explored academic peer leadership in the context of higher education and student affairs. In this study, a peer leader was considered to be "an undergraduate student who has been selected to serve as a mentor or peer educator to other students through a position with a school-run organization" (Keup & Skipper, 2010). The study focused on academic peer leaders, which included students who served within tutoring services, Supplemental Instruction, first-year seminar courses and academic advising. This study examined the change in academic skills and performance as a result of the academic peer leadership experience. Mixed methodology allowed the researcher to gain a deeper understanding of the academic peer leader experience. The 2009 Peer Leadership Survey, conducted by the National Resource Center for The First-Year Experience & Students in Transition in spring 2009, provided the "first national portrait of peer leader experiences" (Keup & Skipper, 2010). Quantitative findings noted that academic peer leaders are better able to make connections between their peer leadership experience and changes in their academic skills and performance, as compared to other types (housed in other programs). Qualitative findings demonstrated how academic peer leaders made the connections between their role and their academic performance. The findings had implications on higher education professional practice and demonstrated a need for future research about peer leader programs and the experiences of students who serve as peer leaders.

Shores, P., & Tiernan, J. (1996). *Peer mentor training: A collaborative exercise in systemic change*. Unpublished manuscript. University of Western Sydney at Nepean. New South Wales, Australia. Available: Ms. Penny Shores, Counseling and Health Unit, University of Western Sydney, Nepean, P. O. Box 10, Kingswood New South Wales 2747, Australia

The Learning Center and the Counseling and Health Unit of the University of Western Sydney (Nepean, Australia) have been piloting a Peer Mentor program that is based on the American Supplemental Instruction (SI) program. The SI program is being used a tool for systemic intervention at the institution by creating an environment for students to change their attitudes. The SI program is being used to serve the increasingly diverse population at the university. Much of the report centered on the training of the SI leaders. Some faculty members also report using the SI program as a feedback mechanism to identify the comprehension level of the students regarding the classroom lectures.

Shuhidan, S. M., Awang, Y., Mohamed, N., & Zakaria, N. N. Z. (2018). Non-accounting students; perception on the development of study skills using In-Class Supplemental Instruction. *e-Academica Journal*, 7. doi: 10.24191/e-aj.v7iSI-TeMIC18.5380. Available online: <http://gids.mohe.gov.my/index.php/JeA/article/view/5380>.

Challenges such as different background and abilities of universities' students, reluctance of academic staff in understanding students' learning style and lack of study skills knowledge among students and lecturers are to be resolved by public universities. Resolving these challenges will provide better learning environment in public universities. Thus, the objectives of this study are to identify the reflective measures of study skills and to examine the students' perception on the development of study skills by using In-Class Supplemental Instruction (ICSI). Using the questionnaires survey, this study found 10 reflective measures of study skills with Cronbach Alpha of 0.930 which indicates all reflective measures have good internal consistency reliability. The respondents are satisfied with the ICSI sessions in helping them to develop their study skills with an average mean of 4.09. It is concurred that ICSI approach assists in developing study skills such as deeper understanding, discussing and solving problem, teamwork and academic skills. Challenges such as different background and abilities of universities' students, reluctance of academic staff in understanding students' learning style and lack of study skills knowledge among students and lecturers are to be resolved by public universities. Resolving these challenges will provide better learning environment in public universities. Thus, the objectives of this study are to identify the reflective measures of study skills and to examine the students' perception on the development of study skills by using In-Class Supplemental Instruction (ICSI). Using the questionnaires survey, this study found 10 reflective measures of study skills with Cronbach Alpha of 0.930 which indicates all reflective measures have good internal consistency reliability. The respondents are satisfied with the ICSI sessions in helping them to develop their study skills with an average mean of 4.09. It is concurred that ICSI approach assists in developing study skills such as deeper understanding, discussing and solving problem, teamwork and academic skills.

Simons, S. (2019). *Evaluating the Effectiveness of Supplemental Instruction on Generation Z Students in AGN 331*. (Master of Science thesis), Stephen F. Austin State University. Available online: <https://scholarworks.sfasu.edu/cgi/viewcontent.cgi?article=1276&context=etds>
The purpose of this research was to determine the effectiveness, barriers and benefits of Supplemental Instruction (SI) on Generation Z students in AGN 331. The theory used as a model for this research was the Pace's Model of College Impress. Prior research indicated that SI improves test scores, final grades, and persistence in historically difficult courses. Correlations and ANOVA's were performed on SAS in order to determine a relationship between the non-SI attendees to those who did attend SI. The final grade reported an average of 0.56 points higher and on the final exam 4.26 points higher if the student had access to SI sessions. The conclusion: SI was effective in increasing final grades in AGN 331. Student perceptions of SI were gathered via Qualtrics. The survey showed that all students, regardless of attendance, thought SI was beneficial. The biggest barrier to their attendance was other obligations at that time.

Simpson, M. L., Hynd, C. R., Nist, S. L., & Burrell, K. I. (1997). College academic assistance programs and practices. *Educational Psychology Review*, 9(1), 39-87. Correspondence should be directed to Michelle L. Simpson, Division of Academic Assistance, University of Georgia, Athens, GA 30602.

This comprehensive article provides an overview to academic assistance for college level learning tasks. After examining four critical issues confronting all academic assistance programs (Should generic or content-specific skills be taught? How can transfer be promoted? What is the role of task and context? What is the role of motivation in self-regulated learning?), the authors examined the goals, assessment procedures, salient features, and program evaluation methods of four prevalent program models: learning to learn course, Supplemental Instruction (SI), required programs for underprepared students, and integrated reading/writing courses. After providing an overview of the SI model, the authors point out that embedded strategy instruction

(modeling of study strategies) is a major feature that distinguishes it from many other systems since they employ a direct instructional procedure to teach study skills. The authors concluded by outlining suggestions for future research (e.g., include both descriptive and experimental paradigms, investigate long-term effects, collect both product and process data, seek linkages across disciplines) and by listing specific questions that college students need to ask about the programs at their institutions.

Simpson, S. (1994, 1994, February 23). How to learn by example, *The Scotsman Education*, p. 22.

This newspaper article describes the use of Supplemental Instruction (SI) at Glasgow Caledonian University in Scotland. The local name for the SI program is Peer Assisted Study Sessions (PASS). The article contained interviews with several students who mentioned some of the benefits of the SI program: filled gaps in knowledge; develop strategies to work out their own answers; provided a transition into difficult courses; encouraged students to form their own study groups in other classes where SI was not offered; and helped to deal with the high volume of material.

Singh, P. K. H., & Thuraisingam, T. (2019). Eliciting the beliefs of probationary students about their attendance of pass within the integrated behavioral model framework. *International Journal of Education, Psychology and Counseling*, 4(30), 197-209. Available online: <http://www.ijepc.com/PDF/IJEPC-2019-30-05-14.pdf>.

The primary purpose of this study is to explore how Peer Assisted Study Sessions (PASS) are perceived by underperforming students at the American Degree Program in view of their irregular attendance and poor CGPA. Methodology - Driven by the Integrated Behavioral Model framework, this qualitative formative research used interview elicitation procedure to identify and understand the antecedent beliefs underlying the determinants of behavior of probationary students at a private institution of higher learning in Malaysia, with regard to their attendance or non-attendance at PASS. The responses were content analyzed to develop insight into the underlying beliefs of attendees and non-attendees as well as a comparative analysis of the two groups. Findings - The findings showed remarkable difference between the two groups in the underlying beliefs on two dimensions of the model; attitudes and perceived norms while there was limited overlap on the dimension of personal agency. Significance - The insights of the study have significance for the PASS community especially the PASS trainers, the PASS leaders and generally educational institutions. Interventions suggested including metacognitive skills and Design Thinking training for PASS Leaders. The underlying beliefs serve as the basis of quantitative measure of IBM dimensions in the context of Malaysia.

Skalicky, J. (2008). Providing multiple opportunities for PASS leaders to reflect critically. *Australasian Journal of Peer Learning*, 1, 91-97. Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/11>

Peer Assisted Study Sessions (PASS) at the University of Tasmania is based on an adaptation of the Supplemental Instruction (SI) model. This article used Brookfield's framework of critical reflection to consider multiple ways in which PASS programs can embed opportunities for PASS leaders to reflect critically upon their practice. "Critically responsive teaching is concerned with developing critical thinking in students, encouraging them to question assumptions and acquire a mind that is skeptical of claims to final truths or ultimate solutions to problems, is open to alternatives, and acknowledges the contextuality of knowledge" (Brookfield, 1990, p. 2) The author advocates for the intentional use of Brookfield's framework during training and as part of the ongoing training/supervision of SI leaders throughout the academic term.

Skalicky, J., & Caney, A. (2010). PASS student leader and mentor roles: A tertiary leadership pathway. *Australasian Journal of Peer Learning*, 3(1), 24-37. Available online: <http://ro.uow.edu.au/ajpl/vol3/iss1/4>.

This article describes a study of the Peer Assisted Study Sessions (PASS) program which is modeled after the Supplemental Instruction (SI) program. The program also includes PASS mentors as part of the scheme. Data was collected using a structured survey with open-ended questions designed to capture the personal experiences and self-reported learning outcomes of students taking leadership roles within the PASS program. Twenty-three student PASS leaders and mentors were part of the study. Twelve themes of leadership development emerged: organization, facilitation, support, attitude, relationships, role model, collaboration, communication, responsibility, decision making, pedagogy, and session management. Students displayed growth as they moved from the initial role as PASS leader to the more demanding role of PASS mentor. The study focused on the experiences of the PASS program at the University of Tasmania.

Skoglund, K., Wall, T. J., & Kiene, D. (2018). Impact of Supplemental Instruction participation on college freshman retention. *Learning Assistance Review*, 23(1), 115-135. Available online: <https://files.eric.ed.gov/fulltext/EJ1170114.pdf>.

Supplemental Instruction (SI), a higher-education academic support program, targets challenging college courses and uses peer-led review sessions to develop academic skills, improve grades, influence persistence, and ultimately increase student retention (Arendale, 2001). The goals of this study were twofold: to determine if differences existed in prior academic performance of freshman students attending SI sessions while determining whether SI attendance improved retention to the sophomore year. Using quantitative analysis, the researchers found that freshman students with a higher high school GPA were more likely to be retained regardless of SI session attendance. Additionally, freshman students with a lower high school GPA were significantly more likely to be retained if participating in SI sessions. The researchers conclude that SI is an effective program to develop academic skills and yield increased retention. Implications for the profession include a renewed emphasis on increasing SI attendance rate of college freshman students, particularly at-risk students with lower college entrance credentials.

Sleiman, J. (2008, 2008, May 31). Record-setting 1,509 students graduate AACC, *Maryland Gazette*, p. A 2.

This newspaper article describes a variety of services provided at Anne Arundel Community College to increase student academic success. Supplemental Instruction (SI) is mentioned by one of the students profiled in the article as contributing to her successful grades in a chemistry course.

Smit, D. (1996). *A student's attitude towards skills, adjustment and performance, and the role of Supplemental Instruction*. (Bachelor of Arts thesis), University of Port Elizabeth, Port Elizabeth, South Africa.

This thesis paper examines the use of Supplemental Instruction (SI) at the University of Port Elizabeth (South Africa). A qualitative research design was employed to study the outcomes of the SI program with students regarding attitudes toward skills, adjustment, and performance. The subject of the study was a first year chemistry student. The researcher noted that since SI is a student-driven activity, some academic skills are emphasized based on SI participant interest.

Smith, J. (1998, 1998, September 4). UTA peer program has students helping each other, *Dallas Morning News*, p. 6A.

This newspaper article indicates that Supplemental Instruction (SI) is being used at the University of Texas at Arlington.

Smith, J., May, S., & Burke, L. (2007). Peer assisted learning: A case study into the value to student mentors and mentees. *Practice and Evidence of the Scholarship of Teaching and Learning in Higher Education*, 2(2), 80-109.

Peer-assisted learning (PAL) is a system of student support used in a growing number of universities in the UK and worldwide which is based on Supplemental Instruction (SI). Practitioners in the School of Surveying at Kingston University have been running such a scheme for first-year undergraduates since 1990 (Author 2003) and have recently undertaken a research project into perceptions of PAL by both attendees and mentors. Case study methodology (Tellis 1997) was the chosen research design for the evaluation in which data from focus groups, interviews, and student questionnaires were collected and analysed. The results support much of the previous literature related to PAL/SI schemes, but also highlight gaps which this study may begin to fill. Student perceptions appeared to be clustered into two groups: those who used PAL as a means of managing a comprehension problem (reactive) that had arisen and those that used it as a means of preventing problems (proactive). Additionally, PAL mentors also fell into two groups: those who elected to become mentors for other-centered reasons and those who did so for personal gain. The findings show that both PAL attendees and mentors perceived a number of benefits from the scheme and that local lessons were learned that enabled the School of Surveying to better support its undergraduate students.

Smith, L. D. (1999). *SI leadership and personal growth: A South African perspective*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

Many first year students at South African tertiary institutions come from a disadvantaged educational background. They tend to be passive learners and rely on rote memorization rather than understanding. This leaves many ill equipped for the demands of higher education. Although Supplemental Instruction (SI) provides academic support, its emphasis on students' identifying problems, finding answers and taking responsibility for their learning requires a significant change in approach for both participants and the SI leader. This study documents the benefits of working as an SI leader. Initial attitudes are compared with those developed in the course of a year, by means of a questionnaire covering self-confidence, self-efficacy, identification with institution, class participation and relationship with lecturers. The personal growth of SI leaders is also compared with that of a group of non-SI cohorts. Employers' perceptions of the responsibility, initiative, creativity and reliability of SI and non-SI graduates are documented.

Smuts, K. B. (1996). The role of student leaders in Supplemental Instruction. *South African Journal of Higher Education*, 16(3), 225-231.

Benefits for the Supplemental Instruction (SI) leaders include: develop a sense of personal adequacy; communication skills; relationship skills; find meaningful use of the subject matter in their own studies; improves their own grades; reinforce their own knowledge of fundamentals; review of course material assists them with professional school entrance exams; develop citizenship skills; and skills for the workplace.

Snyders, A. J. M. (1999). *Foundation mathematics for diversity: Whose responsibility and what content?* Conference Proceedings of the Delta '99 symposium on undergraduate mathematics, Whitsunday Coast, Australia.

This article describes the issues facing the University of Port Elizabeth in South Africa regarding instruction in foundation mathematics for an increasing diverse student body. Video-based

Supplemental Instruction (VSI) and Supplemental Instruction (SI) have been implemented as part of a comprehensive approach. An extensive review of the professional literature concerning mathematics instruction composes the majority of the article.

Sollerman, J., & Näslund, M. (2003). *Implementation of Supplemental Instruction at the Department of Astronomy: A preparatory study*. Unpublished manuscript. Department of Astronomy, Stockholm University. Stockholm, Sweden.

This report describes a plan to implement Supplemental Instruction (SI) as a new pedagogical tool at the Department of Astronomy in Stockholm University, Sweden. The report is written for the second phase of the course Universitetspedagogik i Teori och Praktik (University pedagogics in theory and practice), given by the unit for pedagogical development at Stockholm University. The report authors' goal with this publication is to set the stage for the implementation of SI at the department by clarifying how SI can improve the current learning situation. A major objective of this report is to inform the faculty about what SI proposes to do. Due to this emphasis, the report provides a model for other colleges to consider when implementing the SI program for the first time and seeking to gain faculty support. The report also provides historical background about the development and expansion of SI within Sweden. The report concludes with an analysis of extensive surveys of students regarding their potential interest in participating with the proposed SI program.

Sommerfeld, M. (1995). Who's responsible? Taking sides on remedial classes. *Education Week*, 14(29), 1, 14.

This article discusses alternatives to traditional remedial and developmental education programs. Included in the article is a short interview with David Arendale concerning the use of Supplemental Instruction (SI) and Video-based Supplemental Instruction (VSI). One of the difficulties for first-time students is that they concentrate on the wrong things as they prepare for their first examinations.

Sowa-Jamrok, C. (1994, 1994, July 24). Smaller classes attract students, *Chicago Tribune Newspaper*, p. 17.

This newspaper article mentions that Supplemental Instruction (SI) is one of the strategies used at National-Louis University (Chicago, IL) to help students be more active when they are enrolled in large classes. Ofra Peled, who teaches biology and microbiology mentioned that one of the activities used in SI sessions is to have students write about the class lecture material. They write about a lecture concept, discuss it with a few students in a small group, and then after practicing they share about the concept in the next class lecture.

Spaniol-Mathews, P., Letourneau, L. F., & Rice, E. (2016). The impact of online Supplemental Instruction on academic performance and persistence in undergraduate STEM courses. *Supplemental Instruction Journal*, 2(1), 19-32. Available online: <http://info.umkc.edu/si/wp-content/uploads/2016/09/siJ-Volume-Two-Issue-One.pdf>.

Though demonstrated as an effective strategy for enhancing academic performance and course persistence in higher education, traditional Supplemental Instruction (SI) relies on face-to-face interaction in a classroom setting. Consequently, students who have other obligations or feel apprehensive in a group setting often cannot attend traditional SI sessions. This paper focuses on an innovative alternative to traditional SI: an online SI program currently being implemented at Texas A&M University-Corpus Christi (TAMUCC). This paper describes TAMUCC's online SI program and discusses results from a pilot study that compared the STEM course performance and persistence of TAMUCC undergraduates (N=585) randomly assigned to SI groups (i.e., traditional SI or online SI) in the spring semester of 2015.

Spedding, J., Hawekes, A. J., & Burgess, M. (2017). Peer assisted study sessions and student performance: The role of academic engagement, student identity, and statistics self-efficacy. *Psychology Learning & Teaching*, 1-20. Available online: <http://journals.sagepub.com/doi/pdf/10.1177/1475725716687166>.

The initial year of university is often a sensitive period for new students. Commencing students may lack the necessary skills and resources to adapt to unfamiliar learning environments. One intervention demonstrating academic benefits is Peer Assisted Study Sessions (PASS). PASS is a structured peer led study group where students collectively share knowledge and solve course-related tasks. To date there has been limited empirical exploration into how PASS enhances student performance outcomes. To amend this gap, the current study used both a cross-sectional (n = 264) and a matched longitudinal (n = 76) survey design, combined with PASS attendance and course performance data, to investigate three psychological mechanisms that may mediate these effects: increased academic engagement, a positive student identity, and increased statistics self-efficacy. Sampling a first-year psychology cohort enrolled in an introductory statistics course, both cross-sectional and longitudinal analyses found a positive relationship between PASS attendance and academic performance. Furthermore, self-efficacy mediated the relationship between PASS attendance and student performance.

Speed, K. D. (2004). *Perceptions of teaching, teaching practices and effectiveness of Supplemental Instruction leaders and selected students at a Research I institution*. (Ph.D. dissertation), Texas A & M University, College Station, TX. Available online: http://www.researchgate.net/publication/26898949_Perceptions_of_teaching_teaching_practices_and_effectiveness_of_supplemental_instruction_leaders_and_selected_students_at_a_Research_I_institution

This study examined students and Supplemental Instruction (SI) leaders' perceptions of teaching, teaching practices, and faculty teaching effectiveness. This study also examined the impact of the SI leader's role on those perceptions and subsequent behaviors on end-of-course evaluations and sought to determine whether differences existed between the two groups in order to determine whether or not SI leaders' perceptions should be included in a comprehensive evaluation system. A purposive sample of 17 SI leaders, who had been employed during the spring 2002 semester and returned for the fall 2002 semester, and 17 students, who had attended at least 10 SI sessions during the fall 2002 semester, were selected to participate in this study. Data for the study were collected through individual interviews using a protocol designed to collect their perceptions regarding the following: 1) definitions of teaching and its activities; 2) descriptions of good and bad teaching or good and bad teachers; 3) definitions and descriptions of faculty teaching effectiveness; 4) role of the SI leader; 5) impact of SI leader's role on perceptions of teaching, its activities, and faculty teaching effectiveness; and 6) impact of SI leader's role on behaviors on end-of-course evaluations. A major finding of this study is that SI leaders and students define teaching and its activities in a similar fashion. SI leaders, unlike students, however, report that learning is tied to teaching effectiveness, or lack thereof. This study has three major results: 1) SI leaders end up teaching, rather than facilitating; 2) the SI leader's role impacts views on teaching; and 3) the SI leaders' role impacts behaviors on end-of-course evaluations. A review of the literature on student ratings of instruction and regular attendance at SI indicate that both correlate, to a small degree, with mean end-of-course grades. Claims of validity with respect to both may be somewhat suspect, in light of SI leader's claims that they teach, rather than facilitate. Investigation of the impact of regular attendance at SI on end-of-course grades and end-of-course evaluations may result in the need to draw new conclusions with respect to validity of student ratings of instruction and SI.

Spencer, C., & Loh, H. (1994). *Improving the learning style of first year Aboriginal & Torres Strait Islander nursing students studying anatomy*. Unpublished manuscript. Conference of Science in Nurse Education. Ballarat, Australia.

This report describes the use in 1994 of Supplemental Instruction (SI) at Queensland University of Technology (Australia) with first year Aboriginal and Torres Strait Islander (A&TSI) students. The local institutional name for the program is Peer Assisted Study Sessions (PASS). Many of these A&TSI students began postsecondary education with high anxiety (79% student response), low to medium confidence in passing their courses, limited knowledge of study skills, and high to moderate difficulty levels within their respective subjects. Based on qualitative research interviews with the A&TSI students, the majority reported they were more confident in passing anatomy after attending the SI sessions. Further, they reported that they were more motivated to perform better and most felt that the SI sessions helped them in developing study skills as their anxiety for the subject decreased.

Spencer, G. (1994). *Supplemental Instruction: Adapt or die?* South African Association for Academic Development Conference. Unpublished manuscript. University of Natal, Durban, Republic of South Africa.

This unpublished manuscript describes the use of Supplemental Instruction (SI) at the University of Natal in South Africa. The SI model has been modified increasing the curriculum development focus potential of the model. Academic Development (AD) and Academic Support (AS) are seen as partners in improving teaching and learning. If AD and AS are seen as opposite ends of the learning continuum, SI is shifted toward the AD end of the continuum line in some South African institutions. Several of the modifications of the SI model include that the academic department: take ownership in administration of the SI program; faculty members take additional time to work with the SI leaders; faculty members recognize that changes need to be made regarding instructional delivery and content selection; faculty members modify their course delivery based on common themes of student comments; and key senior faculty members become highly involved in the SI program an ensuring that curriculum develop occurs.

Spencer, G., & Wallace, J. (1994). Conceptualizing Supplemental Instruction. In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 9-14). Birmingham, England: Staff and Educational Development Association
This article places Supplemental Instruction into its appropriate role within British higher education. SI is compared and contrasted with collaborative learning, tutorials, and roles of the instructor. It is emphasized that SI focuses on the student learning process.

Spofford, T. (1990, 1990, October 1). Top students pitch in to lower dropout rates: Peer-run study groups help keep freshmen in college, *The Times Union Newspaper*, pp. A1, A12.
This newspaper article provides an overview of the Supplemental Instruction (SI) program at the State University of Albany (Albany, NY), Hudson Valley Community College (Troy, NY), The College of Saint Rose (Albany, NY), Rensselaer Polytechnic Institute (Troy, NY), and Skidmore College (Saratoga Spring, NY). Some data from some of the programs and interviews with SI Supervisors and SI leaders also is included. Institutions reported a variety of compensation systems for the SI leaders. At SUNY they receive three college credits. Most others paid an hourly wage of \$5.00 to \$6.00. At Rensselaer the SI leaders receive \$1,100 a year, free meals, and a \$500 discount on a room in the freshman dormitory.

Staff. (1991, February 14). Supplemental Instruction program aims to help students earn better grades, *The Blue and White Flash: Jackson State University Newspaper*, p. 4.

The newspaper article provided an overview of the Supplemental Instruction (SI) program that is being implemented at Jackson State University (MS) in the following academic areas: art, English, history, mass communication, music, and urban affairs.

Staff. (1991, March 12). Making the grade: Supplemental Instruction program lets students help other students learn, *The Oscoda County Herald*, p. 14.

This newspaper article provides an overview of the Supplemental Instruction (SI) program at Kirkland Community College (MI). Data from SI sessions in biology and chemistry during Fall 1990 suggest that SI participants earned higher mean final course grades than non-SI participants (chemistry: 2.25 vs. 1.22; biology: 2.56 vs. 1.22).

Staff. (1994, June 4). SAU's tutoring gets high ratings, *Banner-News*, p. 15.

The newspaper article mentions that Supplemental Instruction (SI) program is an important part of academic support services at Southern Arkansas University. Preliminary results from the Noel-Levitz Student Satisfaction Inventory suggested that students were very high in comparison with other institutions in the U.S. SAU was one of the institutions that participated in the national survey.

Staff. (1990, November 19). Education student gets SCUP of reality at Westport High, *University News (Student newspaper of the University of Missouri-Kansas City)*, p. 4.

The newspaper article describes the use of Supplemental Instruction (SI) with high school students enrolled in English and history classes at an urban high school in Kansas City, MO. Students from the UMKC School of Education were some of the persons who served as SI leaders. The article contains an interview with an education major who commented on the positive impact of the experience of working with high school students early in the education degree program rather than until the field teaching experience in a school as an upper level student.

Staff. (1995, August 2). Students helping boost pass rates, *The University of Southern Queensland Newspaper*, p. 5.

This newspaper article describes the implementation of Supplemental Instruction (SI) at the University of Southern Queensland at Toowoomba in the Nursing Department during Fall 1995. In addition to describing the academic benefits to the SI participants, the USQ SI coordinator, David Anderson, reports that a value for SI leaders is that the experience provides leadership development and increases their post-graduate opportunities.

Staff. (1995, July 18). New learning process to help first-year University of Southern Queensland students, *The Chronicle Newspaper*, p. 8.

The newspaper article describes the use of Supplemental Instruction (SI) at the nursing department at the University of Southern Queensland in Australia. In the article Deanna Martin, creator of the SI model, provided an overview of the SI program while she was visiting the university.

Staff. (1993, September 28). US experts focus on teaching strategies, *Inside QUT (Queensland University of Technology Newspaper)*, p. 2.

This newspaper article describes the upcoming arrival of Deanna Martin and Robert Blanc from the University of Missouri-Kansas City to conduct a Supplemental Instruction (SI) Supervisor training workshop at Queensland University of Technology (Brisbane, Australia). The visit to QUT will be supported by the Higher Education Research and Development Society of Australasia. SI is recognized at QUT as one of the teaching strategies which helped the university win the national Good Universities Guide 1993 University of the Year award.

Staff. (1992, July 29). College 'mini-grants' awarded, *San Jose Mercury News*, p. 3.
This newspaper article describes 14 grants that were awarded by the San Jose/Evergreen Community College District to teachers for projects to help improve classroom instruction and student services at their colleges. The grants were created to stimulate innovation and creativity, especially in the areas of staff diversity, recruitment of underrepresented groups, retention, and new technologies and enrollment reduction caused by budget restraints. Susan L. Smith received a special grant for Supplemental Instruction.

Staff. (1996, September 24). Wayne State University retention efforts help students stay in school, *Michigan Chronicle Newspaper*, p. 10A.
This newspaper article describes the use of Supplemental Instruction (SI) at Wayne State University (Detroit, MI). Wayne Excel, the university's comprehensive retention program model was implemented in fall 1991. Excel provides a high level of advising and academic support services for at-risk students during their first two years at WSU. SI is one of the components of the Excel program. Institutional research shows that student retention has increased since the Excel program was started.

Staff. (1995, July 7). Survey shows many study hours wasted, *Campus Review*.
This newspaper article describes the use of Supplemental Instruction (SI). It mentions that the SI program has been adopted for use in several Australian institutions: University of Southern Queensland in Toowoomba, University of Queensland, and the Queensland University of Technology.

Staff. (1997, August 19). Engineering course lifts grades and retention rates, *Inside QUT (Queensland University of Technology, Australia)*, p. 2.
Dr. Martin Murray from Queensland University of Technology in Australia is using Peer-Assisted Study Sessions (PASS) to improve student performance in engineering courses. PASS is the locally used name for the Supplemental Instruction (SI) program. PASS was one of several new additions to the course delivery system that both increased student academic achievement but also lowered the cost of instruction.

Staff. (1990, August 16). UMKC program improves grades, retention of students in college, *Kirkville Daily Express*, p. 1.
This newspaper article provides a basic overview of the Supplemental Instruction (SI) program.

Staff. (1995, August 17). Sessions help students conquer classes with high failure rates, *Omaha World-Herald Newspaper*, p. 28.
This newspaper article describes the use of Supplemental Instruction (SI) at the University of Nebraska-Lincoln.

Staff. (2008, December 14). OUM's Ng helps put the fun back in Mathematics, *New Straits Times*, p. 22.
[Richard Ng], who is the Open University Malaysia director of the Perak Learning Centre, initiated a Maths project, which culminated in a research paper entitled "E-Mathematics: Pre-instructional and Supplemental Instruction and their Impact on Students' Online Participation and Final Exam Score." "I have tweaked the idea to enable online SI coordination. Though the fundamentals are the same, this is more flexible as the learners need not have face-to-face interaction. I am glad to see the increase in learners' online involvement and activities," said Ng, who specializes in Maths, E-Commerce and Marketing.

Staff. (1996, August 30). It makes sense to protect that first year's investment, *Lincoln Journal Star*, p. 7.

This newspaper article describes the use of Supplemental Instruction (SI) to increase academic success of students the University of Nebraska - Lincoln. The article contains interviews with the administrators and their reasons for implementing the SI program.

Staff. (1987). Redefining an attrition risk. *Recruitment and Retention in Higher Education Newsletter*, 1(3), 6-7.

This newsletter article provides an overview of the Supplemental Instruction (SI) program. It contains interviews with Deanna Martin, creator of the SI program, and May Garland who directs SI training workshops. Garland suggests that SI can help bridge students from developmental education into the regular courses in the curriculum.

Staff. (1989). New Mexico program targets at-risk classes. *National On-Campus Report*, 17(2), 3.

The newsletter article provides an overview of the Supplemental Instruction (SI) program as it is being implemented at the University of New Mexico in introductory chemistry and biology classes during 1988. Data suggests a half a letter grade higher final course grades for SI participants.

Staff. (1993). Academic programme at QUT well supported. *The Chinese Business and Professional Association of Queensland Newsletter*, 47(66).

This newsletter article describes the use of Supplemental Instruction (SI) at the Queensland University of Technology (Brisbane, Australia).

Staff. (1993). Academic programme at Queensland University of Technology well supported. *The Chinese Business and Professional Association of Queensland Newsletter*, 20-21.

This newsletter article describes the use of Peer Assisted Study Strategies (PASS) at Queensland University of Technology (Brisbane, Queensland, Australia). PASS is the local institutional name for Supplemental Instruction (SI). The article cites the PASS program as one of the projects that contributed to QUT being selected as Australia's University of the Year in 1993. Benefits reported for PASS participants include reduction of the failure rate and increased student motivation and confidence. PASS leaders listed the following benefits for them: developed personal character and leadership skills, improving their own learning skills, improved their facilitating techniques, acquired group management and presentation skills, and built their self-confidence and self-esteem. Ron Gardiner and Henry Loh are cited as the early leaders of the PASS project.

Staff. (1994). Supplemental Instruction. *South Carolina Association of Developmental Educators Newsletter*, 3.

The newsletter article provides an overview of the Supplemental Instruction (SI) program.

Staff. (1995). Supplemental Instruction equals science success. *Recruitment and Retention in Higher Education Newsletter*, 9(8), 9.

This newsletter article describes the use of Supplemental Instruction (SI) at the University of Wisconsin. The researchers from UW studied why the teaching of science discouraged women from pursuing academic degrees in the area. SI was cited as a supportive learning environment that was different than the one experienced in the classroom. Several suggestions for faculty members: build a comfortable classroom culture; provide collaborative learning activities; accept students' uncertainties about the content material; confirm the capacity of students to learn; and

personalize science so that students see the connections between the content and their personal lives.

Staff. (1996). Georgia's HOPE: A system in transition. *Black Issues in Higher Education*, 13(15), 10-13, 16.

This article describes Georgia's HOPE (Helping Outstanding Pupils Educationally) program to improve academic success of its college students. Dr. Stephen Portch serves as Chancellor of the University of Georgia System and Atty. Juanita Baranco is Regent with the University of Georgia System. Both are interviewed in this article. Portch suggests that Supplemental Instruction (SI), with its focus on at-risk courses rather than at-risk students, allows student to earn higher grades without labeling them in the process or continuing the previous system of remedial education that retaught material from high school.

Staff. (1997). Supplemental Instruction and minority students. *Journal of Developmental Education*, 20(3), 38.

This article describes a national research study of Supplemental Instruction (SI) with students of color. Students of color participated in SI at rates equal or exceeding those for White students (White, 33.3%; African-American, 42.0%; Hispanic-American, 50.9%; Asian-American, 33.3%; and Native-American, 42.9%). Students of color who participated in SI earned higher mean final course grades (2.02 vs. 1.55) and lower rates of D, F and withdrawal rates (36% vs. 43%) than similar students who did not.

Staff. (1998, 1998, January 16). Supplemental Instruction program at UMKC leads the way, *Inside UMKC Newsletter*, p. 1.

This newsletter article describes how the Supplemental Instruction program was featured at a conference hosted by the U.S. Department of Education called "Replacing Remediation in Higher Education" that was hosted at Stanford University on January 26-27, 1998. SI was one of only five programs to be presented at the invitation-only conference.

Staff. (1998). 1998 exemplary programs show how six campuses address pressing issues. *NASPA Forum*, 20(2), 7-10.

The National Association for Student Personnel Administrators (NASPA) conducted a national competition to identify exemplary programs located on postsecondary campuses that meet pressing issues. The Supplemental Instruction (SI) program from the University of Missouri-Kansas City was recognized through this process. This article provides a short overview of the SI program.

Staff. (1999). *Supplemental Instruction in engineering courses: An analysis of student participation*. Unpublished manuscript. University of North Carolina Charlotte. Charlotte, NC.

This report is an excerpt from the final report of a 1998-1999 study conducted on Supplemental Instruction (SI) in a high-attrition "gateway" engineering course at the University of North Carolina-Charlotte. After SI was introduced to UNC in 1985 within the College of Arts and Sciences, it quickly spread throughout the institution. Preentry attributes of the students in the study included ethnicity, gender, Grade Point Average, Predicted Grade Index, SAT scores, class, and academic major. SI participants were defined as those who attended five or more SI sessions during the academic term. There was no significant differences between SI and non-SI participants except for a slightly higher Predicted Grade Index for the SI participants. This was attributed to the possible impact of higher student motivation of the SI participants.

Staff. (2019 April 16). University of Missouri-Kansas City's innovative group study program (Supplemental Instruction) boosts student persistence. Available online

<https://www.prnewswire.com/news-releases/university-of-missouri-kansas-citys-innovative-group-study-program-boosts-student-persistence-300832528.html>

The University of Missouri-Kansas City (UMKC) today released the results of an ambitious effort to quantify the impact of student success initiatives, in collaboration with Civitas Learning. Designed to determine what works, and target resources at the most effective programs, the UMKC-Civitas Learning partnership was focused on identifying the best strategies to boost persistence among historically underrepresented minority students. According to data released today, the institution's supplemental instruction program (which utilizes tailored group-study in lieu of remedial education) boosts student persistence by 7.8 percentage points. "Like most institutions, we face the challenge of quickly and accurately evaluating the impact of our initiatives. By understanding the impact of a program that works on persistence -- and helps us retain tuition -- we can make a clear and compelling case for investments that are making a difference for our students," said Barbara Bichelmeyer, provost at the University of Missouri-Kansas City. "Civitas Learning enables us to quantify the impact of programs and translate data into strategies we can use to scale and replicate success." Although UMKC first pioneered its targeted, group-study program in the early 1970s, university leaders have struggled to quantify its impact. Using its patent-pending Impact analysis, in just hours, Civitas Learning was able to draw upon historically siloed data to identify a 7.8 percent overall increase in persistence for students who attended sessions three or more times each semester, compared to similar students who attended less than three sessions or not at all. The improvement was even more significant for part-time students and African American students in their first semester. Additionally, the analysis found a 9.9% overall increase in persistence for students who attend seven or more times each semester, indicating a potential to improve outcomes by encouraging students to make greater use of this resource. The Civitas Learning analysis also shows that gains achieved through the institution's supplemental instruction program should generate \$590,000 in additional retained tuition per term, with the potential to generate an additional \$1 million in revenue by encouraging students to attend group study sessions more frequently. Equipped with this evidence of the program's success, UMKC is now proposing expanding the program to serve all first-year students -- and using nudge campaigns -- to reach students most likely to benefit from the program.

Stansbury, S. L. (2001). Accelerated Learning Groups enhance Supplemental Instruction for at-risk students. *Journal of Developmental Education*, 24(3), 20-22, 24, 26, 28, 40. Available from the author at Sydbury@Yahoo.com.

In order to increase Supplemental Instruction (SI) attendance, Accelerated Learning Groups (ALGs) were developed. A pilot study investigated whether at-risk students who participated in an ALG/SI combination demonstrated higher self-efficacy and SI attendance than those who participated in only SI. Results suggested that at-risk students were more likely to participate in 12 or more SI sessions if they attended an ALG/SI combination than if they attended only SI. In addition, the range of final grades was higher for those who attended an ALG/SI combination than for those who attended only SI. The development of prerequisite skills was essential for the efficacy of SI to serve academically underprepared students who may shun the very academic intervention that would be of most help to them. Additional research is warranted to investigate this area.

Stansbury, S. L. (2001). *How to turn Supplemental Instruction nonparticipants into participants*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available from the author at Sydbury@Yahoo.com

This study investigated the outcomes of the Supplemental Instruction (SI) model with 215 students enrolled in General Biology and 200 students in General Chemistry at the University of Missouri-Kansas City. A variety of preentry attributes were collected from the students including

self-reported grade in a previous course of the same academic sequence, mastery goal orientation, performance-approach goal orientation, performance-avoidance goal orientation, self-efficacy, and interest in group study. While the findings were complex, several general statements include: higher SI attendance was correlated with higher final course grades, academically weaker students were less likely to attend SI sessions, academically weaker students reported higher levels of self-efficacy suggesting that they were less likely to accurately assess their strengths and weaknesses. This may also partly explain why these students were less likely to participate in SI sessions. The author recommends that the course professor administer a content-valid pretest during the first class period to provide feedback to all students and hopefully motivate the low scoring students to attend SI sessions. The paper concludes with an overview of Accelerated Learning Groups (ALGs), an intervention designed by the author at the University of Southern California to increase the academic success of at-risk students. The objective of ALGs is to identify students who have below average prerequisite skills for a course and assist them in strengthening these skills while they attend SI. ALGs were designed to work simultaneously with the campus SI program. Procedures for implementing ALGs is provided with data from a study of the effectiveness of ALGs in a chemistry course.

Stansbury, S. L. (n.d.). *Beyond the Supplemental Instruction summary report*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available from the author at Sydbury@Yahoo.com

This handout was used during training workshops conducted by the SI Director of Research and Training. Going beyond the descriptive statistics that were the baseline reporting system, Dr. Stansbury presents a variety of research methods to study SI more deeply to understand the impact of SI. In particular, the role of prior academic achievement and the frequency of SI attendance were critical to understand whether SI was making a statistically significant difference for the participating students regarding their final course grades.

Stenseth, C. A. (2005). *The relationship between Supplemental Instruction and locus of control among college students*. (Ph.D. dissertation), Minnesota State University Moorhead, Moorhead, MN.

Stephens, J. E. (1994). Supplemental Instruction in developmental mathematics. *Supplemental Instruction Update*, 1-2.

Based on a research study concerning the use of Supplemental Instruction (SI) with developmental mathematics courses at Tarleton State University (Forth Worth, TX), the data suggests the following: attendance at SI sessions is correlated with the perceived level of academic challenge in the course; academic achievement of SI participants is correlated with the level of activity in the SI sessions; if there is extensive verbalizations of the thinking process by SI session attendees, females will tend to have higher achievement than males; and if there is low levels by SI participants of vocalizing the thinking process the academic achievement is similar for males and females.

Stephens, J. E. (1995). A study of the effectiveness of Supplemental Instruction on developmental math students in higher education [Dissertation, University of North Texas, 1995]. *Dissertation Abstracts International*, 56(05), 1697A. (University Microfilms, No. 9529947). This quasi-experimental doctoral dissertation research study examined the effects of participation in a Supplemental Instruction (SI) program on student test performance in a second-level developmental mathematics class in a four-year university setting (rural North Central Texas, 6300 FTE) during Spring 1994. The research design followed Campbell and Stanley's Nonequivalent Control group Model (1963) with repeated measures. This research deviated from past research on SI in that it examined effects of the SI program at the end of

each of six test blocks rather than at the end of the course only. Test data were analyzed using analysis of variance; final course grades were analyzed using chi-square. Interview notes combined with notes on classroom behavior patterns and SI study session behaviors added to the ethnographic aspect of the study. Results showed that the SI students scored higher on unit tests throughout the semester, and this difference in scores became significant as the semester progressed (Score range: 0 to 100; Exam #1: 67.8 vs. 66.3; Exam #2: 78.97 vs. 74.34; Exam #3: 69.0 vs. 59.03; Exam #4: 84.13 vs. 54.02; Exam #5: 83.03 vs. 68.34; Final Exam: 68.77 vs. 51.35. Exams beginning with #3 were statistically significant ($p < .01$). The rate of A or B final course grades was higher for the SI group (36.6% vs. 6.7%). The rate of D and F grades (24.1% vs. 52.0%), course withdrawals (11.0% vs. 28.0%), and combined rate of D or F final course grades and withdrawals (35.4% vs. 80.0%) was lower for SI participants. Additional analysis examined the impact of low, medium and high attendance at SI sessions. These categories are defined as attending one-third, two-thirds, or all SI sessions during the examination period. Only in two of the six examination blocks was attendance found to be statistically significant (Exam #3 mean scores of SI participants: low, 62.7; medium, 75.33; high, 83.0. Exam #4: low, 78.33; medium, 88.42; high, 96.0). Overall percentage of SI participation grew throughout the academic term: exam #1, 18.7%; exam #2, 36.2%; exam #3, 46.7%; exam #4, 42.3%; and exam #5, 53.2%. Observations regarding behaviors during the SI sessions included: it took time before students became active and verbal participants; students began to understand error patterns revealed during unit examinations; problem solving skills increased; increased ability to explain thinking process regarding problem-solving; discovery of multiple approaches to problem-solving; the group developed camaraderie; and the emergence of several SI participants as subgroup leaders. Observations regarding behaviors during class lectures by SI participants found that after several weeks they began to ask more questions to the instructor concerning lecture material.

Stephens, J. E. (1995). Supplemental Instruction in developmental mathematics: Inquiring minds want to know. *Journal of Developmental Education*, 19(2), 38.

Based on the author's dissertation research concerning Supplemental Instruction (SI), the following observations concerning SI in math were made: (1) the developmental math student participants in SI in relationship to their perceived level of difficulty of the course instructor; (2) SI program success is dependent upon the level that students are active in SI sessions; (3) when the variable of repetition is applied to SI and non-SI participant, higher academic success is associated with first-time course students; (4) when the variable of gender is applied to SI and non-SI participant when there has been a high level of vocalization during SI sessions, females tend to increase more highly in academic terms than males; (5) when the variable of gender is applied to SI and non-SI participant when there has been a low level of vocalization during SI sessions, academic achievement will be fairly equal among the genders.

Stiles, T. (1985, 1985, November 6). Study guides help freshmen take note of differences in learning at college, *Chicago Tribune Newspaper*, p. 2.

This newspaper article provides an overview of the Supplemental Instruction (SI) program. The article discusses the transition shock experienced by many former high school students who were academically successful at the secondary level but are now facing academic difficulty in the more rigorous college environment. Deanna Martin, creator of the SI program, is quoted in the article.

Stockly, S. K. (1996). *Closing the gap in technical skills: Supplemental Instruction and Mexican-American undergraduate women*. Unpublished manuscript. Annual Meeting of the Southwestern Sociological Association. Houston, TX.

This quasi-experimental study in Spring 1994 examines the performance of Mexican American women in an Introductory Economics course (Economics 302, Principals of Macroeconomics) at the University of Texas at Austin. Supplemental Instruction (SI) was offered as an academic enrichment program for students. SI participation rates were higher for women than men and students of color when compared with White students. The data suggest that SI participation had a positive correlation with increased mean final course grades in all comparison groups except Asian American women (White: men, 2.84 vs. 2.37 and women, 2.77 vs. 2.06; African American: men, 1.60 vs. 1.50 and women, 3.00 vs. 1.25; Asian American: men, 3.20 vs. 2.46 and women, 2.78 vs. 3.00; Hispanic: men, 2.10 vs. 1.60 and women, 2.38 vs. 1.46; and all students: 2.68 vs. 2.19).

Stockly, S. K. (2000). Performance of minority students in economics: An econometric evaluation of Supplemental Instruction [Dissertation, University of Texas at Austin, 1999]. *Dissertation Abstracts International*, 60(12), 4541.

The scarcity of minority scholars in Economics is well-recognized, though few studies have addressed the issue. This dissertation identifies the introductory coursework in economics as a significant stumbling block for African American and Hispanic students and analyzes the effects of an extensive Supplemental Instruction (SI) program initiated to improve minority student achievement in these courses. Data were collected for over 9,000 students enrolled during two academic years, 1990-1991 (prior to the inception of SI) and 1993-1994 (after the program was fully operational). The data include independent variables that measure or proxy student-specific characteristics, academic maturity, relative high school quality, and institutional characteristics. Econometric testing of probit and ordered logit models indicate that minority students earn average grades that are significantly lower than those earned by their non-minority counterparts. Decomposition methodology, derived from analysis of wage differentials in Labor Economics, is used to quantify the gap in average grades into proportions that are explained and unexplained by the data. The analysis of the effects of SI on student performance reveals that women and minority students attend the adjunct sessions at higher rates than other students and that students who chose to participate in the program earn average grades that are significantly higher than those earned by students who either chose not to participate or were in course sections where SI was not available. Use of the decomposition methodology to control for the effects of self-selection indicates the SI program offers real value added. Students in the data set were followed for up to four years after the targeted semesters, allowing for an analysis of the long-term effects of participation in SI. Probit and ordered logit models tested whether SI enhanced student interest in taking additional coursework in economics, whether students who participated in SI were then able to achieve significantly higher scores in subsequent coursework, and whether the skills gained through participation in SI helped students achieve higher retention and graduation rates. Overall, the effects of SI in the longer term are positive and statistically significant.

Stone, M. E., & Jacobs, G. (Eds.). (2006). *Supplemental Instruction: New visions for empowering student learning*. New Directions for Teaching and Learning, No. 106, San Francisco: Jossey-Bass

This sourcebook includes the following chapters: 1. The impact of Supplemental Instruction on teaching students "how to learn," Sandra Yancy McGuire. 2. The basic SI model, Maureen Hurley, Glen Jacobs, Melinda Gilbert. 3. Supplemental Instruction at community college: The four pillars, Joyce Ship Zaritsky, Andi Toce. 4. A credit-bearing course for training SI leaders, Sally A. Lipsky. 5. Video-based Supplemental Instruction: Serving underprepared students, Maureen Hurley, Kay L. Patterson, F. Kim Wilcox. 6. Benefits to Supplemental Instruction leaders. M. Lisa Stout, Amelia J. McDaniel. 7. How Supplemental Instruction benefits faculty administration, and institutions, Sandra Zenger, Cathy Clark-Unite, Liesl Smith. 8. New

directions for Supplemental Instruction, Sonny L. Painter . 9. TeamSI : A resource for integrating and improving learning, Carin Muhr, Deanna C. Martin. 10. The New vision for SI: Where are we heading ? Glen Jacobs, Marion E. Stone, M. Lisa Stout.

Stone, M. E., & Jacobs, G. (Eds.). (2008). *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed.). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition. ERIC Document (ED559247) Available online:

https://archive.org/stream/ERIC_ED559247#page/n0/mode/2up

This monograph explores the Supplemental Instruction (SI) model through the following chapters: (introduction) 35 years of SI, F. Kim Wilcox and Glen Jacobs; (1) basic SI model, Maureen Hurley and Melinda Gilbert; (2) research on the effectiveness of SI, Maureen Hurley and Melinda Gilbert; (3) theoretical frameworks that inform the SI model, Sandra Zerger; (4) implementing a new SI program, F. Kim Wilcox; (5) recruiting and training SI leaders, Amelia McDaniel; (6) strategies for adapting SI to specific academic disciplines, Sandra Zerger; (7) Video-Based SI, Maureen Hurley, Kay Patterson, Sonny Painter, and Jennifer Carnicom; (8) SI international adaptations and future directions, Glen Jacobs M. Lisa Stout, and Marion E. Stone; (9) Concluding the first 35 years, Amelia McDaniel; (appendix a) glossary of terms; (appendix b) selected annotated bibliography for SI, David R. Arendale

Stone, M. E., Jacobs, G., & Hayes, H. (2006). Supplemental Instruction: Student perspectives in the 21st century. In D. B. Lundell, J. L. Higbee & I. M. Duranczyk (Eds.), *Student standpoints about access programs in higher education* (pp. 129-141). Minneapolis, MN: Center for Developmental Education and Urban Literacy, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/publications.html>.

This qualitative study was conducted with Supplemental Instruction (SI) participants at the University of Missouri-Kansas City. Themes that emerged regarding the positive benefits of SI included: better organization of course material, reinforcement of major concepts, clarification of questions asked identification of key concepts, learning in a "safe" environment, opportunity to voice understanding., exposure to other perspectives, deeper understanding, and increased confidence. Several themes emerged regarding challenges with the SI model. These included: unproductive SI sessions, SI leaders did not reteach the course material, sometimes received contradictory or confusing information, and some expressed dissatisfaction with peer cooperative learning. SI leaders were also a part of the qualitative study. Themes that emerged included: leadership development, study strategy development, opportunity to teach, deeper content knowledge, and development of relationships.

Stout, B., & Wiatr, J. (2001). Supplemental Instruction (SI): More on recruiting SI leaders. *The Learning Center Newsletter*. Available online:

<http://www.learningassistance.com/2001/Dec01/index.htm>.

This article describes the strategies used at the University of Pittsburgh to attract and retain group leaders to work with their Supplemental Instruction (SI) program.

Stout, B., & Wiatr, J. (2001). Supplemental Instruction (SI): Training SI leaders. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2001/Nov01/index.htm>.

The authors describe the procedures that they followed at the University of Pittsburgh in training the Supplemental Instruction (SI) leaders. The training program included both an intensive workshop before the beginning of the academic term, but also follow-up sessions. These included clinical supervision observations by the campus SI coordinator as well as requiring SI leaders to view sessions run by fellow student leaders to gain more perspectives on how to facilitate their own groups.

Stout, B., & Wiatr, J. (2001). Supplemental Instruction (SI): Recruiting SI leaders. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2001/Aug01/index.htm>. The authors from the University of Pittsburgh make a number of recommendation on strategies for recruiting Supplemental Instruction (SI) leaders. The process for selection is a rigorous one to identify the most appropriate student for the role due to the high demands placed upon the position.

Stout, B., & Wiatr, J. (2001). Getting started with Supplemental Instruction (SI). *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2001/Jun01/index.htm>. This article begins a series in this newsletter devoted to establishing an Supplemental Instruction (SI) program on a campus. The authors directed the SI program at the University of Pittsburgh (PA). A variety of administrative issues are explored concerning the establishment and smooth running of the SI program.

Stout, B., & Wiatr, J. (2001). Supplemental Instruction (SI): Department to SI program dynamics. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2001/Jul01/index.htm>. This article describes the efforts by the campus Supplemental Instruction (SI) coordinators at the University of Pittsburgh (PA) to develop their program and gain campus support. Recommendations are made how to effectively approach academic departments and their faculty members regarding the introduction of SI to the courses.

Stout, B., & Wiatr, J. (2002). Supplemental Instruction: Developing an SI proposal. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2002/Mar02/SI.htm>. This article describes some strategies for gaining and managing financial support for a Supplemental Instruction (SI) program. The authors cite the need to develop a comprehensive funding plan to support all aspects of an SI program.

Stout, B., & Wiatr, J. (2002). Supplemental Instruction (SI): Evaluating the SI program. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2002/Feb02/SI.htm>. This article suggests some simple quantitative research procedures to collect data and provide a rudimentary evaluation system for Supplemental Instruction (SI).

Stout, B., & Wiatr, J. (2002). Supplemental Instruction (SI): Faculty support and the SI program. *The Learning Center Newsletter*. Available online: <http://www.learningassistance.com/2002/Jan02/SI.htm>. This article explores the relationship between the Supplemental Instruction (SI) program and the faculty member that sponsors it with their class. The authors provide a history of the development of SI at the University of Pittsburgh (PA). Also the authors describe the use of SI as a faculty development strategy for faculty members who request the feedback from the SI leader.

Stout, M. L., & McDaniel, A. J. (2006). Benefits to Supplemental Instruction leaders. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 55-62). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter explores the many benefits that accrue to Supplemental instruction (SI) leaders as a result of their participation: academic competency, improved communication and relationship-building skills, enhanced personal development such as higher self-confidence and self-esteem,

and enhanced professional development such as leadership skills, teamwork strategies, verbal and written expression, and self-assurance.

Stratton, C. B. (1998). Transitions in Developmental Education: Interviews with Hunter Boylan and David Arendale. In P. L. Dwinell & J. L. Higbee (Eds.), *The Role of Developmental Education in Preparing Successful College Students* (pp. 25-36). Columbia, SC: The National Association for Developmental Education and the National Center for the Study of the Freshmen Year Experience and Students in Transition

In this book chapter the author interviews two leaders in the field of developmental education. Hunter Boylan directs the National Center for Developmental Education. David Arendale directs national dissemination of Supplemental Instruction. Both have served as past presidents of NADE. Arendale talks about how developmental education must be "mainstreamed" into the college curriculum rather than continuing with the current model of separate tracks of courses and support for students who need academic assistance. Supplemental Instruction and Video-Based Supplemental Instruction are cited as examples for embedding academic assistance into college-level courses. Brief overviews are provided for both programs. He suggests that SI and VSI present an acceptable way for accomplishing the mission of developmental education which is politically acceptable to policy makers at the institution, state, and national level.

Stratton, C. B., Commander, N. E., Callahan, C. A., & Smith, B. D. (1996). *From DS to LS: The expansion of an academic preparation program from developmental studies to learning support*. Conference Proceedings of the National Association for Developmental Education, Little Rock, AR.

With increased emphasis on student retention, a model for expanding academic support through Supplemental Instruction was developed to provide a comprehensive program for a larger population at Georgia State University (Atlanta, GA). Research studies suggested that SI participants earned higher mean final course grades. In addition, students whose predicted success (based on SAT scores and a formula predicting GPA) was low outperformed their peers predicted to be more successful.

Stratton, C. B., Commander, N. E., Callahan, C. A., & Smith, B. D. (2001). A model to provide learning assistance for all students. In V. L. Farmer & W. A. Barham (Eds.), *Selected models of developmental education programs in higher education* (pp. 63-88). Lanham, NY: University Press of America

Supplemental Instruction (SI) ed at Georgia State University, an urban institution with 25,000 students. Due to changing institutional policies, the emphasis was shifted from a traditional developmental education program that focused on the lowest academically prepared students to a campus program that served students from all academic ability levels. SI was a key component of the new mission. Academic achievement data is reported in classes where SI was offered to all students: accounting, biology, history, and political science between 1994 and 1997 and the results favored SI participants. The book chapter reports on a variety of other adjunct instructional approaches to providing academic enrichment for a broader scope of students and the administrative issues that guided the decision making with this change.

Sulski, J. (1991, 1991, January 6). Keeping minorities in college. Schools growing more sensitive to students' needs, *Chicago Tribune Newspaper*, p. 4.

This newspaper article mentions that Supplemental Instruction (SI) is one of the activities that is used to improve student achievement of Hispanic students. The Latin American Recruitment and Educational Services (LARES) program is directed by Leonard Ramirez at the University of Illinois at Chicago. SI is a component of the LARES program to help students develop their study strategies and writing skills.

Sultan, F. K. P. D., Narayansany, K. S., Kee, H. L., Kuan, C. H., Manickam, M. K. P., & Tee, M. Y. (2014). Helping students with difficult first year subjects through the PASS Program. *Journal of Peer Learning*, 6(1), 59-75. Available online: <http://ro.uow.edu.au/ajpl/vol6/iss1/6>.

The purpose of this action research was to find out if participants of a pilot PASS program found it to be helpful. The PASS program is based on the Supplemental Instruction (SI) model. The program was implemented for the first time in an institute of higher learning in Malaysia. An action research design guided the study, with surveys, documents, and reflections as primary data sources. The findings were largely positive, with participants citing PASS sessions to have helped them in the study of difficult first year subjects and in the development of some study skills. PASS also improved social integration. The collaborative and facilitated structure of PASS sessions were reported to be key aspects that improved student learning. Some issues were also highlighted and discussed, such as misconceptions of the role of PASS leaders.

Summers, E. J., Acee, T. W., & Ryser, G. R. (2015). Differential benefits of attending Supplemental Instruction for introductory, large-section, university U.S. history courses. *College Reading and Learning*, 45(2), 147-163. doi: doi:10.1080/10790195.2015.1030516.

The authors investigated students' academic achievement in three high-enrollment, introductory-level history sections at a large, public, Hispanic-serving university. Using a conditional indirect-effects model, they analyzed Supplemental Instruction (SI) attendance and class absences as predictors of course success, after accounting for sex, ethnicity/race, and SAT/ACT scores. Results suggested a positive direct effect of SI attendance on course success and a negative direct effect of absences. A significant interaction effect between ethnicity/race and SI suggested that Hispanic students reaped stronger benefits from SI than Caucasian students, and that the course achievement gap between these groups was smaller when students attended more hours of SI. Their study contributes new findings to research supporting the effectiveness of SI by examining mediation and moderation effects and controlling for confounding variables.

Supple, B. J., Best, G., & Amanda, P. (2016). "My purpose was to help them with accounting, not English": An exploratory study of languages other than English in PASS. *Journal of Peer Learning*, 9(1), article 6. Available online:

<http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1101&context=ajpl>.

This paper considers when and for what purposes Peer Assisted Study Session (PASS) Leaders at an English medium university use their first language (when that language is not the dominant language of instruction) to facilitate PASS sessions in an English speaking university. This small qualitative exploratory study examines the experiences of eight PASS Leaders who speak a language other than English. The paper explores how and for what purposes the PASS Leaders utilised their first language (referred to as L1) of Chinese or Vietnamese and their second language of English (referred to as L2). The research participants revealed complex and well-considered decision-making processes regarding the language(s) they used in their sessions as PASS Leaders. Broadly, the language they used depended on the linguistic backgrounds and preferences of the session attendees, the concepts covered in the sessions, and the importance PASS Leaders ascribed to learning English over learning the subject's content. We suggest that there may be room for languages other than English as a "medium of instruction" in PASS sessions. Our initial investigations warrant broader discussion and further research within the PASS/SI community about the role L1s can play in enhancing the student learning experience in PASS sessions, for both PASS Leaders and PASS attendees.

Sutton, K. (1994, 1994, February 5). Deanna Martin aids University of Port Elizabeth to chop failure rate, *Eastern Providence Herald Newspaper*, p. 7.

This newspaper article contains an interview of Deanna Martin who is creator of the Supplemental Instruction (SI) model. The interview describes the development of the SI model in the United States and its implementation at institutions worldwide. Included is a description of the role of Dr. Andre Havenga in developing the program at the University of Port Elizabeth in South Africa.

Synco, T. M. (2012). *Background or experience? Using logistic regression to predict college retention*. (Ph.D. dissertation), University of Alabama at Birmingham, Birmingham, AL.

Tinto, Astin and others have researched the retention and attrition of students from college for more than thirty years. However, the six year graduation rate for all first-time full-time freshmen for the 2002 cohort was 57%. This study sought to determine the retention variables that predicted continued enrollment of entering freshmen at a large urban, four-year, public institution. Logistic regression was utilized to analyze the data collected over a four-year period. The population studied was 1,346 first-time full-time freshmen entering fall 2007. The variables chosen for analysis were ACT composite, cumulative GPA and high school GPA, ethnicity, gender, Pell eligibility, unmet financial need, advising, early alert notices, engagement and freshman year experience courses, honors participation, change of major, campus housing, and supplemental instruction. Data were analyzed by year of enrollment through spring 2011. Correlation studies eliminated the threat of multicollinearity. The logistic regression models passed goodness-of-fit tests for Hosmer Lemeshow, Omnibus Test of Coefficients, and Cox and Snell and Nagelkerke. The analyses found that ACT Composite, cumulative GPA, advising, ethnicity, engagement courses, change of major, and supplemental instruction were predictors for retention. In year one, two, three and four each one point raise in GPA increased the likelihood of persistence by 3.99, 3.31, 3.52, and 11.60 times, respectively. In year one and two students who were White were 2.29 times and 1.74 times more likely to persist, respectively. Living on campus and having advising appointments in the first year increased the likelihood of persisting by a factor of 1.46 and 1.21, respectively. Changing major in the first year increased the likelihood of returning by a factor of 4. In the fourth year, each change of major decreased the likelihood of persisting by a factor of .62; having a higher ACT composite score decreased the likelihood of persisting while Supplemental Instruction sessions increased the likelihood of persisting. Investigative efforts to validate the coding of participation in freshman year experience courses found large discrepancies between the reported and actual frequency counts reported by the system. A need to audit and correct student information system data related to retention variables was noted.

Szal, C., & Kennelly, K. R. (2017). The effects of Supplemental Instruction on student grades in a blended learning context. *Developments in Business Simulation and Experiential Learning*, 40, 230-236.

Supplemental Instruction (SI) programs have been used in college and university programs since their inception in the 1970's. The programs are viewed as a cost-effective method of delivering peer-assisted instruction to students in courses deemed difficult by virtue of the fact that they suffer from high failure and drop rates. There have been many analyses that attempt to determine the efficacy of these programs in improving student involvement and grades in the courses and in reducing drop rates and retention. Virtually every analysis has arrived at the conclusion that the SI program is successful in these endeavors. A state school is involved in the transformation of many lower-division classes to a blended learning format in an effort to increase efficiency for the use of teaching staff and classroom space. In the view of the authors, the use of SI programs using student leaders takes on added importance. The paper performs an analysis concerning the results for an introductory business statistics class. The results indicate that SI sessions had a large positive effect on student grades in the class, and the effect of SI sessions is larger than either time spent on homework assignments or participation

in lecture activities. For every SI session attended a student's grade improves by 0.73 points on a 100 point scale. The paper concludes by indicating additional data requirements that could help future research clarify the effects of SI on different demographic groups.

Szal, R. (2018). *Gender, statistical anxiety, and Supplemental Instruction* Conference Proceedings of the Developments in business simulation and experimental learning. Available online: <https://absel-ojs-ttu.tdl.org/absel/index.php/absel/article/view/3153/3089>
Supplemental Instruction (SI) programs, which have been used in colleges and universities since the 1970's, are viewed as a cost-effective method of delivering peer-assisted instruction to students in courses that traditionally experience high failure and drop rates. In a previous analysis of students in an introductory business statistics class at a mid-sized university in the Southwest, it was found that SI was very important in a student's grade determination, especially in view of the fact that the course is designed as blended learning meeting one time per week. The analysis also seemed to indicate that there may well be significant differences as between men and women in terms of the effect of SI attendance on grade determination. The present paper investigates the differences between males and females in the course, and concludes that, while both men and women suffer from a fear of statistics (and mathematical courses in general) upon entering the course, their reactions to the anxiety are very different. While men appear to be better prepared than women when beginning the course, at the end of the semester, there is no significant difference in final grades. Several possible reasons for this are given, and the results may hold important lessons for encouraging greater participation of females in STEM activities from an early age.

Taksa, I., & Goldberg, R. (2004). Web-delivered Supplemental Instruction: Dynamic customizing of search algorithms to enhance independent learning for developmental mathematics students. *Mathematics and Computer Education*, 38(2), 152-164.
Supplemental Instruction (SI) was modified for web delivery to increase its use and effectiveness of results for students. The focus was on serving developmental math students at the City University of New York.

Tanaka, C. (1995). *Peer Assisted Study Sessions in HUB 661 Japanese*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.
This research report documents the use of Peer Assisted Study Sessions (PASS) at Queensland University of Technology (Brisbane, Queensland, Australia) in HUB 661 Japanese language course. This course is often chosen as a second-semester, first year subject for International Business students. PASS is the local institutional name for the Supplemental Instruction (SI) program. Benefits of the PASS program for participants included slightly higher mean final course grades and lower rates of withdrawal. The professor who had PASS attached to his class reported receiving helpful feedback from the PASS leader concerning the comprehension level of the students. This afforded them an opportunity to revise lectures and review upcoming examinations. PASS leaders reported the following behavioral changes: learned how to give feedback to the course lecturer in an appropriate fashion; learned to work in harmony with other students and leaders; improved their own communication skills; improved their content knowledge and skill; and gained valuable insight into the learning process.

Tangwe, M. N. (2016). Students' insights on the implementation of peer academic support programs at one university in South Africa. *Dirasat: Educational Sciences*, 43(3), 2163-2176.
The worldwide business regarding the high dropout and low throughput rates at previously disadvantaged universities in South Africa led to the institution of academic support programs. The report examines the insights of undergraduate students regarding the execution of the supplemental instruction and speech and writing consultant programs at the University of Fort

Hare, South Africa. The findings revealed that these programs are very useful and helpful to undergraduate students, though there were some shortcomings that require the attention of the governing body of the university. In this regards, some recommendations were provided in order to improve the implementation of these cherished programs. The evaluation study was conducted at the University of Fort Hare in the Eastrn Cape Province of South Africa.

Tangwe, M. N., & Rembe, S. (2014). The perceptions of students on the implementaiton of peer academic support programmes at one university in South Africa. *Mediterranean Journal of Social Sciences*, 5(4), 378-389. doi: 10.5901/mjss.2014.v5n4p378. Available online: <http://mcser.org/journal/index.php/mjss/article/viewFile/2225/2211>.

The general concern regarding the high dropout and low throughput rates at previously disadvantaged universities led to the establishment of academic support programmes. The paper examines the perceptions of undergraduate students regarding the implementation of the Supplemental Instruction and language and writing consultant programmes at one university in South Africa. The findings reveal that these programmes are very useful and helpful to undergraduate students though there are some shortcomings that need the attention of the administration of the university. In this regards, some recommendations are presented in order to ameliorate the implementation of these cherished programmes

Tangwe, M. N., & Rembe, S. (2015). Monitoring and evaluation of peer academic support programs in South African higher education institutions. *International Journal of Education Science*, 8(7), 249-260. Available online: <http://www.krepublishers.com/02-Journals/IJES/IJES-08-0-000-15-Web/IJES-08-2-000-15-Abst-PDF/IJES-8-2-249-15-507-Tangwe-N-N/IJES-8-2-249-15-507-Tangwe-N-N-Tx%5B1%5D.pdf>.

The high failure and retention rates at universities despite peer academic support programs has necessitated the need for the present study to investigate how monitoring and evaluation is carried out to support the facilitators of these programs. The study adopted a qualitative approach, collecting data from a sample of 12 participants made up of program oordinators and peer academic facilitators. The results indicate that there is monitoring and evaluation of these programs by program coordinators and peer facilitators. This is achieved through observation during sessions, unannounced visits and support to facilitators. However, the structures and mechanisms of monitoring and evaluation are not strong enough to enhance effective implementation of the programs. It is concluded that although there are good peer academic support programs at this university under study, there is need for rigorous monitoring and evaluation as well as support by more qualified person

Taylor, G. T., Healy, C. E., & Macdonald, M. (1994). Engineering educational development: Raising the quality through partnerships. In J. Wallace (Ed.), *Kingston University HEFCE Supplemental Instruction Project* (pp. 225-230). London, England: Kingston University

The changes which face education today make it essential that quality is raised by moving from a teaching to a learning culture. Supplemental Instruction (SI) was used to create a partnerships between student, staff and employers working together to develop a learning environment in the Department of Energy and Environmental Technology at Glasgow Caledonian University in Glasgow, England. Students indicated the following reasons for SI participation: students want to work in peer groups; students recognize the academic difficulty of their courses; and students believe that peer groups are a source of information and help for them. In an evaluation of the SI program, SI leaders indicated growth in the following areas: verbal and nonverbal communications, learning techniques, interpersonal communication skills, consideration of college major change to a teaching career, and gaining employment skills that makes them more attractive to potential employers.

Terrion, J. L., & Daojust, J.-L. (2011). Assessing the impact of Supplemental Instruction on the retention of undergraduate students after controlling for motivation. *Journal of College Student Retention: Research, Theory and Practice*, 13(3), 311-327.

The University of Ottawa (UofO) in Ottawa, Canada offers a formal Supplemental Instruction program, called the residence study group program (RSGP), to residence students registered in first year courses that are associated with a high degree of failure or attrition. The objective of this study was to assess the impact of this program by comparing a sample of first year residence students who participated in the RSGP with a sample who did not participate. The study compared final grades of students in these courses after controlling for personal motivation and found that while those who participated in the RSGP did not receive higher final grades than non-participants, they were more likely to persist in their studies. It appears that the RSGP contributes in many important ways to the academic and social integration of first year students and these are critical to persistence beyond the first year.

Thalluri, J., O'Flaherty, J. A., & Shepherd, P. L. (2014). Classmate peer-coaching: "A study buddy support scheme". *Journal of Peer Learning*, 7(1), Article 8. Available online: <http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1097&context=ajpl>.

This study had two aims: firstly, to determine whether participation in a peer support scheme called Study Buddy Support (SBS) improves pass rates of "at risk" students, and secondly, to examine the advantages of this model over hierarchical models where senior students tutor junior years. Bachelor of Nursing and Midwifery students in a first year Bioscience course completed an assessment early in the semester. Based on their performance, "at risk" students (Buddies) and high achievers (Buddy Leaders) were identified to participate in this scheme, either on campus (internal) or via Virtual Classrooms (VC) (external). Quantitative percentage failure rates for those "not at risk" and those "at risk" utilising and not utilising SBS were compared. Qualitative comments were also examined. Of those in the SBS scheme, 72% passed, while only 49% of those not participating passed. Buddies identified the reassurance of not being alone, as well as a friendly, non-intimidating learning environment, as SBS positives. For Buddy Leaders, consolidation of learning, developing networks, and improved team and leadership skills were positives. The current SBS scheme increased percentage pass rates and Buddies and Buddy Leaders alike suggested personal benefits for the initiative. The networks developed in this SBS scheme can progress throughout the entire degree but are lost in a hierarchical model as senior mentors graduate. This suggests that the advantages of the SBS scheme may persist beyond first year and may further strengthen retention in later years.

Thomas, G., Roche, L., Brocato, M., & McGuire, S. (2019). Supplemental Instruction levels the playing field in STEM at Louisiana State University. In Z. S. Wilson-Kennedy, G. S. Byrd, E. Kennedy & H. T. Frierson (Eds.), *Diversity in Higher Education* (Vol. 22): Emerald Publishing. The Center for Academic Success (CAS) at Louisiana State University (LSU), certified as a Center of Excellence by the National College Learning Center Association, has utilized Supplemental Instruction® (SI) for the past 20 years to provide student support for historically difficult courses – those courses with D, F, or withdrawal rates of greater than 30%. In this model, peers called "SI leaders" facilitate study sessions outside of class time to help the enrolled students develop effective learning strategies and better understand and master course concepts. SI relies upon collaboration with faculty and is supported by cognitivism and social constructivism learning theories. Benefits of the successful model include supporting students to become self-directed independent learners, reducing the stigma associated with using academic support and reducing the demands for tutoring. Outcomes observed at LSU include positive correlations between the course-passing rates and six-year graduation rates of women, underrepresented minorities and first-generation college students who participated in SI compared to the peers who participate less frequently and those who do not participate.

Thomas, L., Quinn, J., Slack, K., & Casey, L. (2002). Student services: Effective approaches to retaining students in higher education of Work. of Work. Department. Institute for Access Studies, Staffordshire University. Stoke-on-Trent, United Kingdom.

Bournemouth University in the United Kingdom describes its Peer Assisted Learning (PAL) program which is based upon Supplemental Instruction (SI) on page 51 of this directory of programs used at postsecondary institutions in England to meet needs of students to support their persistence towards graduation.

Thomas, L., Quinn, J., Slack, K., & Casey, L. (2003). Effective approaches to retaining students in higher education: Directory of practice of Work. of Work. Department. Institute for Access Studies, Staffordshire University. Stoke-on-Trent, United Kingdom.

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Thompkins, C. D. (2001). Learning to facilitate construction of understanding: A case study of Supplemental Instruction leaders [Dissertation, North Carolina State University, 2001].

Dissertation Abstracts International, 62(01), 70.

The purpose of this study was to investigate the verbal interactions between Supplemental Instruction leaders and students within the context of Supplemental Instructions sessions to acquire an understanding of how dialogue exchanges were established and maintained over the course of a semester. Three novice Supplemental Instruction leaders were selected for this study. Their classes were observed and recorded throughout the semester through the use of audio and video recordings and observer field notes. Their beliefs about teaching and learning, their rationale for making instructional decisions and their perceptions about their students' learning were identified through the use of interviews. A socio-constructivist perspective was used to frame and interpret the findings of the study. This perspective embraces the idea that students not only construct knowledge individually, they construct knowledge socially through interactions with others by establishing a sociocultural system. This system establishes the norm for how classroom interactions will occur. Analysis of verbal interchanges that took place over the semester in each of the SI leaders' classrooms indicated that the type of talk that occurred in two SI leaders' sessions changed, resulting in an increase in student involvement. No differences in exchanges over the semester were found for the third SI leader. The factors that seemed to most strongly influence how SI leaders led sessions were their initial beliefs about teaching and learning and their perceptions of students' needs. The factors found to affect implementation of instructional strategies were the numbers of students attending the session, the immediate stated and observed needs of the students and the pedagogical inexperience of the SI leaders. The findings of this study indicated that the three SI leaders respective belief systems ultimately determined what went on in SI sessions. Although all three had the same SI training and initially indicated that they would actively involve students, only two SI leaders were eventually able to do this.

Timmermans, S. R., & Heerspink, J. B. (1996). Intensive developmental instruction in a pre-college summer program. *The Learning Assistance Review*, 1(2), 32-44.

This article describes a modification of the Supplemental Instruction (SI) model at Calvin College (Grand Rapids, MI) to take into account the cognitive and developmental factors of high school students. This instructional component was placed in a pre-college summer program called Intensive Developmental Instruction (IDI). Unique features of IDI include: high school students are placed in college-level classes beyond their current level of academic ability; the SI

leader is a certified K-12 teacher from outside the course area who takes the class along with the high school students; and explicit instruction is provided by the IDI leader in learning strategies. A comparison was made between the IDI high school students and the college students in the same classes who did not participate in IDI. It was assumed that the college students were stronger academically than the high school students since their mean ACT score was higher (24 vs. 20 for IDI students). IDI students received a grade of C or higher 88.7 percent of time compared with 80.6 percent for the college students. Results from the Learning and Study Strategies Inventory suggest that their involvement in IDI improved their use of learning strategies.

Tinto, V. (2014). Tinto's South Africa lectures. *Journal of Student Affairs in Africa*, 2(2). Available online: <https://www.ajol.info/index.php/jssa/article/view/133565/123172>.

Professor Tinto discussed the Supplemental Instruction program during one of his talks in South Africa.

Toby, E., Scott, T., Migl, D., & Kolodzeji, E. (2016). Supplemental Instruction in Physical Chemistry I. *The Learning Assistance Review*, 21(1), 71-79.

Physical chemistry I at Texas A&M University is an upper division course requiring mathematical and analytical skills. As such, this course poses a major problem for many Chemistry, Engineering, Biochemistry and Genetics majors. Comparisons between participants and non-participants in Supplemental Instruction for physical chemistry were made using analyses that controlled for prior mathematical ability and academic achievement. When controlling for prior mathematical ability, no statistical evidence was found that supplemental instruction attendance increased the final grade in physical chemistry I. However, when controlling for prior academic achievement, students with lower prior achievement were found to benefit from supplemental instruction while high achieving students derived no benefit.

Tonsetic, R., & Warren, B. Z. (1997). *Assisting faculty and students in adjusting to large class environments*. Unpublished manuscript. University of Central Florida. Orlando, FL.

This paper discusses the use of Supplemental Instruction (SI) at the University of Central Florida (27,000 students) as one component in dealing with helping faculty and students deal with large classes. In Spring 1997 39 classes had an enrollment of 200 or more students. During Fall 1996 SI was provided for four large class sections including a chemistry course for non-science majors. SI participants earned a higher mean final course grade (3.39 vs. 1.72). When adjusted for differences in SAT scores, the SI group still received higher grades (2.54 vs. 1.71). The percent of A and B final course grades was higher for the SI group (47% vs. 20%) as well as lower rates of D, F or course withdrawals (18% vs. 56%). Positive results were also reported for the SI in general biology and American national government. There were no significant differences in the calculus course. While there was high satisfaction with the SI participants, the grade differences were not significant. The authors suggest that the SI sessions in math need modification for more effective use. In addition, the authors administered several personality instruments for additional research. The Student Behavior Checklist (Long, 1985) examined the Long Reactive Personality Types with the SI participants and generated the following results: aggressive-independent (16%); aggressive-dependent (48%); passive-independent (8%); and passive-dependent (16%). Using the Long Personality Traits instrument the following results were generated concerning the SI participants: phobic (31%); compulsive (69%); impulsive (15%); and hysteric (32%).

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: A typology and review of the literature. *Higher Education*, 32(3), 321-345.

The increasing use of peer tutoring in British higher education necessitates a clear definition and typology. Through an extensive review of the literature, the author discusses peer tutoring in general with a short review of and the Supplemental Instruction (SI) program. Research studies from both the U.S. and U.K. suggest that participation in SI is positively correlated with higher mean final course grades. Other UK studies suggested improved communication skills and deeper understanding of the curriculum occurred for SI participants and higher grades for the SI leaders themselves.

Tran, C., Hartmann, K., Olsker, T. C., & Bonsangue, M. (2016). The impact of Supplemental Instruction on the SI leader. *Supplemental Instruction Journal*, 2(1), 6-18. Available online: <http://info.umkc.edu/si/wp-content/uploads/2016/09/siJ-Volume-Two-Issue-One.pdf>.

This study conducted at California State University, Fullerton, examined the impact of SI upon the leaders. Variables included sex, first generation status, and underrepresented minority group status. Men increased confidence and communication effectiveness at higher rates than women. The underrepresented group reported higher ability to handle student conflict and communicate with peer than majority students.

Tuerk, R. (2018). *The effects of Supplemental Instruction on student attitudes and academic skills*. (Ph.D. dissertation), Texas A&M, Commerce, TX.

At post-secondary institutions in the United States, the frequent topics of discussion are undergraduate retention, persistence, and graduation rates. Researchers have identified specific factors that promote student retention, engagement, and degree completion; these factors involve a combination of academic and cognitive development and social integration (Astin, 1999; Terenzini, 1987; Tinto, 1987). Supplemental Instruction (SI), a form of peer assisted tutoring, incorporates peer interaction and collaboration while engaging students in academic activities (Maxwell, 1998; McGuire, 2006). Since the inception of SI in the early 1970s it has proven to be an effective intervention in regards to producing positive results related to student retention, persistence, and graduation rates (Bowles, McCoy, & Bates, 2008; Ramirez, 1997). Although many researchers have focused on SI and the long-term and short-term student outcomes, very little is known regarding effects of SI on student attitudes and academic skills. The purpose of this study was to assess if a change in student scores occurs on the College Learning Effectiveness Inventory (CLEI) in relation to academic self-efficacy, organization and attention to study, stress and time pressure, involvement with college activity, emotional satisfaction, and class communication from the beginning and the end of the semester based on SI usage. Keywords: Supplemental Instruction (SI), College Learning Effectiveness Inventory (CLEI), academic integration, social integration

Turner, A. L. (2017). *Increasing student performance in Algebra through support programs*. (Ph.D. dissertation), Northcentral University.

Due to national criticism of developmental math programs, community colleges have had to identify ways to support under prepared students in the college level math classroom. Developmental math programs have long been costly without producing results that transfer to retention, graduation or transfer credits. Using archived data of college algebra students at the community college of Denver, this study compared student's performance when in a support course to similar students performance not enrolled in a support course. This study also compared student's performance when attending Supplemental Instruction sessions to those students that did not attend Supplemental Instruction sessions. The study was a quasi-experimental mixed method study. ANOVA was used to determine if there was a statistical significant difference between the two groups of students. In all groups there was no statistical difference between students that were enrolled in a concurrent support course and those that were not enrolled at all at risk levels. The mean at risk level two and level three was lower with

students that were enrolled in the concurrent support group. While supplemental instruction did produce a higher mean in all at risk group levels, the participation in the program was low and did not produce statistically significant results. Recommendations include training advising programs to make sure students are placed in the correct math pathway course and providing professional development to concurrent support course instructors to create a more student centered, active classroom that supports the college algebra course.

Turner, M. (2004, 2004, October 2). \$3M grant helps students with learning, teaching, *The Modesto Bee*, p. A 22.

This newspaper article describes how Supplemental Instruction (SI) is being implemented to support academic success of students but also provide a professional development experience for the SI leaders. The article contains quotations from SI program administrators and SI leaders. One of the leaders describes how serving as a SI leader provided insight to a potential teaching career.

United Press International. (1990, 1990, August 16). UMKC program improves grades, retention of students in college, *Kirksville Daily News*, pp. 1-2.

The newspaper article carried by United Press International (UPI) provides a short overview of the Supplemental Instruction (SI) program.

Urban, C. Q. (2005). *The effects of using computer-based distance education for Supplemental Instruction compared to traditional tutorial sessions to enhance learning for students at-risk for academic difficulties*. (Ph.D. dissertation), George Mason University, Fairfax, VA.

The purpose of this study was to investigate the effects of using computer-based distance education (CDE) Supplemental Instruction compared to traditional tutorial sessions (TS) to enhance learning for students at-risk for academic difficulties. The research question guiding this study was: Does using computer-based distance education for supplemental instruction prove comparable to, or better than, traditional tutorial sessions to enhance learning for baccalaureate nursing students at risk for academic difficulties? Two hypotheses were generated based on this question. Previous studies had suggested that using computer-based distance education for supplemental instruction was an effective method to enhance student learning. Moore's theory of transactional distance (1993) supports using CDE methods that provide adequate structure and dialogue to decrease the amount of transactional distance and enhance learning. Research Hypothesis 1 stated that adult students attending a classroom lecture course augmented by supplemental instruction provided by computer-based distance education (CDE) would demonstrate a higher change score between a knowledge-based posttest and pretest than their cohorts attending weekly traditional tutorial sessions (TS). There were no significant differences noted on 2-way ANOVA testing based on method or risk category between the experimental (CDE) and control (TS) and Research Hypothesis 1 was not supported. But with the exception of the TS not at-risk student group, all CDE groups had higher mean change scores than their cohorts. Research Hypothesis 2 stated that adult students accessing computer-based distance education (CDE) supplemental instruction would score higher on five separate unit exams given throughout the course than their cohorts attending weekly traditional tutorial sessions (TS). Only two tests resulted in a significant difference on 2-way ANOVA testing. There were significant differences between both the method (CDE/TS group) and for the risk category "not at-risk" on only two exams and Research Hypothesis 2 was only partially supported. For most exams, both WebCT(TM) and Tutorial groups had an increase in score of at least one point (2% points) when compared to the total class mean with the WebCT(TM) group scoring up to two points higher (4% points) than the Tutorial group and one point higher than the total class mean. While Research Hypothesis 1 was not supported and Research Hypotheses 2 was only partially supported, the increases noted in the mean

scores for both the CDE and TS groups have positive practical implications for a student at risk for academic difficulty. Computer-based distance education for Supplemental Instruction may be viewed as comparable to traditional tutorial sessions and provides students with flexible options for learning.

Utah State University. (2008). SI leader training manual, Available online:

http://www.usu.edu/arc/supplemental_instruction/pdf/SI_Manual.pdf

This is a training manual developed at Utah State University for training of its Supplemental Instruction (SI) leaders.

Van Der Karr, C. A. (2001). Becoming a cooperative learner: Supplemental Instruction experiences at a community college [Dissertation, Syracuse University, 2000]. *Dissertation Abstracts International*, 62(04), 1347.

This study is an exploration of the Supplemental Instruction experience at a community college. The study was designed to gain a better understanding of these peer lead study groups grounded in the perspectives of students. The community college was located in the northeast and served 8000 full time, part time, and continuing education students. The qualitative design included data collection via participant observation, individual interviews, group interviews, and review of related materials over the course of a semester. The students described a cooperative environment built upon shared values, goals, and expectations. This environment included norms around appropriate behavior, creating a safe environment, and protecting the group culture. Within this group environment and culture, students described perceptions and patterns of shared authority framed through the role of the leader. Authority was a fluid point on a continuum between high leader authority and high shared authority in group. Authority was presented through three domains of leadership: social leadership, administrative leadership, and content leadership and students and group leaders both resisted and promoted shared authority. The students engaged in this negotiated authority in different ways related to their personal perspectives and experiences. They described critical perspectives that relate to their patterns of participation in the groups. As students described higher levels of participation in group, they also described shifts in their perceptions of themselves as learner, peers, relationship to content, and locus of control. The participants of this study explained how Supplemental Instruction served as an opportunity to engage in content within a social context. The social engagement not related to higher content understanding; it provided a form of involvement for students whose involvement was often limited by other life roles and responsibilities. The findings support the critical role peers and cooperative learning have in student learning, satisfaction, integration, and persistence. The findings also suggest dimensions to cooperation that may yield design that is more effective, implementation, and assessment of group learning.

van der Meer, J., & Scott, C. (2008). Shifting the balance in first-year learning support: From staff instruction to peer-learning primacy. *Australasian Journal of Peer Learning*, 1, 70-79.

Available online: <http://ro.uow.edu.au/ajpl/vol1/iss1/9>

At the University of Otago, New Zealand, peer-learning is critical for enhancing student learning outcomes and improved effectiveness of student learning support centers. This paper argues that a shift must occur from a instruction focus of learning support to a focus on peer learning. This increases student engagement and increased learning outcomes. Peer Assisted Study Sessions (PASS) programs are popular approaches to increasing student academic success.

van der Meer, J., & Scott, C. (2009). Students' experiences and perceptions of Peer Assisted Study Sessions: Towards ongoing improvement. *Australasian Journal of Peer Learning*, 2(1), 3-22. Available online: <http://ro.uow.edu.au/ajpl/vol2/iss1/2>

This study focused on understanding students' reasons for participating in Peer Assisted Study Sessions (PASS), a variation of the Supplemental Instruction (SI) model. The study also reviewed the student perceptions of the effectiveness of the program operating at a college in Australia. The survey of students who participated in PASS revealed the following: improve course grade; complete the course with a passing grade; be less likely to drop out of the institution; increased satisfaction with the course; improved their study-skill development; wanted more classes to have the PASS program attached to them; and other feedback used by the researchers with improvement of the training program of the PASS leaders.

Van der Meer, J., Skalicky, J., & Speed, H. (2019). "I didn't just want a degree": Students' perceptions about benefits from participation in student leadership programmes. *Journal of Leadership Education*, 19(1), 25-44.

Increasingly, universities are involved in providing leadership development opportunities that support students' academic endeavours and their personal and professional development, including employability and citizenship skills. Leadership experiences are beneficial not only for students, but also for universities, the wider community, and future employers. To develop a greater understanding of students' perceived benefits of their involvement in peer leadership activities, a group of Australasian universities participated in a pilot survey based on the United States National Survey of Peer Leadership. Overall, the results suggest students believe they benefit from peer leadership experiences across a range of key outcomes areas, most prominently creative problem solving, appreciation of diversity, and a sense of belonging and contributing to the university community.

van der Meer, J., Wass, R., Scott, S., & Kohaua, J. (2017). Entry characteristics and participation in a peer learning program as predictors of first-year students' achievement, retention, and degree completion. *AERA Open*, 3(3), 1-13. doi: 10.1177/2332858417731572. Available online: <http://journals.sagepub.com/doi/10.1177/2332858417731572>.

Success in the first year of higher education is important for students' retention beyond their first year and for completion of their undergraduate degree. Institutions therefore typically front-load resources and interventions in the first year. One such intervention is the Peer Assisted Study Sessions (PASS) program. This program is known in the United States as Supplemental Instruction. It provides first-year students with an opportunity to learn study skills in the context of a particular unit of study (course/module). In this article, we consider the relationship between students' prior academic achievement and participation in the PASS program, as well as the impact of participation on first-year students' first-year grade point average, retention, and degree completion. The findings suggest that PASS does not just attract academically high-achieving students and that participation in it contributes to students' academic achievement in their first year, retention beyond the first year, and completion of an undergraduate degree.

van der Meer, J., Wass, R., Scott, S., & Kokaus, J. (2017). Entry characteristics and participation in a peer learning program as predictors of first-year students' achievement, retention, and degree completion. *AERA Open*, 3(3), 1-13.

Success in the first year of higher education is important for students' retention beyond their first year and for completion of their undergraduate degree. Institutions therefore typically front-load resources and interventions in the first year. One such intervention is the Peer Assisted Study Sessions (PASS) program. This program is known in the United States as Supplemental Instruction. It provides first-year students with an opportunity to learn study skills in the context of a particular unit of study (course/module). In this article, we consider the relationship between students' prior academic achievement and participation in the PASS program, as well as the impact of participation on first-year students' first-year grade point average, retention, and degree completion. The findings suggest that PASS does not just attract academically high-

achieving students and that participation in it contributes to students' academic achievement in their first year, retention beyond the first year, and completion of an undergraduate degree.

van Hamburg, E. (1998). Leerfasilitering in kontakonderrig. *Didaktikom*, 19(1), 1-4.

Van Lanen, R. J., & Lockie, N. M. (1992). *Addressing the challenge of student diversity: Impact of Supplemental Instruction on performance in a freshman level chemistry course*. Unpublished manuscript. Saint Xavier University. Chicago, IL.

The paper is based on the results of a pilot research study designed to determine the effect of Supplemental Instruction (SI) attendance on the performance and retention of a diverse student population in Chemistry 108 for various levels of SI attendance and to determine relationships between demographic and academic variables of the sample and participation in SI. The sample consisted of Saint Xavier University (Chicago, IL) students enrolled in Chemistry 108 (N=61) in Fall, 1990 and Spring, 1991. Significant differences in performance in Chemistry for the SI group and the non-SI group, as measured by final course grades, were observed when the SI group was defined as students attending six or more SI sessions and the non-SI group was defined as students attending five or fewer SI sessions. Both academic variables and the demographic variables were compared for the SI group and for the non-SI group.

Van Lanen, R. J., & Lockie, N. M. (1997). Using Supplemental Instruction to assist nursing student in chemistry: A mentoring program's support network protects high-risk students at Saint Xavier University. *Journal of College Science Teaching*, 26(6), 419-423.

This article discusses the use of Supplemental Instruction (SI) with nursing students in Principles of Organic and Biochemistry (Chemistry 108) at Saint Xavier University (IL). Chemistry 108 is the second class in a two-semester introductory chemistry course designed for freshman nursing students. After a basic overview of the SI model, the article discusses a research study to examine the effectiveness of the SI program. The Chemistry 108 class was composed mainly of women (94.5%), transfer students (75.8%), and nursing majors (95.1%). It was equally distributed between students above and below age 23. In this study SI participants were defined as students who attended six or more times. The SI group received a higher mean final course grade (2.52 vs. 2.21) and a lower rate of D, F and course withdrawals (14.3% vs. 29.1%). The authors postulate that due to the variety and complexity of skills needed to understand chemistry -- complex content mastery, language, and problem solving -- higher levels of SI attendance are needed to show more consistent positive academic results. Three themes emerged from SI participants concerning why they felt SI was helpful: (1) working out problems on the black board; (2) opportunity to share information; and (3) chance to help each other.

Van Lanen, R. J., Lockie, N. M., & McGannon, T. (2000). Predictors of nursing students' performance in a one-semester organic and biochemistry course. *Journal of Chemical Education*, 77(6), 767-770.

Saint Xavier University, Illinois, has identified predictors of nursing students' performance in a one-semester organic and biochemistry course. Early identification of predictors of performance would allow for intensive academic advising and implementation of specific academic support strategies appropriate to the student's needs. Data were collected over 7 semesters from 308 undergraduate students enrolled in Chemistry 108, about half of whom were traditional students and half were continuing education students. Three predictor variables were identified for the traditional group: mathematics placement test score, total number of supplemental instruction sessions attended, and Chemistry 107 grade. Two predictor variables were identified for the continuing education group: Chemistry 107 grade and Nelson Denny reading test score, which assesses understanding of written vocabulary and mastery of reading comprehension.

Vanmali, B. H. (2012). *Assessing assessment: How use of the concept inventory of natural selection influences the instructional practices of an experienced biology professor and Supplemental Instruction leader*. (Ph.D. dissertation), University of Missouri-Columbia, Columbia, MO. Available online:

<https://mospace.umsystem.edu/xmlui/bitstream/handle/10355/33113/research.pdf?sequence=2>

Assessment has garnered increased interest in recent years. It is seen as critical to enhancing student learning and understanding. Formative assessment tools such as concept inventories could be valuable in moving toward such goals. Concept inventories, a recent addition to biology education, hold much promise for helping faculty to understand the preconceptions their students hold and therefore, how to design lessons to better support students' conceptual change processes. While these are the hopes of the developers of concept inventories, no one has examined what professors and other academic professionals actually do with results of the concept inventories. Likewise, academic support programs such as Supplemental Instruction have gained attention as mechanisms by which to help students improve understanding and increase achievement. Much research has touted the efficacy of Supplemental Instruction programs. However, little research has examined the mechanisms by which those learning gains are attained. Do innovations such as concept inventories help improve teaching and learning? How are they used and what can we learn from the experiences of faculty and academic support professionals who use them? Would learning improve if concept inventories were utilized in an academic support environment such as Supplemental Instruction? This study used interviews with an experienced biology professor and an experienced Supplemental Instruction Leader to examine how they used the collective results of the Concept Inventory of Natural Selection (CUB, used as a pre- and post test) to design and implement lessons in a large lecture introductory biology course and in Supplemental Instruction sessions. Using observations and document analysis as supporting data, themes were identified that describe these educators' views of learning, knowledge of assessment principles, and knowledge of assessment interpretation and action taking. This study provides the first data for how concept inventories are interpreted by faculty and Supplemental Instruction Leaders and used to guide instructional planning and implementation. Data analysis revealed that an experienced biology professor did not rely on the diagnostic pre-assessment tool (the CINS) to understand and act upon students' prior knowledge and misconceptions. Rather, she was already aware of common student misconceptions and prepared to help students modify their knowledge. Instead, she preferred to rely on such instruments as a tool to help students self-assess the status of their knowledge. Likewise, this experienced Supplemental Instruction Leader was also aware of students' misconceptions and prepared to work with students to revise their understandings prior to receiving the results of the CINS pre-assessment. She relied on a variety of formative assessment tasks to help students build their knowledge and periodically check their understandings in a collaborative, small group environment. This study sheds light on areas of strength as well as needed professional development and education for faculty members and Supplemental Instruction Leaders. It provides the first data on how concept inventories may be used in the biology classroom and in Supplemental Instruction sessions. It also identifies areas of educator knowledge where more understanding and research is greatly needed by the teacher educator community.

Vasquez, S. (2000). How to structure a Supplemental Instruction session: Daily agendas and semester goals. *NCLCA Newsletter*, 8-8.

Supplemental Instruction (SI) programs typically employ undergraduate students to serve as SI leaders. Sometimes their inexperience leads to less productive SI sessions for the participants. Adding structure to the SI sessions can assist novice SI leaders until they gain experience and confidence to respond more quickly to needs presented by students attending the SI sessions.

A suggested agenda is: identify common questions of the students; engage students in a preplanned collaborative learning activity; focus on the most important concepts covered in the class lecture and textbook; and answer questions that have not been answered by the aforementioned SI session activities.

Villén, V. (2002). *How to prevent student drop outs? An example from Lund University*. (Master's of Arts thesis), Pedagogical Institution, Lund University, Lund, Sweden.

This Master Thesis (written in Swedish) describes how Lund University in Sweden is implementing a variety of programs to deal with student drop outs. Two programs featured in the manuscript are Supplemental Instruction and Video-based Supplemental Instruction.

Visor, J. N., Johnson, J. J., & Cole, L. N. (1992). The relationship of Supplemental Instruction to affect. *Journal of Developmental Education*, 16(2), 12-14, 16-18.

This Supplemental Instruction study that examined college students enrolled in an introductory psychology course conducted at Illinois State University (Normal, IL) addressed the following questions: a) Are students who elect to participate in SI affectively different from those who choose not to do so? b) does SI affect a positive change in noncognitive factors for participants? The noncognitive factors examined were locus of control, self-efficacy, and self-esteem. Results suggested that those who participated regularly in SI were affectively different from those who participated only occasionally or not at all. SI participants tended to have a higher internal locus of control and higher self-esteem than others. The researchers suggested that this may have been due to the manner in which the SI program was promoted to students. Self-efficacy actually decreased for the more frequent SI participants. The researchers suggested that these students may have developed a more accurate understanding of their strengths and weaknesses while the others were "blissfully ignorant of what it takes to succeed." Increased sensitivity by the SI leader may be needed to effectively meet the needs of "at-risk" students (external locus of control, low self-efficacy, and low self-esteem). The authors suggest additional research is needed regarding non-cognitive variables.

Visor, J. N., Johnson, J. J., Schollaet, A. M., Good-Majah, C. A., & Davenport, O. (1995).

Supplemental Instruction's impact on affect: A follow-up and expansion. Conference Proceedings of the 20th Annual Conference on Developmental Education, Chicago, IL. Following up a previous study (Visor, Johnson, and Cole, 1992), the authors sought to determine whether positive change in certain affective variables was associated with participation in Supplemental Instruction (SI): locus of control, the feeling of being in charge of one's own destiny; self-efficacy, beliefs about one's ability to succeed at a given task; and self-esteem. Students from an introductory psychology course at Illinois State University (Normal, IL) were studied in fall of 1994. Students were divided into three categories of participation: regular participants (4 or more times during the term); occasional participants (1 to 3 times); and nonparticipants. The data suggested the following trends. Among freshmen, regular participants tended to have (a) higher self-esteem than nonparticipants, (b) greater self-efficacy than nonparticipants, and (c) greater internal locus of control than nonparticipants and occasional participants. Among upperclassmen, regular participants tended to have (a) higher self-esteem, (b) greater self-efficacy, and (c) greater internal locus of control than nonparticipants and occasional participants. A causal relationship between SI participation and these affective changes is difficult to empirically establish due to confounding demographic variables.

Vorozhbit, M. P. (2012). *Effect of Supplemental Instruction on student success*. (Master of Science thesis), Iowa State University, Ames, IA. Available online:

<http://lib.dr.iastate.edu/etd/12606>

Supplemental instruction (SI) was developed in the late 1970s but many institutions still do not realize academic benefits of this program. The analysis of the data collected at a large public research university in the Midwest, demonstrated that the final course grade for all three courses is higher for SI-participants than for non-participants. At the same time, the SI participants on average have lower ACT score than the non-participants. Moreover, the final course grade positively correlates with the number of SI sessions attended meaning that the more SI sessions the students attend the higher grade they receive for the course.

Waimon, D. A. (1999). *The impact of Supplemental Instruction on student graduation records*. (Master's of Science thesis), Illinois State University, Normal, IL.

This study investigated Supplemental Instruction (SI) at Illinois State University (Normal, IL) for first time students who enrolled during Fall 1993 regarding its impact on student graduation records (graduation rates at the end of the fourth and fifth year of college and grade point averages upon graduation from the university). The students were enrolled into the following classes: psychology, economics, communication, science, history, and problem solving. Preentry attributes studied were ACT composite score and high school percentile rank standing. The three findings of the study were: SI participants have better graduation records than their non-SI participants; students who attend more SI sessions during their first year have better graduation records than students who attend fewer; and students who start SI first semester of the first year fare no better in their graduation records than students who do not participate in the program until second semester of their first year (though first semester SI participants earned higher grade point averages upon graduation than those who did not participate until the second semester).

Wallace, J. (1992). Students helping students to learn. *The New Academic*, 1(2), 8-9.

This article describes the use of Supplemental Instruction (SI) at Kingston University in London, England. In addition to reports of improved academic performance by SI participants, interviews with SI leaders suggest they had the following results: higher final course grades in other subjects, increased leadership skills, higher confidence levels, and increased contact with faculty members.

Wallace, J. (1993). *The use of Supplemental Instruction in sub-degree vocational courses*. Unpublished manuscript. Kingston University. Surrey, England.

This report describes the use of Supplemental Instruction (SI) with sub-degree vocational courses at Kingston University (London, UK). Kingston runs a number of sub-degree courses leading to the Higher National Diploma (HND) in Electronic Engineering which is obtained from the Business and Technology Education Council (BTEC) through the university. In October, 1990 SI was introduced into several courses in the Faculty of Technology at Kingston. Data from 1990 to 1991 suggests that SI participants received statistically ($p < .05$) higher final course grades (Mathematics: 60.9 percentile vs. 48.1 percentile; Circuits & Systems: 64.0 vs. 49.9; Electronic Principles: 60.0 vs. 49.4; Software Principles: 55.3 vs. 41.5; and Management Studies: 69.4 vs. 53.5). and had lower rates of withdrawal. In addition, interviews with SI participants suggest that they also develop "transferable skills" that help them in other courses.

Wallace, J. (1994). *Kingston University HEFCE Supplemental Instruction Project: 1993-94*. Unpublished manuscript. Kingston University. London, England.

This report review four years of development and research into the use of Supplemental Instruction at Kingston University in the United Kingdom. An additional emphasis area for the SI model has been with staff and faculty development. Included are reports from Kingston University, Glasgow Caledonian University, University of Central Lancashire, Luton University, University of Brighton, and Oxford Brookes University.

Wallace, J. (1994). Provoking the teaching and learning debate. In J. Wallace (Ed.), *Kingston University HEFCE Supplemental Instruction Project* (pp. 99-117). London, England: Kingston University

This chapter contains responses from several educators regarding the impact of Supplemental Instruction (SI) with improving the learning environment for college students in the United Kingdom. The SI program has attracted considerable attention from student unions and unionized teacher trade unions since it has become another partner in the learning process. UK educators who have implemented the SI program have been very careful to position SI as an enhancement to the learning process rather than an alternative to traditional means of delivering instruction to students. Teaching and learning are carefully separated with the UK system.

Wallace, J. (1995). Supplemental Instruction: Students helping each other with their learning. *UCoSDA Briefing Papers, 20*, 1-4. Available: UCoSDA, Level Six, University House, Sheffield, England S10 2TN.

This paper provides an overview of the Supplemental Instruction (SI) model as it is implemented in the United Kingdom. In addition to the traditional purposes of the SI program, there are two additional emphasis areas for the SI program. First, SI leaders are expected to feed back to the course professor students comments (e.g., relevance of instructional pace, understanding of the lecture material, relevance of support materials such as handouts). SI leaders receive special training to delicately share this information with the faculty members. The second emphasis area is on staff and educational development. Faculty members are encouraged to make adjustments of their teaching behaviors to accommodate the needs of the students.

Wallace, J. (1996). Peer tutoring: A collaborative approach. In S. Wolfendale & J. Corbett (Eds.), *Opening doors: Learning support in higher education* (pp. 101-116). London, England: Cassell Publishers

This chapter is a description of how the Supplemental Instruction program was customized for use in the United Kingdom. The key to the success of the program was effective awareness raising for academic staff, the training of the student leaders and the effective management of the scheme. Quotations from SI leaders and faculty members cite a variety of reasons for support for the SI program.

Wallace, J. (Writer). (1996). Supplemental Instruction: The challenging way forward [Videotape]. In G. Mair (Producer). Glasgow, Scotland: Glasgow Caledonia University

This videotape provides an overview of the implementation of Supplemental Instruction (SI) in the United Kingdom. It contains an interview with two SI leaders (Paul Irwin and Mel Dobie) concerning benefits of the SI program to the SI leaders: increased leadership skills, improved use of study strategies, higher confidence level, and increased content knowledge.

Wallace, J. (Writer). (1996). Supplemental Instruction: A profile of the scheme [Videotape]. In G. Mair (Producer). Glasgow, Scotland: Glasgow Caledonia University

This videotape provides an overview of the implementation of Supplemental Instruction (SI) in the United Kingdom. Jenni Wallace, Certified Trainer for the United Kingdom, provides a historic perspective of SI's use in the United Kingdom. Following is an interview with two SI leaders (Paul Irwin and Mel Dobie) concerning benefits of the SI program to the SI leaders: increased leadership skills, improved use of study strategies, higher confidence level, and increased content knowledge.

Wallace, J. (1999). *SI supporting quality in higher education in the United Kingdom*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

This article examined how the American SI model has been modified to work with the United Kingdom postsecondary education system in more than thirty institutions. In addition to traditional measures of effectiveness of the SI program regarding student academic performance, the UK SI model is seen as a contributor to supporting educational quality. A government agency called the Quality Assurance Agency reviews institutions much in the same way as American regional accrediting agencies. SI is seen as contributing to high achievement of all six performance measures: curriculum design, content, and organization; teaching, learning, and assessment; student progression and achievement; student support and guidance; learning resources; and quality management and enhancement.

Wallace, J., & Rye, P. D. (1994). What is Supplemental Instruction? In C. Rust & J. Wallace (Eds.), *Helping students to learn from each other: Supplemental Instruction, SEDA Paper 86* (pp. 7-8). Birmingham, England: Staff and Educational Development Association

This article provides a short overview for how the Supplemental Instruction program is most often implemented in the British higher education system.

Wambach, C. A., Brothen, T., & Dikel, T. N. (2000). Toward a developmental theory for developmental education. *Journal of Developmental Education, 24*(1), 2-10, 29.

The writers propose a developmental theory to help categorize what developmental educators have been doing for years to assist in student improvement. The theory rests on developmental psychology research that examines developmental outcomes and that encompasses research on schools as caring communities and on students' adjustment to college. In order to explain how developmental students came to be as they are and the things that they may need to succeed, concepts of self-regulation, demandingness, and responsiveness are used. These concepts can also be useful in predicting the results of employing certain institutional structures, educational practices, and teacher behaviors. The writers discuss the efficacy of techniques like Supplemental Instruction, cooperative learning, and the personalized system of instruction.

Warner, J. M. (2008). *Supplemental Instruction for non-science majors biology students: Meanings and influences on science identities for women*. (Ph.D. dissertation), University of North Carolina at Greensboro, Greensboro, NC.

The purpose of this study was to examine the meanings women make of their participation in a Supplemental Instruction (SI) program associated with a postsecondary non-majors biology course. Interview and survey data were utilized to determine why women attended SI, the affordances provided by regular SI participation, how women depicted the learning environment of SI, and how women described science as they experienced it in SI. Additional interviews were conducted with a sub-population of participants who regularly utilized SI to provide an understanding of the role SI participation played in terms of access to science identities for women who changed their majors, minors, or concentration within an education major to biology as a result of their experiences in non-majors biology and SI. The results of this study suggest that the SI experience provides more than just a means to increase grades for women who participate regularly. The supportive and safe climate of the SI environment set a comfort level for women that increased their competence and confidence in biology. The SI experience increased interest in biology and afforded the opportunity for women to be recognized by others, and to recognize themselves, for their science abilities. Additionally, for a small number of women, their experiences in non-majors biology and SI facilitated a shift in science identities that led the women to immigrate into science

Warren, B. Z. (1997, October 10-11, 1997). *Personality, learning style, gender, and ethnic characteristics of students attending Supplemental Instruction*. Conference Proceedings of the Annual Teaching/Learning Conference, Ashland, KY. Available online: ERIC database. (ED413019).

A study was conducted to gather information on students participating in Supplemental Instruction (SI) at the University of Central Florida in Spring 1997. Using Long's Personality Checklist, 163 students classified themselves as aggressive-dependent, aggressive-independent, passive-independent, or passive-dependent. Kolb's Learning Style Inventory was administered to the group. Findings included: (1) Although the majority of SI students were White and female with aggressive-dependent personality styles, science students displayed assimilator and converger learning styles, while non-science students displayed accommodator learning styles. (2) Hispanics most commonly identified their learning style as assimilator. (3) Black and Hispanic students showed the least inclination toward the converger learning style, while it was one of the main styles displayed by White students.

Warren, B. Z. (1999). *Assessing the impact of college teacher's learning style on student outcomes: A pilot study at the University of Central Florida*. Unpublished manuscript. Available online: ERIC database. (ED434083).

This paper investigates the effects of faculty learning style on students grades in five different class sections at the University of Central Florida: Chemistry I, Chemistry for Non-Majors, General Biology, and Law and the Legal System. Kolb's Learning Style Inventory was used. The research recognized that other variables impacted upon this study including participating in Supplemental Instruction.

Warren, B. Z., & Tonsetic, R. (1997). Supporting large classes with Supplemental Instruction (SI). *Journal of Staff, Program, and Organization Development*, 15(2), 47-54.

This paper discusses the use of Supplemental Instruction (SI) at the University of Central Florida (27,000 students) as one component in dealing with helping faculty and students deal with large classes. In Spring 1997 39 classes had an enrollment of 200 or more students. During Fall 1996 SI was provided for four large class sections including a chemistry course for non-science majors. SI participants earned a higher mean final course grade (3.39 vs. 1.72). When adjusted for differences in SAT scores, the SI group still received higher grades (2.54 vs. 1.71). The percent of A and B final course grades was higher for the SI group (47% vs. 20%) as well as lower rates of D, F or course withdrawals (18% vs. 56%). Positive results were also reported for the SI in general biology and American national government. There were no significant differences in the calculus course. While there was high satisfaction with the SI participants, the grade differences were not significant. The authors suggest that the SI sessions in math need modification for more effective use.

Watson, J. (2000). *A Peer Assistance Support Scheme (PASS) for first year core subjects*. Conference Proceedings of the 4th Pacific Rim First Year in Higher Education Conference: Creating Futures for a New Millennium, July 5-7, 2000. QUT: Brisbane.

This paper examines a peer assisted study program that has been offered to three core first year subjects in the School of Economics at the University of New South Wales in Australia. While the paper refers to the program as PASS, it is adapted from Supplemental Instruction (SI) originally developed in the United States. Several variations of the SI model include: not requiring the SI leaders to attend class along with the rest of the students and employing faculty members or academic staff members to supervise the program rather than staff from the campus learning center. Common classes supported through PASS were microeconomics and accounting. The PASS program was evaluated through both student questionnaires as well as evaluating their final course grades. The questionnaire data suggested that PASS contributed to

higher satisfaction and deeper learning of the course content material. Evaluation of the final grades suggested a statistically significant relationship between attending six or more PASS sessions and higher grades. PASS leaders reported benefits of the program as well with development of personal communication skills as well as deeper understanding of the course material.

Watters, J. J., & Ginns, I. S. (1997). *Peer assisted learning: Impact on self-efficacy and achievement*. pages. Paper presented at the American Educational Research Association Conference, March 24-28, 1997, Chicago, IL.

This paper describes the use of program modeled after Supplemental Instruction (SI) in a teacher education course at Queensland University of Technology (Brisbane, Australia). The institutional name for the program is Peer Assisted Study Sessions (PASS). The class had 124 students enrolled in a course designed for first-year Bachelor of Education students. Program outcomes were that SI participants earned higher final course grades (4.88 vs. 4.15 on a scale of 0 to 7) and self-reported development regarding confidence and improved attitudes to learning and science. There was a trend for higher grade achievement with higher levels of attendance at the SI sessions. The SI leaders reported improved confidence, facilitator skills, and insight into adult education.

Watts, H., Makis, M., & Billingham, O. (2015). Online Peer Assisted Learning: Reporting on practice. *Journal of Peer Learning*, 8(1), 85-104. Available online: <http://ro.uow.edu.au/ajpl/vol8/iss1/8/>.

Peer Assisted learning (PAL) in-class is well-established and flourishing in higher education across the globe; nevertheless, interest is growing in online versions and is reflected by a number of pilot schemes. These programs have responded to perceived and actual needs of students and institutions; they have explored the available software packages and have begun to create a bank of learning through academic publications, institutional reports, evaluations, and SINET listserv discussions. This paper examines existing online PAL practice from Australia, Canada, the UK and the USA, and focuses on synchronous modes. We discuss (a) the context, mode, and scope of online PAL, and (b) implementation considerations. Despite some "teething problems" of these pilots we are convinced by the early and so far limited explorations highlighted here that online PAL can make a significant contribution to learners in higher education by improving engagement through the flexibility afforded by the online space.

Webster, T., & Dee, K. C. (1997, 1997). *Supplemental Instruction benefits students in an introductory engineering course*. Conference Proceedings of the Proceedings of the Conference on Frontiers in Education, Pittsburgh, PA.

This paper describes the use of Supplemental Instruction (SI) during Fall 1996 in Introduction to Engineering Analysis at Rensselaer Polytechnic Institute (Troy, NY). The course is generally taken in the first semester of the freshman year and covers vector mechanics (statics), linear algebra, and computer-based matrix methods for solving engineering problems. Of the students in the class, 23 percent participated in SI sessions. Students who participated in SI earned higher mean final course grades (3.13 vs. 2.67, $p < .025$), higher rate of A & B final course grades (77% vs. 62%, $p < .01$) and received a lower rate of D, F or withdrawals (0% vs. 18%, $p < .01$). There was a positive correlation between higher levels of SI attendance and higher final course grades. All students who attended at least four SI sessions throughout the semester received a final course grade of A or B. A subpopulation of students who were designated as "at-risk" or "high risk" were studied. SI participants earned higher grades their counterparts who did not attend SI sessions (At-risk: 2.60 vs. 2.18; High-risk: 2.38 vs. 1.58; $p < .01$). The researchers reported that unfortunately half of these students did not participate in any SI sessions. Surveys of students suggested the following improvements for the SI program: hold

more sessions during the academic term to help reduce SI session size (mean size = 13); hold SI sessions longer than one hour to provide sufficient time to deal with material; and consider more than one SI leader to allow smaller SI session size. SI leaders provided feedback to the course instructor concerning the comprehension level of students concerning the course material. Instructors used the feedback to modify future course lectures. SI leaders the following benefits of the SI program for themselves: deeper understanding of course material, excelled in other courses since they were reviewing basic concepts in the SI course, developed communication skills, improved teaching skills, and enhanced leadership skills.

Webster, T., & Dee, K. C. (1998). Supplemental Instruction integrated into an introductory engineering course. *Journal of Engineering Education*, 87(4), 377-383.

This article describes the use of Supplemental Instruction (SI) during Fall 1996 in Introduction to Engineering Analysis at Rensselaer Polytechnic Institute (Troy, NY). The course is generally taken in the first semester of the freshman year and covers vector mechanics (statics), linear algebra, and computer-based matrix methods for solving engineering problems. Of the students in the class, 23 percent participated in SI sessions. Students who participated in SI earned higher mean final course grades (3.13 vs. 2.67, $p < .025$), higher rate of A & B final course grades (77% vs. 62%, $p < .01$) and received a lower rate of D, F or withdrawals (0% vs. 18%, $p < .01$). There was a positive correlation between higher levels of SI attendance and higher final course grades. All students who attended at least four SI sessions throughout the semester received a final course grade of A or B. A subpopulation of students who were designated as "at-risk" or "high risk" were studied. SI participants earned higher grades their counterparts who did not attend SI sessions (At-risk: 2.60 vs. 2.18; High-risk: 2.38 vs. 1.58; $p < .01$). The researchers reported that unfortunately half of these students did not participate in any SI sessions. Surveys of students suggested the following improvements for the SI program: hold more sessions during the academic term to help reduce SI session size (mean size = 13); hold SI sessions longer than one hour to provide sufficient time to deal with material; and consider more than one SI leader to allow smaller SI session size. SI leaders provided feedback to the course instructor concerning the comprehension level of students concerning the course material. Instructors used the feedback to modify future course lectures. SI leaders the following benefits of the SI program for themselves: deeper understanding of course material, excelled in other courses since they were reviewing basic concepts in the SI course, developed communication skills, improved teaching skills, and enhanced leadership skills.

Webster, T., & Hooper, L. (1998). Supplemental Instruction for introductory chemistry courses: A preliminary investigation. *Journal of Chemical Education*, 75(3), 328-331. Available: Thomas Webster, The Advising and Learning Assistance Center, Rensselaer Polytechnic Institute, Troy, NY 12180.

This article describes the use of Supplemental Instruction (SI) between Spring 1995 and Fall 1995 at the University of Pittsburgh (PA) for two semesters in General Chemistry I and for one semester in Organic Chemistry I. After a review of the literature concerning academic needs in science, the researchers describe the results of their study. The percentage of students that participated in SI ranged from 37 to 45 percent. Students uniformly rated the SI sessions very helpful (0 to 5 point scale: ranged from 4.1 to 4.5). The results uniformly favored the SI participants: Gen Chemistry S95: A & B grades, 39% vs. 30%; D, F & W, 10% vs. 34%; mean final grade, 2.34 vs. 1.95. General Chemistry F95: A & B grades, 43% vs. 33%; D, F & W, 15% vs. 31%; mean final grade, 2.46 vs. 2.19. Organic Chemistry F95: A & B grades, 54% vs. 33%; D, F & W, 6% vs. 26%; mean final grade, 2.59 vs. 2.17. The researchers suggested that SI has helped in chemistry since it helped in the following areas: mathematics, problem solving, conceptualization, theoretical, and familiarization with the chemical language.

Webster, T., & Malloch, C. (1997). *Supplemental Instruction benefits students in a traditional and non-traditional introductory physics course: A two semester study*. Unpublished manuscript. Rensselaer Polytechnic Institute. Available: Thomas Webster, The Advising and Learning Assistance Center, Rensselaer Polytechnic Institute, Troy, NY 12180

After a review of the literature concerning physics education, this paper describes the use of Supplemental Instruction (SI) at Rensselaer Polytechnic Institute (Troy, NY). An introductory physics course (Physics 2) was studied during Fall 1996 and Spring 1997. The fall course was taught in the traditional method. The spring section of the course used the CUPLE Studio Physics Project and was much smaller than the fall course. Students who received a D or F on the second exam were classified as "high-risk" and students who received a C on the same exam were designated as "at-risk." Students who attended SI received significantly ($p < .01$) higher mean final course grade (3.37 and 3.08 for the traditional and non-traditional learning environments, respectively) than those students who did not attend SI (3.09 and 2.44, respectively). Students who attended SI received a significantly ($p < .01$) lower rate of D and F final grades (1% and 5%, respectively) than the students who did not attend (8% and 37%, respectively). The data suggests that students who began to attend SI early and frequently (at least 6 times throughout the semester) benefitted more than SI than students who attended SI late in the semester or infrequently. Students who were classified as at-risk or high-risk and attended SI earned higher grades than their counterparts who did not attend SI sessions.

Weil, D. (1996, 1996, April 23). New program focuses on high-risk courses, *The Alestle Newspaper*, pp. 1, 4.

This newspaper article describes the use of Supplemental Instruction (SI) program at Southern Illinois University at Edwardsville in the biology department. Dr. Gertraude Wittig, coordinator of the SI program in the biology department, said that SI is different from traditional tutoring since students are actively involved in the sessions and focus is placed on development of both learning skills and content mastery.

Weiner, R. (1995, 1995, December 7). Community colleges' program helps students help each other, *St. Louis Post-Dispatch Newspaper*, p. 3.

This newspaper article describes the use of Supplemental Instruction (SI) at two community colleges in the St. Louis, MO area (St. Louis Community College-Meramec and St. Louis Community College-Florissant Valley). Gwen Nixon, who administers academic support programs at Florissant Valley said that success rates rose by ten percent in Spring 1995 in courses where SI was offered. SI is offered in the following courses at Florissant Valley: American history, economics, accounting, college algebra, chemistry, and biology. Willis Loy, Associate Dean for Mathematics and Communications at Meramec stated that the SI program is cost effective since it only takes the retention of one student who would have withdrawn from a course to pay for the salary of the SI leader.

Weiner, R. (1995, 1995, December 4). Community college students get help from 'old pros' people who have already passed classes give newcomers a boost, *St. Louis Post Dispatch Newspaper*, p. 1.

This newspaper article describes the use of Supplemental Instruction (SI) at two area community colleges in the St. Louis, MO area (St. Louis Community College-Meramec and St. Louis Community College-Florissant Valley). Meramec's president, Richard Black, said that the SI program was part of a program to ensure accountability in education to improve its effectiveness in serving students.

Weiner, R. (1995, 1995, November 30). College officials tout new program. Students having trouble in class can get extra instruction, *St. Louis Post Dispatch Newspaper*, p. 2.

This newspaper article describes the use of Supplemental Instruction (SI) at two area community colleges in the St. Louis, MO area (St. Louis Community College-Meramec and St. Louis Community College-Florissant Valley). Meramec's president, Richard Black, said that the SI program was tied to the State of Missouri's Funding for Results program that rewards colleges for achieving results.

Westin, L. K., & Nordström, M. (2002). *Supplemental Instruction (SI) - Applied on the course Object-Oriented Programming Methodology*. Unpublished manuscript. Department of Computing Science, Umeå University. Lund, Sweden.

Supplemental Instruction (SI) was started in the introductory computer programming course at Umea University (Sweden) due to the low pass rate of the students in recent years. The SI program was started in Fall 2002 and the report describes the SI program results. After the introductory section of the report devoted to an overview of SI and identifying the need for academic assistance with the Swedish students, the report provides a detailed narrative for how SI was implemented with recommendations for program modifications. The final section of the report is devoted to an analysis of the impact of SI with students regarding test scores and course withdrawal. If students attended three or more times during the academic term, academic results were favorable for the SI participants.

Whatman, S. (1995). *Peer assisted study sessions with Aboriginal and Torres Strait Islander students during semester two, 1995*. Unpublished manuscript. Queensland University of Technology. Brisbane, Queensland, Australia.

This report describes the use in semester 2, 1995 of Peer Assisted Study Sessions (PASS) at Queensland University of Technology (Australia) with first year Aboriginal and Torres Strait Islander (A&TSI) students who were attending class at the Gardens Point Campus. PASS is the locally used name for Supplemental Instruction (SI). A&TSI students had typically experienced considerable difficulty in courses such as Information Technology and Business. These courses historically had low Indigenous student enrollments, and consequently, had very few successful graduates. Eight courses were selected for PASS support: Computer Applications, Software Development 1 & 2, Technology of Information Systems, Business Communication & Application Development, Theoretical Perspectives on Communication, Microeconomics, and Reporting Principles. Before introduction of the PASS program in the second semester, the A&TSI students as a group earned fairly low grades. At the end of the semester with PASS support, the students earned higher final course grades. PASS leaders reported the following benefits for themselves: more opportunity to talk with faculty members, greater understanding of course content which helped in other classes, and developed friendships with more students that they would normally would have not met.

White, B. (1996). The student peer mentor program in its trial year: A mentor's perspective. *Queensland University of Technology Law Journal*, 12(1), 221-228.

In 1994 the Student Peer Mentor program was piloted in the Bachelor of Laws program of study (two individual classes: Torts and Law of Contract) at Queensland University of Technology in Australia. The program was based upon Supplemental Instruction (SI). This article describes the program from the perspective of one of the student mentors. Strengths of the program included: less private time needed to study; non-threatening environment; identified academic skills needed for success; and expanded social circles. Benefits of the program for the mentors included: improved interpersonal communication skills; increased content comprehension; provided personal satisfaction of helping others; and improved confidence in leadership and group situations.

Wiatr, J., & Stout, B. (1999). *Get creative: Working with SI data*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

This article examined possibilities of developing graphic visuals that help relate necessary information to a variety of audiences interested in the SI model. Starting with data routinely collected in the term end report, the authors moved to considering other resources needed to answer a diverse range of questions about the value of SI in the post-secondary setting.

Widhaim, S. (2004, 2004, April 12). Meeting of minds: Studying in groups pays off in learning, *The Washington Times Newspaper*, p. B1.

This newspaper article describes the Supplemental Instruction (SI) program at George Mason University. The article contains numerous quotations by SI leaders as well as SI participants.

Widmar, G. E. (1994). Supplemental Instruction: From small beginnings to a national program. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 3-10). New Directions for Teaching and Learning No. 60. San Francisco: Jossey Bass

The chief student affairs officer at the University of Missouri-Kansas City offers a historical review of the development and implementation of Supplemental Instruction (SI). The SI program was first implemented with the Dental, Medical, and Pharmacy schools since an unacceptable rate of students were leaving the institution. Later the SI program was expanded to the College of Arts and Sciences. The author describes the administrative and political issues that must be addressed to meet issues important to administrators and faculty members. Since the Division of Student Affairs views its programs as cocurricular rather than extracurricular, administrative placement of the SI program with Student Affairs was a natural fit for the campus. Faculty and administrative support for SI remains for the following reasons: SI supports cultural diversity; SI supports critical thinking; SI supports student retention and academic performance; and SI is both replicable and adaptable.

Widmar, G. E., & DeBuhr, L. (1987). Supplemental Instruction: Meeting the academic development needs of students at urban universities. In A. Artibise & W. Fraser (Eds.), *New Directions for Urban Universities: International Perspectives*. Winnipeg, Canada: Institute of Urban Studies

This book chapter discusses the use of Supplemental Instruction (SI) as a strategy to support the academic success of students.

Wiethop, C. (1985). Supplemental Instruction planned. *Current (University of Missouri-St. Louis Student Newspaper)*, 1-3.

This newspaper article describes the implementation of the Supplemental Instruction (SI) program on the campus of the University of Missouri-St. Louis.

Wiggers, N. R., Rheysen, R., & Ammeter, T. (2014). SI's role in promoting engagement in academics. *Supplemental Instruction Journal*, 1(1), 72-89. Available online:

<http://info.umkc.edu/si/wp-content/uploads/2015/09/siJVVolumeOne.IssueOne.ConferenceProceedings.pdf>.

The study of engagement and entitlement in higher education has garnered increased attention in the literature because of its relationship with academic performance. Using data collected from over 400 students enrolled in SI-supported courses, this study addresses the relationship between SI attendance and student engagement in academic courses. Students completed two instruments, the Academic Engagement Survey and the Academic Entitlement Questionnaire. The results were then correlated with SI attendance and final course grade. SI was significantly

correlated with academic engagement. Contributions and implications of these findings, along with limitations and suggestions for future research are discussed

Wilcox, F. K. (1992). Reasons educators and students choose Supplemental Instruction. In D. C. Martin & D. R. Arendale (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (2nd ed., pp. 27-30). Columbia, SC: National Resource Center for The Freshman Year Experience and Students in Transition. Available online: ERIC database.(ED354839).

In this chapter a variety of factors are identified that have been reported as significant in generating interest by educators and students with Supplemental Instruction. These factors include: SI supports high academic standards; cost-effectiveness of the SI program; meets immediate pragmatic needs of students; SI avoids a remedial/developmental image; SI sessions are non-threatening for students; SI sessions develop a community of supportive learners; and SI helps students to develop transferable study strategies..

Wilcox, F. K. (1992). Twenty years of Supplemental Instruction: An interview with Deanna Martin. *Supplemental Instruction Update*, 1, 6.

This newsletter interview of Deanna Martin, creator of the Supplemental Instruction (SI) program, discusses the historical development of the model and its part in the development of collaborative learning in higher education. Martin believes that the next stage of development for SI is its mainstreaming of academic support and integration of learning strategies into the classroom. She reports of how SI is being used for faculty development.

Wilcox, F. K. (Writer). (1993). Supplemental Instruction: Improving academic success in historically-difficult courses [Audio cassette], *1993 National Conference on Higher Education, New Orleans, LA*. Iowa City, IA: National Center for Student Retention

Taped at the 1993 National Conference on Higher Education in New Orleans, LA, Dr. Kim Wilcox from UMKC discusses his experience with Supplemental Instruction (SI), a nonremedial model of student academic assistance that targets historically-difficult courses rather than high-risk students.

Wilcox, F. K. (1995). Supplemental Instruction and efficiency in learning. In M. T. Keeton, B. Mayo-Wells, J. Porosky & B. Sheckley (Eds.), *Efficiency in adult higher education: A practitioner' handbook* (pp. 102-107). College Park, MD: The University of Maryland University College, Institute for Research on Adults in Higher Education

This chapter provides an overview of the Supplemental Instruction (SI) program. The SI program is efficient since it provides a highly effective academic support program (higher grades, lower course withdrawals, higher reenrollment and graduation rates) for a moderate cost by employing student facilitators. Since the SI sessions occur outside of class, it preserves the time available for the course professor and allows them to more efficiently use their class time addressing the course material rather than using a portion of the time to address issues best addressed during the SI sessions.

Wilcox, F. K. (1996). Supplemental Instruction in South Africa: An interview with Andre Havenga. *Supplemental Instruction Update*, 1, 3.

This interview describes the development of the Supplemental Instruction (SI) program at institutions in the Republic of South Africa. Andre Havenga is an SI Certified Trainer for South Africa and is also the Director of Instructional and Organizational Development at the University of Port Elizabeth (UPE). UPE provides SI support for 77 courses in 21 academic departments. Havenga reports the following benefits of the SI program: provides academic support for the new student subpopulations that were formerly excluded by government policy; academic

support is mainstreamed with academic courses; provides faculty development through feedback that allows the instructor to clarify and provide additional information at the next class session; and provide another forum for social integration. SI leaders report a number of benefits for themselves: enhanced academic skills; improved self-confidence; additional work experience that may help with job interviews; and additional contact with key faculty members from their discipline.

Wilcox, F. K. (1996). Supplemental Instruction in Sweden: An interview with Marita Bruzell-Nilsson and Leif Bryngfors. *Supplemental Instruction Update*, 1, 3.

This interview describes the development of the Supplemental Instruction (SI) program in Sweden. Academic assistance at postsecondary institutions in Sweden is a new movement. The interviewees are SI Supervisors at Lund University (Lund, Sweden) and are also Certified Trainers for SI. Nearly a dozen institutions in Sweden have established SI programs. SI leaders report that they like serving in the program since they have an opportunity to: develop their presentation skills; practice putting forth a point of view; and developing group management skills that will be useful when they become employed.

Wilcox, F. K. (1996). Supplemental Instruction: Academic support in high-risk courses. *Midwest Regional Association for Developmental Education Newsletter*, 10-11.

This newsletter article provides an overview of the Supplemental Instruction (SI) program.

Wilcox, F. K. (Writer). (1996). Supplemental Instruction session demonstration [Videotape]. In F. K. Wilcox (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape provides a simulation of a Supplemental Instruction (SI) session in an introductory Physical Science course. Students who are participating in SI during the current academic term simulate a SI session for a recent class lecture. Common SI session activities are illustrated: vocabulary development, identification of main ideas, connecting ideas, creating visual matrixes, lecture note review, and test question prediction. SI participants and the SI leader for the course share benefits of SI participation. The moderator then provides a debrief of the SI session.

Wilcox, F. K. (1997). Supplemental Instruction in Australia: An interview with Ron Gardiner. *Supplemental Instruction Update*, 1-2.

This interview with Ron Gardiner provides an overview of the development of Supplemental Instruction (SI) at institutions in Australia. Gardiner, a physicist, is an SI Certified Trainer and is Emeritus Professor and Coordinator of the SI program at Queensland University of Technology in Brisbane. An additional feature of the SI program is that the classroom instructor requests feedback from the SI leader concerning the comprehension level of the students. This provides an opportunity for the instructor to clarify or provide more information at the next class period.

Wilcox, F. K. (1998). Supplemental Instruction. *NASPA IV West Newsletter*, 4.

This short newsletter article provides a basic overview of the Supplemental Instruction (SI) program. The article three of the reasons that are commonly cited by institutions regarding why they have selected SI: (1) high risk courses are easy to identify; (2) SI meets the perceived needs of students; and (3) SI avoids a remedial image and is non-threatening.

Wilcox, F. K. (1999). Killer course survival: Supplemental Instruction. *The College Parent Advisor*, 3(1), 2-3.

This article provides a general overview of the Supplemental Instruction (SI) model.

Wilcox, F. K. (Writer). (1999). Supplemental Instruction: Empowering student learning [Videotape]. In K. Patterson & K. Wilcox (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape provides an overview of Supplemental Instruction (SI) through short interviews with SI leaders, SI participants, campus administrators, and Deanna Martin, creator of the SI model.

Wilcox, F. K. (2008). Implementing a new Supplemental Instruction program. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 29-38). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

This chapter presents critical elements for implementing a new Supplemental Instruction (SI) program. This elements include: carefully designing a small pilot program before a wide-spread implementation; providing sufficient staff to manage the pilot SI program (trained SI supervisor, trained SI leaders); carefully selecting courses that are historically-difficult; developing positive relationships with the faculty members who teach the classes for the pilot SI program; securing institutional funding for the program staff, materials; locating the SI pilot program in appropriate classroom space; marketing the SI program to administrators, faculty, and students; appropriately assessing and evaluating the SI pilot program; and planning for a thoughtful expansion o f the SI program after a successful pilot experience.

Wilcox, F. K., & Jacobs, G. (2008). Thirty-five years of Supplemental Instruction: Reflections on study groups and student learning. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. vii-x). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

This chapter reviews the history of SI as it was created at the University of Missouri-Kansas City in 1973 and has since spread to more than 1,500 colleges and universities in 29 countries. Topics explored in the chapter include providing additional venues of conversation for students in addition to that with the course professor, extending learning outside of the classroom to deepen understanding, and helping students to make sense out of their class notes, memory, and textbook readings.

Wilcox, F. K., & Koehler, C. (1996). Supplemental Instruction: Critical thinking and academic assistance. *Metropolitan Universities: An International Forum*, 6(4), 87-99.

This article provides a basic overview of the Supplemental Instruction (SI) including data from the University of Missouri-Kansas City. A UMKC study reviewed data from a geographically and institutionally diverse group of 146 institutions that used SI in 2,875 courses of diverse academic areas with an enrollment of 298,629 students. The data suggests that SI participants earned higher mean final course grades (2.30 vs. 1.85); higher percent of A and B final course grades (47.5% vs. 35.8%) and a lower rate of D, F and course withdrawals (23.7% vs. 38.0-%). A 1989 study at UMKC found that SI participants reenrolled the following semester at a higher rate than non-SI participants (90.0% vs. 81.5%). A study of SI and non-SI participants during their first academic term at UMKC in Fall 1983 found that by Fall 1989 the SI participants had graduated at a higher rate (30.6% vs. 18.2%). A comparison is made between the traditional paradigm of learning that is the current pedagogy of most classroom instructors and the new reflective learning paradigm. SI sessions help students to use both paradigms to maximize learning and academic achievement.

Wilcox, F. K. E. (n.d.). *Supplemental Instruction Update*.

The Supplemental Instruction Update newsletter is published by the National Center for Supplemental Instruction (SI) at the University of Missouri-Kansas City. Topics in the newsletter include: interviews with SI programs in programs around the world; articles discussing adaptations of the SI model; reports of SI research studies; information regarding upcoming training workshops for SI Supervisors and conferences for SI program managers; and other topics. Subscriptions are complimentary for anyone regardless of whether they have currently active SI programs.

Wilkerson, S. L. (2008). *An empirical analysis of factors that influence the first year to second year retention of students at one large, Hispanic Serving Institution (HSI)*. (Ph.D. dissertation), Texas A&M University, College Station, TX.

The purpose of this study was to identify how input and environmental factors impact first-to-second year retention of undergraduate students at a large Hispanic Serving Institution (HSI). An additional purpose of the study was to determine the usefulness of the Astin Typology as a predictive factor for student retention. The sample for the study was 1,296 first-year students enrolled at the University of Texas at San Antonio during the 2002, 2003, and 2004 academic years. Data used for the study included student responses to the Cooperative Institutional Research Program (CIRP): Freshman Survey (to identify each participant's Astin type), gender, ethnicity, SAT scores, rank in high school class, first-generation status, financial need, first-semester residence, entry-college, semester credit hours attempted, academic course difficulty, participation in Supplemental Instruction, and enrollment in a first-year seminar course. Both descriptive and univariate statistics were used to describe the sample population, as well as the similarities and differences found to exist among the seven Astin types. Three separate logistic regression analyses organized by Astin's I-E-O framework were conducted to develop a predictive model for retention from the first-to-second year of college. Subsequent analyses were conducted to identify the specific factors that were useful for predicting retention for each of the seven Astin types. The major findings of this study were: (1) The most frequent Astin type identified within the sample population was Status Striver; (2) The model that included both Input and Environmental factors was the most accurate model for predicting retention; (3) Students who were classified as Hedonist, Status Striver, and Uncommitted were less likely to be retained at this institution when all other input and environmental factors were controlled. (4) Environmental factors were most useful for predicting retention, in particular, semester credit hours attempted that had an inverse relationship with retention for all Astin types; (5) First-generation status, financial need, SAT score were not useful for the prediction of retention; (6) First-year seminar course enrollment and participation in Supplemental Instruction had a positive impact on retention.

Wilkinson, J., & Brent, G. (2019). Peer Assisted Study Sessions (PASS): Recognizing employability through PebblePad *Blended learning designs in STEM higher education* (pp. 139-149): Springer

Peer Assisted Study Sessions (PASS) is a voluntary, weekly, academic assistance program utilizing peer-led group study to help students succeed in traditionally difficult subjects. PASS provides opportunities for students to strengthen their knowledge by being actively involved in group learning that is focused on identifying and reviewing key lecture content, testing understanding of difficult concepts, gaining confidence through discussing complex course material, and engaging in cooperative problem-solving methods. The sessions are facilitated by students who have completed at least one year of study, have excelled in the course, maintained a strong Grade Point Average and have completed a two-day intensive PASS Leader training course. Through planning, leading, and organizing sessions, leaders develop strong transferable attributes including interpersonal communication skills, listening skills, time management and organizational skills, leadership and team working skills, equipping them for

professional life beyond university. Leaders are observed at least twice per trimester, by the PASS Coordinator and by a Senior Leader, with feedback provided to support development. Using an observation template on PebblePad ensures that comments can be easily reviewed before observations and leaders receive timely feedback that is stored in an accessible format, providing evidence of contribution and skills. Leaders also use PebblePad to reflect on their experience of the PASS Program and transferable skills developed, allowing them to identify, document, and evidence key employability skills and attributes.

Williams, B., Fellows, H., Eastwood, K., & Wallis, J. (2014). Peer teaching experiences of final year paramedic students: 2011-2012. *Journal of Peer Learning*, 7(1). Available online: <http://ro.uow.edu.au/ajpl/vol7/iss1/7/>.

Peer assisted learning (PAL) is one method of teaching which involves peers, or people from similar social groups, in reciprocal learning where one peer educates another and in return learns through the teaching experience. There have been many reported benefits of PAL programs. PAL has a long history of use in healthcare education; however, for paramedic education there is a paucity of literature. A pilot PAL project was undertaken in the Bachelor of Emergency Health (BEH) course at Monash University in Melbourne, Australia. This study had two aims: i) to evaluate the effectiveness of the pilot PAL program, and ii) to compare academic grades between peer teachers and those not involved in the PAL program over 2011–2012. Forty-one students volunteered, with 23 students in 2011 and 18 in 2012. At the completion of their peer teaching, all students were asked to complete the 14-item Peer Teaching Experience Questionnaire (PTEQ). Of the 41 students, 63.4% were female, 73.2% were under 25, 82.9% had been taught by peers previously, 31.7% had taught peers previously, and 51.2% had undertaken previous tertiary studies. Students strongly agreed teaching and leadership were important to the paramedic role. Students also strongly agreed that their peer teaching experience was personally rewarding, increased their knowledge and skills, and would be of direct benefit to them as a graduate paramedic. Moreover, students who participated in the PAL project as peer teachers obtained higher clinical marks on their final clinical examination than their non-PAL counterparts (2011 76.5% vs. 71.0%, $p < .001$, and 2012, 75.2% vs. 72.7%, $p < .001$). This study suggests PAL programs have a great potential to provide a wide range of benefits in paramedic courses. As this was a pilot program, there were many limitations and caution should be used in making any generalisations. However, the overwhelmingly positive response from the students strongly suggests PAL programs should continue to be implemented in paramedic education.

Williams, O., Jeffries, M., & Fortier, P. (1990). Minority student retention: A successful partnership. *The 1990 National Conference on Student Retention, Washington, D.C.* [Audio cassette]. Madison, WI: Topitzes & Associates

Taped at the 1990 National Conference on Student Retention in Washington, D.C., three experts provide a general administrative overview of minority student retention programs at the University of Illinois (Urbana); discuss the linkages of minority students to academic support services such as tutoring, study skills, and Supplemental Instruction; and explain the academic monitoring process of counseling students. Finally the three discuss the success rate that the combined program has promoted. A question and answer period follows.

Williams, T. S. (2014). *Influences on science education: The use of Supplemental Instruction on academic success in introductory science courses t a two-year community college.* (Ph.D. Dissertation), Colorado State University, Fort Collins, CO. Available online: https://dspace.library.colostate.edu/bitstream/handle/10217/88547/Williams_colostate_0053A_12680.pdf?sequence=1&isAllowed=y

This dissertation uses a mixed method design model to investigate the influences of Supplemental Instruction (SI) on student final grade outcomes in introductory science courses at the community college level. The literature states that student comprehension in the field of science is critical; however, educators are discovering that certain student demographics are falling behind in science comprehension. The research focuses on the issue of disparity among different demographics and analyzes whether the introduction of the academic intervention technique, Supplemental Instruction (SI), increases the academic success of students in introductory community college biology and chemistry courses. A series of Two Way ANOVA analyses revealed that the use of SI had a positive effect (i.e., increased final grade outcomes) on community college student demographics; however, in some sections, a negative final grade outcome was found. In this study, data indicate that SI supported biology classes had a greater effect (or positive direction) on Black Non-Hispanic overall final grades. However, White Non-Hispanic students enrolled in SI supported introductory biology courses showed a slight decrease (or negative direction) in marginal means ($d = -0.180$). Hispanic students enrolled in SI supported courses showed a very slight increase (or positive direction) in final grade outcomes ($d = 0.11$). Another analysis outlined in this study showed the impact of SI on student grades in introductory science courses and first-generation student status. The analysis indicates a positive direction between the use of SI in an introductory science course on overall student final grades and student first-generation status. The data indicate that with the use of SI in an introductory science course, student final grades in the first generation student population showed an effect size of $d = 0.1897$. These data indicate that SI supported science courses had a positive effect on First Generation student overall final grades. The research examined the impact of SI on the principle SI Student Leaders (SISL) and found that student participation in the program had positive influences on SISL discipline comprehension, engagement, overall course satisfaction

Willox, A. C. (2007). Reclaiming impersonal academic space through Supplemental Instruction: Reflections on the transformation of the learner and the learning environment at the undergraduate level. *Journal of Student Centered Learning*, 3(3), 151-156. Supplemental Instruction (SI) was used at the University of Guelph in Canada to improve student academic performance. The author describes the learning space that is created for student dialogue and personal reflection.

Wilmot, J., Peralex, K., & Telang, N. (2016, July 31 - August 2, 2016). *Supplemental Instruction pilot program for an introductory electrical engineering course*. Conference Proceedings of the First Year Engineering Experience Conference, Columbus, OH. Available online: <http://fyee.asee.org/FYEE2016/papers/152.pdf> Each fall over 400 incoming Cockrell School of Engineering students enroll in the University of Texas' EE302 Introduction to Electrical Engineering, a required course for all Electrical and Computer Engineering (ECE) majors. Many students are underprepared for the rigorous curriculum and difficult coursework; as a result this course has one of the highest rates of D's, F's, drops, and withdraws ("DFQW rate") in the department. Charged with improving four-year graduation rates, the ECE department partnered with the Sanger Learning Center to provide Supplemental Instruction (SI) sessions to support the academic success of students enrolled in this course. SI is a non-remedial model that emphasizes the development of study skills through the delivery of content review sessions. A fall 2015 pilot program employed two SI leaders, provided four study sessions per week, and reached 59% of the class population with 37% attending more than one session. A mixed-methods analysis reveals that session attendance positively impacted exam scores and DFQW rates, and that students held favorable perceptions of the SI program. Analysis additionally revealed a need for further study of continued academic performance and retention within the engineering program.

Wilmot, J., & Telang, N. K. (2017). *Assessment of Supplemental Instruction programming on first year academic success*. Conference Proceedings of the 2017 American Society of Electrical Engineers Annual Conference & Exposition, Columbia, OH. Available online: <https://peer.asee.org/27644>

During the 2015-2016 academic year, the Electrical and Computer Engineering (ECE) Department and the learning center at the university collaborated to bring academic support to a freshman level introductory course by establishing a pilot Supplemental Instruction (SI) program. Intending to aid students in adjusting to the university experience and be successful in their first year, the SI program provides non-remedial review and study skill development in the form of optional weekly discussion sessions. Analysis of quantitative and qualitative data aid in understanding the efficacy of the newly implemented SI program in the ECE department. Comparisons of course grades and passing rates reveal that fall 2015 course grades did not vary much between the SI-attending and non-attending groups, though students who attended SI had slightly improved passing rates compared to the non-attending group and the prior fall. Comparisons for the spring 2016 semester reveal that the course grades for the SI-attending group were improved yet not statistically significant; while the overall passing rate was not affected for the spring semester, a considerably larger proportion of SI attendees successfully passed the course than non-attendees. The differences in performance outcomes observed between the fall and spring semesters are potentially explained by the differences in the student populations. The spring enrollment is roughly ten percent of the fall enrollment and has a larger proportion of transfer students, those retaking the course, and first generation students. Studying the demographics and performance outcomes of the student population choosing to attend SI allows program administrators to better understand the potential of the SI program to help students find success in the ECE department.

Wilmot, J., & Telang, N. K. (2017). *Assessment of Supplemental Instruction programming and continued academic success*. Conference Proceedings of the 2017 American Society of Electrical Engineers Annual Conference & Exposition, Columbia, OH. Available online: <https://peer.asee.org/27643>

A main aspect of the Supplemental Instruction program's mission is to help students develop transferable study skills that will improve their academic performance in all of their university coursework. At the university, the Electrical and Computer Engineering (ECE) department partnered with the learning center to provide Supplemental Instruction programming to the freshman-level course Introduction to Electrical Engineering (EE 101) in fall 2015. This course is the first part of a two-course sequence, the second of which is Circuit Theory (EE 102). Of the students enrolled in EE 102 in the spring 2016 semester, students who attended SI sessions during the fall 2015 EE 101 course had higher course grades than the non-attendees, even though this group's spring 2016 end of semester grade point averages were lower and this group's course grades in EE 101 were lower. To continue to investigate the long-term implications of SI attendance and gain a better understanding of what the SI program can offer students in the ECE program at the university, future studies will benefit from additional data as students continue to progress through their program, and the inclusion of qualitative measures for a mixed-methods approach.

Wilson, B., & Rossig, S. (2014). Does Supplemental Instruction for Principles of Economics improve outcomes for traditionally underrepresented minorities? *International Review of Economics Education*, 17, 98-108. doi: 10.1016/ire.2014.08.005.

Principles of Economics typically have a high non-success rate and traditionally underrepresented minorities (URMs) generally have a higher non-success rate than non-URMs. This paper describes our Supplemental Instruction (SI) course and tests the effectiveness of SI

on grade improvement, while accounting for self-selection bias. We find that SI improves grades by a bit less than half a letter grade in the full sample and by a larger amount for URMs and a smaller amount for non-URMs. We also find evidence that weaker URM students and stronger non-URM students are more likely to enroll in our SI course.

Wilson, M. (2005). Supplemental Instruction in the Canadian context. *The Journal of Student Centered Learning*, 2(2), 109-119.

The University of Guelph in Ontario, Canada has modified the Supplemental Instruction (SI) program and as a result renamed it Supported Learning Groups (SLG)s. In addition to traditional elements of SI programs, the SLG approach has fostered curriculum and faculty development as a result of feedback provided by the peer leaders. Students also receive mentoring from the SLG leaders as well. The program has continued to expand based on successful results.

Wisniewski, E. O., Shapiro, R. L., Kaeli, E., Coletti, K. B., DiMilla, P. A., & Reisberg, R. (2015). *The impact of Supplemental Instruction on the performance of male and female engineers in a freshmen chemistry course*. Paper presented at the American Society for Engineering Education Annual 122nd Conference, Seattle, WA. Available online: http://scholar.google.com/scholar_url?url=http://www.asee.org/file_server/papers/attachment/file/0005/7218/2015ASEEPaperFinal2BSubmitted__1_.pdf&hl=en&sa=X&scisig=AAGBfm2RUFrbH8ykmlPHWOz8V_XntzKToQ&nossl=1&oi=scholaralrt.

This study used statistical analysis to examine correlations between first year engineering students' use of SI and their performance in a required general chemistry course at Northeastern University. Overall we found that students who used SI were more motivated in General Chemistry than their counterparts. We also draw the following specific conclusions from our data: Students who were more confident that they would receive a high grade in General Chemistry at the beginning of the course had a higher average grade threshold for seeking SI. Students who sought SI exhibited a positive correlation between grade threshold for seeking help outside the classroom and final grade received. Females who used SI had significantly higher grades than females who did not. SI in the form of Chem Central, the Connections Chemistry Review, and the COE Tutoring Office were all found to have the potential to have a significant positive impact on students' grades. Students who did not use SI were significantly more likely to skip lecture than students who do attend SI. Increased absenteeism in lecture was associated with lower final grades in both fall 2013 and fall 2014. Females were more likely to attend lecture regularly than males. When extra credit incentives were offered to attend lecture, both genders skipped significantly fewer lectures and received significantly higher grades. We believe the results we have found regarding relationships between students' use of SI and their success in General Chemistry for Engineers can be applied to improve SI across the freshman engineering curriculum. For example, as Chem Central, the Connections Chemistry Review, and the COE tutoring office were all found to have a positive impact on students' grades, resources like these could be created to help freshman students in their other courses. Further study of possible interaction effects among these and other variables for which we have data are ongoing. Our results also show that the students who often skip lecture are the students who do not take advantage of resources for SI and receive lower course grades. These may be students who need additional advising and mentoring during their freshman year in order to succeed. The issues raised are important topics of focus for future work in order to gain a further understanding of the impact of SI on freshman engineering students.

Wittig, G., North, S., & Thomerson, J. E. (1996). Supplemental Instruction improves student retention and performance in biology. *Transactions*, 89(65), 79.

This article reports the use of Supplemental Instruction (SI) in a biology course at Southern Illinois University at Edwardsville. Success in Biology 120, which introduces into the majors

core, is a strong predictor of academic survival. Because 50 percent of students earned D, E and withdrawal grades, SI was introduced. Undergraduate SI leaders were placed in both lectures and laboratories, and they offered weekly, out-of-class SI sessions. Of 171 Fall 1995 and 88 Spring 1996 students, 56 and 67 percent respectively participated in SI. Students attending from 4 up to 37 sessions per semester averaged a full grade point better course grades than non-SI students and hardly any (4 and 0 respectively) D, E, and withdrawal grades. Differences were significant at the 1 and 5 percent level respectively.

Wolfe, R. F. (1987). The Supplemental Instruction program: Developing learning and thinking skills. *Journal of Reading*, 31(3), 228-232.

The author describes implementation of the Supplemental Instruction at Anne Arundel Community College in Arnold, Maryland. A Fall 1986 research study concerning the impact of the SI program with a History 211 course suggested that SI participation contributed to higher final course grades (2.5 vs. 1.6) and lower rates of D, F and withdrawal (16% vs. 55%) even though the SI participants had a lower mean SAT score. SI participants self-reported high satisfaction with their experience in the SI program (4.5 on a 5 point scale). Some professors at the college reported using the SI program for faculty development in the following ways: sometimes the course instructor incorporated SI leader developed materials initially used during SI sessions; used the SI leader as a feedback forum for evaluating the comprehension level of students of key concepts.

Wolfe, R. F. (1987). Writing across the curriculum through Supplemental Instruction. *Maryland English Journal*, 21(2), 43-48.

At Anne Arundel Community College (Arnold, MD), the Supplemental Instruction (SI) program is also used to improve students' writing skills. In SI sessions for a history class during Fall 1986 additional activities were directed to developing writing skills. Research suggests that SI participants demonstrated improved performance in written essay examinations. The activity had four steps: 1) overview all material from notes and text that could be used to answer the question; 2) organize the information; 3) develop a summary statement; and 4) develop an outline for the answer. SI participants earned a higher mean final course grade (2.5 vs. 1.6) and a lower rate of D, F and course withdrawals (16% vs. 55%).

Wolfe, R. F. (1987). The Supplemental Instruction program: Developing learning and thinking skills across the curriculum. *Issues in College Learning Centers*, 5, 5-12.

The author describes implementation of the Supplemental Instruction (SI) at Anne Arundel Community College in Arnold, Maryland. A Fall 1986 research study concerning the impact of the SI program with a History 211 course suggested that SI participation contributed to higher final course grades (2.5 vs. 1.6) and lower rates of D, F and withdrawal (16% vs. 55%) even though the SI participants had a lower mean SAT score (370 vs. 430). Another indication of the influence of the SI program was a shift of the overall rate of D, F and course withdrawals from 45 percent down to 33 percent for the History 211 course. Some professors at the college reported using the SI program for faculty development in the following ways: sometimes the course instructor incorporated SI leader developed materials initially used during SI sessions; used the SI leader as a feedback forum for evaluating the comprehension level of students of key concepts.

Wolfe, R. F. (1988). *Supplemental Instruction with mentoring support at Anne Arundel Community College*. Conference Proceedings of the Midwest College Learning Center Association Conference., Chicago, IL. Available online: ERIC database. (ED413942).

The Supplemental Instruction (SI) program at Anne Arundel Community College (Arnold, MD) was modified to use faculty members as SI supervisors. While this was the initial focus for the

faculty members, the mentor role evolved into an opportunity for them to observe colleagues and to grow as teachers. Faculty mentors were placed in classes outside their own discipline. The classroom instructor and faculty mentor would meet periodically to provide feedback to each other and discuss strategies to improve instructional effectiveness.

Wolfe, R. F. (1988). A model retention program for the community college. *Maryland Association for Higher Education Journal*, 11, 18-20.

This article describes the implementation of the Supplemental Instruction (SI) program at Anne Arundel Community College (Arnold, MD). In addition to a descriptive overview of the SI program, data from a 1987 research study suggests that SI participants received higher mean final course grades (2.6 vs. 1.9) and lower rates of D, F and withdrawals (24% vs. 44%). Using the same data set, when developmental education students and students of color were studied regarding the impact of SI attendance, the results were more pronounced than when examining the entire class of students. SI participants earned higher mean final course grades (3.1 vs. 1.8).

Wolfe, R. F. (1990). Professional development through peer interaction. *The Journal of Professional Studies*, 14(1), 50-57.

The Supplemental Instruction (SI) program at Anne Arundel Community College (Arnold, MD) was modified to use faculty members as SI supervisors. While this was the initial focus for the faculty members, the mentor role evolved into an opportunity for them to observe colleagues and to grow as teachers. Mentors are placed in classes outside their own discipline. Faculty mentors were placed in classes outside their own discipline. The classroom instructor and faculty mentor would meet periodically to provide feedback to each other and discuss strategies to improve instructional effectiveness. Faculty mentor roles included: 1) attending a three-day pre-semester training seminar (e.g., examined learning strategies, examined their own teaching and learning styles, learned questioning techniques, and practiced group management); 2) attending all classes and study sessions as a student in the target class for the first four weeks of the semester; 3) working with student leaders to prepare strategies for the study session; 4) working with student leaders to create supplemental materials such as graphic representation of abstract concepts; 5) formally evaluating student leaders during the second half of the semester, and 6) keeping a daily journal to record their observations and reflections about classes and SI sessions.

Wolfe, R. F. (1991). *Supplemental Instruction with mentoring support at Anne Arundel Community College*. Anne Arundel Community College. Arnold, MD. Available online: ERIC database. (ED413942).

Anne Arundel Community College's Supplemental Instruction (SI) with Mentoring Support provides a program of academic support for students enrolled in difficult required courses, while also creating valuable opportunities for faculty professional development and community interaction. By adapting the SI model for the community college, this program has trained students and faculty to work together to facilitate learning and thinking skills through a learner-centered approach of peer group study and community and faculty mentoring support. Student SI leaders are trained through a three-credit hour practicum in education course. Faculty who are trained in study skills and learning strategies through a three day pre-term training seminar: attend classes and study sessions in courses outside their discipline for the first four weeks of the academic term; work as mentors to student SI leaders to prepare strategies for SI sessions; work with SI leaders to create supplemental materials; formally evaluate SI leaders during the second half of the academic term; and maintain a daily journal. In evaluating the project, faculty mentors stated the program provided an opportunity to broaden their professional expertise and their perspectives on student learning. They had developed new teaching approaches, an

awareness of their teaching styles, and an understanding of students' needs. A second modification to the SI program provided local community leaders in their career fields to provide mentoring support in small group sessions and on-site visits. On the day of the community leader's visit, SI leaders conduct an abbreviated SI session, giving the community mentor the opportunity to observe and participate in an SI session. Then, the community mentor speaks informally with students, discussing career related topics and answering students' questions.

Wolfe, R. F., & Wells, E. (1990). Community mentors for Supplemental Instruction. *National Association for Developmental Education Newsletter*, 12.

Anne Arundel Community College (Arnold, MD) has made an adaption of the Supplemental Instruction (SI) to provide additional information concerning personal and career options related to the courses that have SI attached to them. A community person (mentor) is invited to attend one SI session for a course that is applicable to the mentor's field. A mentor may be a personal friend of the course instructor, or may be active in the vocational trade council, cooperative education, or advisory boards serving career programs at the college. The SI leader helps prepare the SI participants to generate questions for the mentor's visit. The mentors become another partner in encouraging academic success and the meaningfulness of the course for future jobs. Upon mutual interest, the mentors and students may continue discussions outside of class and SI sessions that might result in job site visits or additional career discussions.

Wong, J. G., Waldrep, T. D., & Smith, T. G. (2007). Formal peer-teaching in medical school improves academic performance: The MUSC Supplemental Instructor program. *Teaching and Learning in Medicine*, 19(3), 216-220.

The Medical University of South Carolina's Center for Academic Excellence created a Supplemental Instruction (SI) program which employed upper-level medical students to teach junior peers in basic science topics using SI activities and protocols. A control group of similar students were assigned to small study groups that followed more traditional recitation procedures. Both groups of students had similar academic profiles. The SI participants received higher USMLE Step 1 and Step 2 scores and final medical school GPA compared to the non participants.

Wood, T. (1984, 1984, September 10). Plan aims at making students better thinkers, *The Kansas City Star Newspaper*, pp. 1A, 5A.

The newspaper article provides an overview of the Supplemental Instruction (SI) program. The article contains an interview with several SI personnel -- including Deanna Martin, creator of the SI program -- and faculty members who have SI attached to their class. Faculty report support for the program for the following reasons: do not have to spend time in class repeating content material since it can be discussed more fully in SI sessions; improves academic performance of students; and does not infringe upon the tradition of the professor's role in the learning process. In the Foundations of Philosophy course the SI participants received a mean final course grade of 2.3 (out of 4.0) as compared with 1.4 for non-SI participants.

Woolrych, T., Zaccagnini, M., Stephens, M., Stace, M., Middleton, R., Stephen, M., . . .

Kornhoff, A. (2018). *Peer Assisted Study Sessions (PASS) Online: Investigating the impact of an online format across different first year university subjects*. Conference Proceedings of the 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), Wollongong, NSW, Australia. Available online:

<https://ro.uow.edu.au/cgi/viewcontent.cgi?article=5571&context=sspapers>

As the demand for flexible learning increases, it is important to explore and expand online learning opportunities, especially in student supported learning. Peer Assisted Study Sessions (PASS) is a student led academic support program designed to help students transition into

university and increase student retention. PASS is offered in traditionally challenging first year core subjects. Due to increased popularity of PASS, along with limited space and time availability, a synchronous online format (Blackboard Collaborate) was piloted in three first year University of Wollongong (UOW) subjects in the faculties of Business, Nursing, and Psychology. The aim was to test the effectiveness of the online delivery of PASS by comparing student final grade outcomes from online cohorts with face-to-face (F2F) modes, and those students who had not attended PASS. Results demonstrated that students who attended PASS obtained significantly higher marks compared to students that did not attend PASS. Final grade outcomes for F2F versus online also varied between subjects. The different result profiles for the three subjects suggests there may be different drivers for student success in the online space. This paper presents these findings providing consideration of different factors that may influence student success, with directions for future research.

Worthington, A., Hansen, J., Nightingale, J., & Vine, K. (1995). *Peer teaching and introductory economics: An application using the Peer Assisted Study Scheme (PASS) at the University of New England*. Conference Proceedings of the Australian Economics Education Symposium in conjunction with the 24th Conference of Economists, Adelaide, South Australia, Australia. This paper discusses the use of Peer Assisted Study Scheme (PASS) with approximately 300 students in an Introductory Microeconomics class at the University of New England (Australia) in 1995. PASS is an Australian contextualization of the Supplemental Instruction (SI) program. After an overview of peer collaborative learning and challenges with student learning in economics courses, the paper shares the results of qualitative and quantitative research. Quantitative data included assessment scores, the final exam results and the responses to a 34 item survey administered to all students in the class. The survey included questions about their experience in the PASS sessions, reasons they did or did not participate in PASS, usefulness of the tests, possible reasons for academic difficulty in the class, and to predict their final grade in the class. Data were analyzed using Item Response Theory and multiple linear regression techniques. Qualitative data were collected by the PASS coordinator from weekly written reports of the PASS facilitators, PASS session observations, and in-depth interviews. About one-third of the students participated in SI. Of these students, more than 50 percent attended more than half of the available sessions during the academic term. The PASS participants listed either "to improve understanding" or "to gain additional information" as the top reason for attending the sessions. Only five percent listed "to learn study skills" as the top reason. Only 22 percent of the nonparticipants said that they had no desire to attend or thought they were unnecessary. The most common reason not to attend related to insufficient time. It appears that the SI programs is directly beneficial to the SI participants and indirectly beneficial to non-SI participants since the program influenced the teaching staff to increase student learning. Before introduction of PASS, the failure rate in the course was 33 percent. Following the introduction of PASS, the failure rates have dropped to 18 percent. Through weekly feedback from the PASS facilitator, the class lecturer reported that he intentionally modified the lecture content and his lecturing style. One change was that the lecturer reduced the volume of information delivered so that more time could be spent on improving student understanding of critical concepts.

Worthington, A., Hansen, J., Nightingale, J., & Vine, K. (1997). Supplemental Instruction in introductory economics: An evaluation of the University of New England's Peer Assisted Study Scheme (PASS). *Australian Economic Papers*, 69-80. This article discusses the use of Peer Assisted Study Scheme (PASS) with approximately 300 students in an Introductory Microeconomics class at the University of New England (Australia) in 1995. PASS is an Australian contextualization of the Supplemental Instruction (SI) program. After an overview of peer collaborative learning and challenges with student learning in economics courses, the paper shares the results of qualitative and quantitative research.

Quantitative data included assessment scores, the final exam results and the responses to a 34 item survey administered to all students in the class. The survey included questions about their experience in the PASS sessions, reasons they did or did not participate in PASS, usefulness of the tests, possible reasons for academic difficulty in the class, and to predict their final grade in the class. Data were analyzed using Item Response Theory and multiple linear regression techniques. Qualitative data were collected by the PASS coordinator from weekly written reports of the PASS facilitators, PASS session observations, and in-depth interviews. About one-third of the students participated in SI. Of these students, more than 50 percent attended more than half of the available sessions during the academic term. The PASS participants listed either "to improve understanding" or "to gain additional information" as the top reason for attending the sessions. Only five percent listed "to learn study skills" as the top reason. Only 22 percent of the nonparticipants said that they had no desire to attend or thought they were unnecessary. The most common reason not to attend related to insufficient time. It appears that the SI programs is directly beneficial to the SI participants and indirectly beneficial to non-SI participants since the program influenced the teaching staff to increase student learning. Before introduction of PASS, the failure rate in the course was 33 percent. Following the introduction of PASS, the failure rates have dropped to 18 percent. Through weekly feedback from the PASS facilitator, the class lecturer reported that he intentionally modified the lecture content and his lecturing style. One change was that the lecturer reduced the volume of information delivered so that more time could be spent on improving student understanding of critical concepts.

Wright, G. L., Wright, R. R., & Lamb, C. E. (2002). Developmental mathematics education and Supplemental Instruction: Pondering the potential. *Journal of Developmental Education*, 26(1), 30-35.

During the Spring, Summer, and Fall 2000 semesters, data were gathered and analyzed concerning the effective use of Supplemental Instruction (SI) in 90 developmental mathematics courses. The study monitored student outcomes in a small pilot program conducted at a southern state university with about 11,000 students. The student outcomes suggested that Supplemental Instruction may have made a positive difference in the performance and retention rates of developmental mathematics students when the instructor was actively involved in promoting the SI group and certain modifications were made to the traditional role of the SI leader in the classroom.

Yard, J. (2017). *Mandatory Supplemental Instruction in mathematics: Evaluating the first five years of a program to promote student success in calculus and developmental mathematics*.

Conference Proceedings of the Proceedings of the 13th Annual National Symposium on Student Retention, Destin, FL. Available online:

<https://bar.indiana.edu/pdf/2017NSSRProceedings.pdf#page=208>

Introductory mathematics courses can pose significant challenges for freshmen and often become barriers to student success and persistence in science and science-related majors. Mandatory attendance was required for SI.

Yates, J., Gill, F., & Webb, C. (1995). *Peer mentoring to facilitate learning in economics*.

Conference Proceedings of the Australian Economics Education Symposium, Adelaide, South Australia, Australia.

This paper describes and provides a preliminary evaluation of Supplemental Instruction (SI) used at the University of Sydney (Australia) in an economics course during 1995. Three quarters of the SI leaders listed the following benefits of involvement with the program: improved teaching skills; improved leadership skills; increased confidence; and/or a change in the way they thought about economics.

Yeung, K.-P. (2004). *An evaluation of a Supplemental Instruction programme in a business statistics subject*. University of Hong Kong, Hong Kong, China.

Yockey, F. A., & George, A. A. (2000). The effects of a freshman seminar paired with Supplemental Instruction. *Journal of the First-Year Experience and Students in Transition*, 10(2), 57-76.

This study examines the impact on student performance of one section of a new model of first-year seminar, which is paired with an introductory-level core social science course. The freshman transition seminar instructor attends the core course, takes notes and exams, does class projects, models good student behaviors, and leads a weekly review of the core course material which is presented in a model similar to Supplemental Instruction (SI). The authors collected data over three semesters on core course grade and semester grade point average for students in the first-year seminar and students in a control group selected from a matched sample. Their results indicate that students in the first-year seminar paired with SI achieved significantly higher grades in the paired core course, attained significantly higher semester grade point averages for the semester of intervention, and had significantly better retention rates after two years than students in the control group.

Young, C. A. (2015). *Determining the relationship of Supplemental Instruction to student attitudes*. (Ph.D. dissertation), Texas A & M, College Station, TX.

Attendance patterns of students enrolled in Supplemental Instruction (SI) study groups were examined to determine if attendance could explain outcomes related to student success. Students took the College Learning Effectiveness Inventory (CLEI) early in the semester and again at the end of the semester to measure student attitudes and behaviors that are usually associated with student success. Mean scores were calculated for each participant in the study for each administration of the CLEI. Change scores were calculated by subtracting mean scores of the second administration from mean scores of the first administration. Student attendance at SI groups was reported at the time of the second administration of the survey. Comparisons were made to determine whether there were differences in gains on mean scores on scales of the CLEI based on SI attendance, as well as ethnicity and gender. The results of the study showed no significant differences in change scores on the CLEI scales based upon SI attendance. There were also no significant changes based upon SI attendance and ethnicity or gender.

Young, D. G., Hoffman, D. E., & Reinhardt, S. F. (2019). An exploration of the connection between participation in academic peer leadership experiences and academic success. *Journal of Peer Learning*, 12(1), 45-60. Available online: <https://ro.uow.edu.au/ajpl/vol12/iss1/4/>.

This study examined the relationship between peer leader involvement and academic success outcomes in the United States. Results are based on the 2013 administration of the National Survey of Peer Leaders conducted at 49 institutions of higher education in the United States. Findings show that academic peer leadership experience was a strong, positive predictor of self-reported academic performance. The total number of peer leader experiences was also a positive, yet weak, predictor of academic success.

Yue, H., Rico, R. S., Vang, M. K., & Giuffrida, T. A. (2018). Supplemental Instruction: Helping disadvantaged students reduce performance gap. *Journal of Developmental Education*, 41(2), 18-25. Available online: <https://files.eric.ed.gov/fulltext/EJ1200705.pdf>.

This study examined how Supplemental Instruction (SI) visits help traditionally disadvantaged students reduce the performance gap in their courses. A student is defined as holding a "disadvantaged" status when he or she can identify

with the following factors: underrepresented minority status, first-generation status Federal Pell Grant eligible status, and English/ mathematics remedial status. This study revealed that students including both disadvantaged and nondisadvantaged would benefit from an increase of SI participation. The more disadvantaged students gained larger performance improvement than less disadvantaged students with more SI visits, indicating the importance of regular SI participation for disadvantaged students to close the performance gap with nondisadvantaged students.

Zaccagnini, M., & Verenikina, I. (2014). Peer Assisted Study Sessions for postgraduate international students in Australia. *Journal of Peer Learning*, 6(1), 86-102. Available online: : <http://ro.uow.edu.au/ajpl/vol6/iss1/8>.

Peer Assisted Study Sessions (PASS), a peer led academic support program that has multiple documented academic, social, and transition benefits, is increasingly being utilised in Australian institutions. PASS is based on the Supplemental Instruction (SI) model. Whilst PASS has been evaluated from multiple angles in regard to the undergraduate cohort, there is limited research regarding the benefits of PASS for postgraduate students, particularly international postgraduate students. This specific cohort's perspective is significant as international students constitute a large proportion of postgraduate students in Australian universities. This study investigates the role of PASS in contributing to the experience of international postgraduate coursework students at an Australian university through an investigation of its perceived benefits by this cohort of students.

Zacharopoulou, A., Giles, M., & Condell, J. (2015). Enhancing PASS leaders' employability skills through reflection. *Journal of Learning Development in Higher Education*(November). Available online:

[http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path\[\]=348](http://www.aldinhe.ac.uk/ojs/index.php?journal=jldhe&page=article&op=view&path[]=348).

Whilst the benefits for students attending Peer Assisted Study Sessions (PASS) have been widely acknowledged, the benefits for its leaders have not been as clearly evaluated. This paper will explore how the more senior students who take on the role of PASS leader can develop employability skills through a programme of activity that formally rewards students for their participation and assists them in articulating their competencies. The paper presents the findings of a project undertaken by a cross-disciplinary team at Ulster University which focused on the benefits for PASS leaders and, more explicitly, on graduate employability skills such as communication, teamwork and leadership. Students were required to reflect on the PASS process and plan for subsequent sessions whilst also engaging in a series of skill-building activities (games and various practical exercises) which focused on those facets of employability that are of direct relevance to the PASS experience. Quantitative and qualitative methods were employed to evaluate the impact of the PASS programme: initial findings suggest that the programme served to enhance students' perceived competence in respect of some employability skills (e.g. spoken communication) but, more generally, served to raise their awareness and highlight their limitations in some areas. This paper suggests that the process of reflection has helped them to better articulate these skills and identify the steps needed to further develop them. As such, this project has provided research evidence to support the effectiveness of the PASS process and a collection of materials to support the further development of its leaders.

Zaritsky, J. S. (1989). *Peer tutoring: Issues and concerns, results of a survey*. Unpublished manuscript. La Guardia Community College. Long Island City, NY. Available online: ERIC database. (ED315134).

In 1988, a survey was conducted to determine the characteristics and extend of peer tutoring program at two- and four-year colleges in New York. Findings included: 95 percent of

institutions had at least one peer tutoring program; 2) 41 percent had centralized tutoring labs; 3) institutions most commonly provided Supplemental Instruction in mathematics, biology, business, chemistry, and English; and 4) 96 percent provided peer tutors with training.

Zaritsky, J. S. (1994). *Supplemental Instruction: A peer tutoring program at La Guardia Community College*. Unpublished manuscript. La Guardia Community College. Long Island City, NY. Available online: ERIC database. (ED373859).

This report describes the use of Supplemental Instruction (SI) at La Guardia Community College (NY). In spring 1993, an SI program was pilot tested in Principles of Accounting I, Introduction to Economics I and Fundamentals of Human Biology I courses. In Economics I the SI participants received a higher percent of A, B, and C final course grades (37% vs. 27%) and a lower rate of D, F, and course withdrawals (63% vs. 73%). In Economics I the SI participants received a higher percent of A, B and C final course grades (51.7% vs. 43.6%) and a lower rate of D, F and course withdrawals (48.3% vs. 56.4%). In Human Biology I the SI participants received a higher rate of A, B, and C final course grades (63.2% vs. 48.3%) and a lower rate of D, F, and course withdrawals (36.7% vs. 51.7%). Some SI leaders reported personal improvement in the following areas: higher self-confidence since they helped other students to do better; increased content knowledge through second review of the course; improved interpersonal communication skills; accelerated emotional and intellectual growth.

Zaritsky, J. S. (1998). *Supplemental Instruction: What works, what doesn't*. Conference Proceedings of the National Association for Developmental Education, Atlanta, GA.

This conference abstract describes the use of Supplemental Instruction (SI) at an urban two-year college (LaGuardia Community College, Long Island, NY). LaGuardia piloted SI in three courses in 1993. It now has grown to support more than 20 courses. The average final course grade of SI participants exceeds that of non-participants by approximately a full letter grade. Six key factors were identified for SI programs with positive outcomes for students: SI program supervisor handles multiple roles; college administration is supportive of the program; faculty enthusiasm and support; talented SI leaders; courses selected for SI support have high rates of D, F, or withdrawals; and highly involved SI participants.

Zaritsky, J. S. (1999). *Supplemental Instruction and collaborative learning*. Conference Proceedings of the National Association for Developmental Education, Detroit, MI.

This conference abstract describes the use of Supplemental Instruction (SI) at an urban two-year college (LaGuardia Community College, Long Island, NY). LaGuardia. This paper explores the use of collaborative learning to improve SI: positive interdependence, face-to-face promotive interaction, individual accountability, interpersonal and small group skills, and group processing.

Zaritsky, J. S. (2001). Supplemental Instruction at an urban community college. In J. E. Miller, J. E. Groccia & M. S. Miller (Eds.), *Student-assisted teaching: A guide to faculty-student teamwork* (pp. 103-108). Bolton, MA: Anker Publishing Company. Available online: ERIC database. (ED449713).

Supplemental Instruction (SI) is used at LaGuardia Community College in New York to serve an ethnically-diverse student body. After providing a general overview of the SI model, a 1997-98 research study was shared that analyzed the impact of the program with courses in accounting, computer science, biology, and chemistry. Overall mean final course grades favored the SI participants (2.75 vs. 1.65) and higher percentage of successful grades (82% vs. 53%).

Zaritsky, J. S., & Toce, A. (2006). The basic SI model. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 23-32). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter describes how SI has since 1993 been successful in improving grades and reducing failure in high-risk courses at LaGuardia Community College, an urban institution. In addition, the SI experience has benefits for the SI leaders: better understanding of the course material, discovering the joy of learning and helping others, gaining self confidence, strengthen communication and leadership skills.

Zerger, S. (1990). *Supplemental Instruction: Learning through modeling*. Unpublished manuscript. Bethel College. North Newton, KS.

This unpublished manuscript describes the use of Supplemental Instruction (SI) to improve student learning. The paper focuses on explaining how learning occurs in SI, using the social learning theory described in Bandura to do so. According to Bandura, humans can and do learn most things through watching others. This capacity to learn by observation enables humans to acquire large integrated patterns more quickly than if they had to learn all via direct trial and error.

Zerger, S. (1994). Supplemental Instruction in the humanities. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 41-52). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc. Supplemental Instruction sessions in the humanities must differ from those in other disciplines because the epistemology and the axiology differ: a) prior knowledge; b) audience expectations; c) the nature of claims or evidence. Some of the issues important for many SI sessions: need to focus on the big picture; expansion of information rather than data reduction (common in science); careful use of language; importance of writing activities; and role of authority and evidence.

Zerger, S. (1999). *Discipline-specific SI strategies for writing*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

Research and scholarship in composition theory investigates differences in reading and writing across the academic disciplines. Some of these differences are reflected in vocabulary; patterns of organization; kinds of evidence; documentation; and research methodologies. Due to the unique requirements of the disciplines, some of the following activities might be quite useful for students: preparatory writing, focused timed writings, brainstorming ideas for upcoming papers or reports, peer response to other student writing samples, and summarizing reading assignments.

Zerger, S. (2008). Theoretical frameworks that inform the Supplemental Instruction model. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 21-28). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition. This chapter explores the theories that inform and guide best practices of Supplemental Instruction (SI). Topics explored in the chapter include: behavioral theories and modeling; application of a cognitive model of student learning; Piaget and evolution of the SI model; social interdependence theory and cooperative learning; and critical theory with its empowerment of the student learner. The SI model draws upon all of these theories and creates a meaningful framework to use them appropriately with the SI model to improve student learning and increase student outcomes.

Zerger, S. (2008). Strategies for adapting Supplemental Instruction to specific academic disciplines. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 57-65). Columbia, SC:

University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition

This chapter focuses on the adapting of the Supplemental Instruction (SI) model for different academic disciplines. While there are a wide variety of generic or transferable skills that apply in nearly any SI session, there are also a number that are very useful in different academic content areas: humanities and history, natural sciences, and mathematics and engineering,

Zerger, S., Clark-Unite, C., & Smith, L. (2006). How Supplemental Instruction benefits faculty, administration, and institutions. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 63-72). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

Based on the experiences from Nelson Mandela Metropolitan University in South Africa, SI has been useful for faculty members, administrators, and the institution. SI affects faculty and staff development through informal discussions, workshops, trainings, and coursework. The institution benefits through the provision of a professional development programs for its faculty and staff as well as the enhanced outcomes for students.

Zha, S., Estes, M. D., & Xu, L. (2019). A meta-analysis on the effect of duration, task, and training in peer-led learning. *Journal of Peer Learning*, 12(1), 5-28. Available online <https://ro.uow.edu.au/ajpl/vol12/iss1/2>.

This meta-analytic study compared the effect of peer-led learning versus non peer-led learning on students' cognitive achievement in post-secondary education. Twenty-eight studies published in English from six countries between 1993 and 2017 were identified and used in the analysis. Some of these studies included ones of Peer-led Team Learning, Supplemental Instruction (SI), or variations of SI as used in other countries under different names. Result of the analysis on the random-effect model showed a moderate but positive effect, meaning that peer-led learning was associated with higher cognitive achievement than non-peer-led learning. Three study characteristics were examined including duration, student leaders' training, and task type. Only the task type was found significant in moderating the effect of peer-led learning. Student leaders' facilitation of problem-based learning tasks outperformed other types of tasks. Results of this study not only provided suggestions for peer-led learning designers and coordinators but also called for future research of student leaders' readiness as well as online peer-led learning.

Zhu, S., Estes, M. D., & Xu, L. (2019). A meta-analysis on the effect of duration, task, and training in peer-led learning. *Journal of Peer Learning*, 12(1). Available online: <https://ro.uow.edu.au/cgi/viewcontent.cgi?article=1153&context=ajpl>.

This meta-analytic study compared the effect of peer-led learning versus non peer-led learning on students' cognitive achievement in post-secondary education. Twenty-eight studies published in English from six countries between 1993 and 2017 were identified and used in the analysis. Result of the analysis on the random-effect model showed a moderate but positive effect, meaning that peer-led learning was associated with higher cognitive achievement than non-peer-led learning. Three study characteristics were examined including duration, student leaders' training, and task type. Only the task type was found significant in moderating the effect of peer-led learning. Student leaders' facilitation of problem-based learning tasks outperformed other types of tasks. Results of this study not only provided suggestions for peer-led learning designers and coordinators but also called for future research of student leaders' readiness as well as online peer-led learning.

Zulu, C. (2003). A pilot study of Supplemental Instruction for at-risk students at an Historically Black University (HBU) in South Africa. *Association Internationales de Linguistique Appliquée Review*, 16(1), 52-61.

This article discusses a pilot study during 2002 that sought to evaluate the effectiveness of Supplemental Instruction (SI) at the University of North-West, an historically black university in South Africa. The course under investigation was "Introduction to South African Legal Method and Theory" which first-year law students enrolled. Two questions were investigated: does SI have an effect on students' mastery of content? and does SI have an effect on students' perceptions of their mastery of skills? Three measures were used to evaluate SI: pre and posttests of content knowledge, student perceptions, and final course grades. There was a correlation of higher SI attendance and higher final course grades. The study also revealed barriers and challenges that students experience at the institution. SI was most effective for students who were better prepared academically and for whom English was their first language. These students had more capacity to engage in the SI sessions and gain the most benefit. The author also noted the disadvantage of voluntary SI attendance. Often the students who most needed to be there chose not to attend due to self-reported reluctance to expose their weakness and discomfort due to lacking the skills of the most prepared students. The author recommends that SI attendance be made compulsory and that SI be combined with other academic interventions such as Accelerated Learning Groups developed by Dr. Sydney Stansbury.

Zywicki, C. (2014). *The monetary value of Supplemental Instruction to Iowa State University due to reenrollment of SI participants, FY2014*. Iowa State University. Ames, IA. Available online: <http://www.asc.dso.iastate.edu/sites/default/files/supplemental/SIValue.pdf>

Academic success is an important factor in students' persistence through college (Tinto, 1987). For a university, academic success equates to retention of students, and retention of students becomes retention of tuition dollars. Results of a national, longitudinal study on student retention showed SI participants from one semester reenrolled the following semester at a rate of 10% higher than peer students who did not participate in SI (Arendale & Martin, 1997). Two formulas describe the monetary value of SI to universities. These formulas show: 1. The monetary value SI contributed to Iowa State University during FY14 was \$3,286,771. 2. To cover all expenses, SI at Iowa State University would need to contribute to the retention of less than .39% of all SI Participants.

Video-based Supplemental Instruction (VSI)

VSI was developed at the University of Missouri-Kansas City by Dr. Deanna Martin during the 1990s. VSI combines course content and Supplemental Instruction (SI) study sessions with video recordings of lectures identical to the instructor's in-person class session. Trained facilitators, using the recorded lectures and the SI model, guide students through the learning process while emphasizing critical thinking and study skills. VSI students, led by a trained facilitator, start and stop the videotaped presentation at pre-determined times and, in addition, whenever they have a question or want clarification. Professors design the video presentations to include periodic small group assignments to insure mastery of one concept before the next is introduced. Students complete these tasks under the supervision and with the guidance of the facilitator. When the taped lecture resumes, the professor models how he/she thinks about the assigned tasks. In this way, the students have time to construct and verify their understanding as well as compare their own thinking to that of the expert. Assessment is provided by the professor, keeping the facilitator in the role as a peer supporter and not an evaluator. The program was originally designed to take the place of developmental-level courses that were prohibited due to an institution mandate. VSI differs from SI in several respects. The students enroll in required, core curriculum courses. The course professor records all didactic presentations on videotape for use with underprepared students as well as other students who opt for this interactive way of learning. Instead of attending the professor's regular lecture classes, students enroll in the video section of the professor's course. Students in both sections are held to the same performance standards. Specially designed facilitator and student manuals support the video sections.

1 - Homepage of the annotated bibliography of postsecondary peer cooperative learning programs. Compiled and edited by David R. Arendale, Available online:
<https://www.arendale.org/peer-learning-bib>

This website contains annotated bibliographies on all known publications related to the following national or international peer learning models: Accelerated Learning Groups, Emerging Scholars Program, Peer Assisted Learning (UMN), Peer-Led Team Learning, Supplemental Instruction (also known as PAL, PASS, and other names), Structured Learning Assistance, and Video-based Supplemental Instruction. The annotated bibliography is also provided as separate smaller bibliographies for each of the individual peer models and topics that include any of the models. The database is also available for download for personal use under a Creative Commons license.

Arendale, D., R, (Compiler/Editor),. (2019). *Annotated bibliography of postsecondary peer cooperative learning programs*. Unpublished manuscript. Department of Curriculum and Instruction, University of Minnesota. Minneapolis, MN. Available online: <http://z.umn.edu/peerbib>
This annotated bibliography contains all known citations regarding the following postsecondary peer collaborative learning programs: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Program (PAL), Peer-led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI) also known as PASS, and Video-based Supplemental Instruction (VSI). It has nearly 1,600 entries in the following categories: dissertations and thesis papers; books, chapters, and monographs; journal articles; audio and videotapes; newsletter articles; ERIC documents; published conference proceedings; unpublished manuscripts; Internet resources; newspaper and magazine press coverage. In

addition to the print version of the document, the web site provides a downloadable version of the EndNote database that permits searching by a variety of criteria along with several subject bibliographies.

Arendale, D. R. (1999). *Introduction*. Conference Proceedings of the First National Conference on Supplemental Instruction/VSI, Kansas City, MO.

The author provides an introduction to the conference proceedings of the First National Conference on Supplemental Instruction/VSI held in Kansas City, MO during May 1999.

Arendale, D. R. (2004). Pathways of persistence: A review of postsecondary peer cooperative learning programs. In I. M. Duranczyk, J. L. Higbee & D. B. Lundell (Eds.), *Best practices for access and retention in higher education* (pp. 27-42). Minneapolis, MN: Center for Research on Developmental Education, General College, University of Minnesota. Available online: <http://education.umn.edu/CRDEUL/monographs.html>.

This chapter focused intentionally on a subset of the educational practice that share a common focus with increasing student persistence towards graduation. Rather than a meta-analysis of all published research studies, this chapter is a preliminary review and a description of six models. At the end of the chapter several suggestions are made for differentiating the models from each other and the level of institutional resources and resolve with implementing them. The six student peer learning programs included in this chapter meet the following characteristics: (a) the program must have been implemented at the postsecondary or tertiary level, (b) the program has a clear set of systematic procedures for its implementation at an institution, (c) program evaluation studies have been conducted and are available for review, (d) the program intentionally embeds learning strategy practice along with review of the academic content material, (e) the program outcomes include both increased content knowledge with higher persistence rates, and (f) the program has been replicated at another institution with similar positive student outcomes. From a review of the professional literature six programs emerged: Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer-Led Team Learning (PLTL), Structured Learning Assistance (SLA), Supplemental Instruction (SI), and Video-based Supplemental Instruction (VSI). As will be described in the following narrative, some of the programs share common history and seek to improve upon previous practices. Other programs were developed independently.

Arendale, D. R. (2009). Course-based Learning Assistance (CLA) program guide. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-evaluation guides: Best practice in academic support programs* (2nd ed., pp. 105-138). Clearwater, FL: H&H Publishing.

These program standards provide guidance for management of postsecondary peer cooperative learning programs such as Accelerated Learning Groups (ALGs), Emerging Scholars Program (ESP), Peer Assisted Learning Groups (PAL), Peer-Led Team Learning (PLTL), Supplemental Instruction (SI), Structured Learning Assistance (SLA), and Video-based Supplemental Instruction (VSI). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are six sections to the chapter: mission and goals; assessment and evaluation; program design and activities; human resources; and value system. The items within each section are divided between essential (important for any peer learning program) and recommended (useful for some peer learning programs due to their design). A more detailed examination of assessment and evaluation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2009). Specific assessment and evaluation protocols for Course-based Learning Assistance (CLA) programs. In S. Clark-Thayer & L. P. Cole (Eds.), *NADE self-*

evaluation guides: Best practice in academic support programs (2nd ed., pp. 183-193). Clearwater, FL: H&H Publishing.

These program standards provide guidance for assessment and evaluation of postsecondary peer cooperative learning programs such as Supplemental Instruction (SI), Structured Learning Assistance (SLA), Emerging Scholars Program (ESP), Accelerated Learning Groups (ALGs), Peer Assisted Learning (PAL), Video-based Supplemental Instruction (VSI), and Peer-led Team Learning (PLTL). These standards were developed through extensive field testing of professionals in the field operating these peer learning programs. There are four progressive levels of assessment and evaluation: program activity reports, immediate outcomes, short-term outcomes, and longer-term outcomes. The levels within each section are divided among questions to investigate, data needed for collection for analysis, and finally, analysis procedures. Depending on the particular peer learning program, some of these protocols would be more appropriate than others. A more detailed examination of mission, program design, administration, and other issues related to implementation of peer learning programs is provided elsewhere in the larger publication.

Arendale, D. R. (2020). *Draft Course-based Learning Assistance (CLA) program guidelines*.

Department of Curriculum and Instruction, University of Minnesota. Available online:

<https://z.umn.edu/peerguides> and <https://www.arendale.org/peer-learning-resources>

Course-Based Learning Assistance (CLA) is defined as peer cooperative learning assistance that accompanies a specific targeted course to serve as a supplement for that course. While many CLA activities operate outside of the course, CLA is integrated into the course by some instructors. Other CLA programs are hybrid or totally online. These guidelines are applicable to national and international CLA program models have been implemented at thousands of postsecondary and tertiary institutions in more than thirty countries (a) Emerging Scholars Program, (b) Peer-Led Team, (c) Structured Learning Assistance, (d) Supplemental Instruction, and (e) Video-based Supplemental Instruction). When using the CLA Guides, it is not expected that administrators of campus CLA programs implement every “essential” and “recommended” practice listed in this guide. Some “essential” practices are not relevant to a particular type of CLA program. Limitations of campus budget, personnel, and available time make other “essential” practices difficult to implement. “Recommended” practices are simply practices that some CLA program administrators have found helpful. Therefore, those practices have been separated from the “essential” ones. For simplicity’s sake, all the practices have been divided into these two categories. Some “recommended” practices could be categorized as aspirational, something to pursue if there is sufficient budget, personnel, and time to implement. The bottom line is that the purpose of the guides is not to judge existing programs, but rather to provide guidance and practices that could increase their effectiveness and efficiency. In addition to their use for academic study groups, these guides may be useful for faculty members to incorporate learning activities and pedagogies into their courses. The administrative and education best practices in this publication have been reviewed and approved by multiple members of an external expert panel of qualified reviewers. Educators need to investigate these education practices to discover effective learning practices that can be adapted and adopted for use in supporting higher student achievement, closing the achievement gap, increasing persistence to graduation, and meeting the needs of culturally-diverse and historically-underrepresented students. Updates to this set of guidelines are available at <https://z.umn.edu/peerguides>

Arendale, D. R., & McLaren, A. (1999). *Supplemental Instruction: Variations on the basic theme*.

Conference Proceedings of the Annual Conferences of the Pennsylvania Association of Developmental Educators, Hershey, PA. Available online: ERIC database. (ED428632)

This paper describes some of the successful variations of Supplemental Instruction (SI). After an initial overview of SI, descriptions about innovations of the model. The first concerns Video-

based Supplemental Instruction (VSI). VSI is described as an information delivery system. College students enroll in telecourses that are identical to credit courses delivered live on campus by the same professor. Students enrolled in these VSI course sections attend class eight hours a week rather than three hours since the videotape lectures are frequently stopped to engage in SI session activities. Developmental level students enrolled in VSI course sections earn higher final course grades than the traditional students enrolled in the live course sections. The second variation of the SI model is to use it for faculty development and renewal. Successful models include Salem State College and Anne Arundel Community College. Common activities include: SI leader providing anonymous feedback to the course lecturer; lecturer incorporating SI session activities inside of class sessions; lecturers serving as assistant SI supervisors and expanding their instructional/learning skills by observing other professors; and other associated activities.

Armstrong, L., Power, C., Coady, C., & Dormer, L. (2011). Video-based Supplemental Instruction: Creating opportunities for at-risk students undertaking engineering mathematics. *Journal of Peer Learning*, 4(1), 3-15. Available online: <http://ro.uow.edu.au/ajpl/vol4/iss1/3/>. At the University of Western Sydney (UWS) Australia, the Peer Assisted Study Sessions (PASS) program has been very successful. PASS is based on the Supplemental Instruction (SI) model. Video-based Supplemental Instruction (VSI) provides a more intensive and integrated learning experience based on collaborative processing of pre-recorded lectures for students who lack the prerequisite knowledge to successfully complete the course. Quantitative and qualitative evaluation methods were used to study the effectiveness of VSI with at-risk students enrolled in engineering mathematics. In three of the comparison student groups, the VSI students outperformed peers attending a traditional course. The at-risk VSI participants performed at nearly the same level as the non at-risk students attending the traditional lecture course. The main themes that emerged from the VSI participants were: increase in confidence, higher understanding of content, positive attitudes towards learning and math in particular, and improved study habits and learning strategies.

Austrell, P.-E., Barmen, G., Bryngfors, L., & Gustavsson, P. (2001). *VSI och "collaborative learning" for att minska variathionen i forkunskaper i mekanik bland nyborjarstudenten*. Conference Proceedings of the Academic Access Conference, Norrkoping, Sweden.

Blanc, R. A., & Martin, D. C. (1994). Supplemental Instruction: Increasing student performance and persistence in difficult academic courses. *Academic Medicine: Journal of the Association of American Medical Colleges*, 69(6), 452-454.

The authors describe the use of Supplemental Instruction (SI) with medical students to earn higher final course grades in historically difficult courses. The SI process has been used successfully with students who are preparing for the USMLE Step I examination. The authors state that SI can strengthen a prematriculation program for students whose MCAT scores place them in the high-risk category for completing the medical school curriculum. To maximize learning efficiency for students in the prematriculation program, the authors suggest that a small-group preview session precedes each lecture and a small-group review follows. The article concludes with a short overview of Video-based Supplemental Instruction (VSI).

Burmeister, S. L. (1996). Supplemental Instruction: An interview with Deanna Martin. *Journal of Developmental Education*, 20(1), 22-24, 26.

This is the transcript of an interview with Dr. Deanna Martin, creator of the Supplemental Instruction (SI) model. Issues discussed in the interview include: new innovations in the SI model; cost effectiveness of the model; use of SI in other countries; current educational climate in higher education; disagreement with mandatory testing and placement of students into

tracked developmental education programs; challenges with lecture-based educational delivery systems with increasing student learning mastery; and future opportunities for use of SI and Video-based Supplemental Instruction

Butler, A. F. (2014). *Effective institutional and instructional practices in developmental math education: A study of a southeastern community college system*. (Ph.D. dissertation), Capella University.

Developmental math education continues to be a rising challenge for many postsecondary two-year institutions. In response to this challenge, many colleges are adapting their developmental math education programs by implementing best institutional and instructional practices as defined by recent literature. This descriptive and correlational study used data from the Developmental Education Program Survey (DEPS) and the selected state's Department of Education to explore how community colleges within the state have implemented these research-based, promising instructional and institutional practices in the area of developmental mathematics education. The quantitative study through multiple linear regression analysis determined if the implementation of certain practices predicted the success of the students. Findings indicated that developmental education math programs were implementing most of the research-based best practices for developmental math education. In addition, the results of this study indicated that changes in the instructional aspect of the program increased student success in developmental math more than changes in institutional policy. This study found that implementation of best institutional practices as defined in the literature had no relationship to student success while implementation of best research-based instructional practices had a significant relationship to student success. The researcher recommends that institutions utilize cooperative, collaborative and mastery learning in their developmental math courses and that they consider offering developmental math instruction as math refresher workshops, bridge programs, and co-requisite courses to college-level math.

Carter, S. (2014). *Access barriers to higher education for rural community college students*. (Ph.D. dissertation), University of Arkansas.

The purpose for conducting the study was to examine factors related to rural low-income, first generation college students' obstacles to community college enrollment. The study examined barriers students overcame to attend college and focused on rural college students from two community colleges in Missouri and Arkansas. The following questions guided the research: 1. What attendance barriers did rural community college students identify as being most difficult for them to overcome? 2. Were there differences between the self-identified attendance barriers based on gender for male and female rural community college students? 3. Were there differences in attendance barriers for rural community college students based on whether they enrolled immediately out of high school or postponed attendance? 4. Were there differences in attendance barriers for rural community college students based on low-income or first generation classifications? A purposeful sample was chosen and 170 surveys were collected overall. Results were tabulated using descriptive statistics. The survey results showed that respondents believed their cumulative GPA had a great deal of influence on their decision to enroll at the local, rural community college. Financial aid eligibility and if the student's parents had attended a community college or university also played a major role in their successful enrollment.

Demireoz, E. (2016). *The mathematics emporium: Infusion of instructional technology into college-level mathematics and psychosocial factors of learning*. (Ph.D. dissertation), University of Missouri-Kansas City, Kansas City, MO.

This manuscript-based (European style) dissertation consisted of three different, but conceptually related manuscripts. The series of manuscripts examined psychosocial factors of

learning including attitude towards mathematics, motivation to learn mathematics, and satisfaction from the mathematics instruction in both redesigned and traditionally- taught college algebra courses at one of the Midwest research universities. This was a quantitative research study that used various statistical methods including exploratory factor analysis, internal replicability analysis, paired-samples t-tests, hierarchical multiple regression analysis, reliability and validity statistics. The first manuscript was an inclusive literature review that focused on course redesign—mathematics Emporium—and infusion of instructional and learning technologies into college algebra. The second manuscript focused on developing a new inventory to measure students' attitudes toward mathematics, motivation to learn mathematics, and satisfaction from the instructional practices specifically in a technology-supported mathematics education context. It focused on the psychometric properties—validity and reliability—of the Psychosocial Factors of Learning in Redesigned Introductory College Mathematics (PFL-RICM) scale. The third manuscript examined changes in psychosocial factors of learning not only in the redesigned context, but also in the traditionally-taught college algebra settings. Results of comparative analyses revealed that learners' attitudes toward technology-supported mathematics, and overall attitudes toward mathematics changed negatively in both traditionally taught and redesigned college algebra over the course of the semester. In traditionally-taught college algebra, beliefs about learning mathematics also changed significantly, but changes in learner motivation and satisfaction were not statistically significant. Attitude toward mathematics, extrinsic motivation to learn mathematics, satisfaction from technology-supported mathematics, satisfaction from instructional design and overall satisfaction of learners from college algebra changed significantly in redesigned college algebra settings. Between group comparisons resulted in significant differences on students' attitudes toward mathematics, and attitudes toward technology-supported mathematics. Learners who enrolled in traditionally-taught college algebra had higher attitudes toward mathematics scores, whereas learners who enrolled in redesigned college algebra had higher attitudes toward technology-supported mathematics.

Du Plooy, P. (1999). *VSI partnerships, and the transformation of education in South Africa*. Conference Proceedings of the First National Conference on Supplemental Instruction and Video-based Supplemental Instruction, Kansas City, MO.

The issue of partnerships between public and private institutions has been generating a great deal of interest in recent years in South Africa. One example of the development of a private-public partnership in higher education is that of the academic development program, Video-based Supplemental Instruction (VSI). This paper examines the introduction of VSI to South African institutions, in particular the establishment of a partnership which has evolved to drive this project, and how the VSI program has proved successful as an alternative route into higher education for severely underprepared students. Rather than requiring students to take additional time and spend limited tuition dollars to enroll in remedial courses, students are able to concurrently develop learning strategies while enrolled in rigorous college-level courses.

English, B. J. (1999). *Effects of social integration on the academic performance of international students*. Unpublished manuscript. The University of Southern California. Los Angeles, CA. This manuscript describes the use of Supplemental Instruction (SI) with postsecondary international students. A comparison is made between SI and the English Language Fellows Program at the University of Rhode Island which has similar purposes. The focus of the sessions is placed more on the use of language as the means for communicating and understanding the course material. The pairing of the native and nonnative speakers of English provides a rich atmosphere for language acquisition and fostering higher comprehension of the course content. The author then explores adapted use of Video-based Supplemental Instruction

(VSI) for nonnative speakers as a supplement to challenging courses to aid in language development and mastery.

Fitzgerald, N. (1997). The dropout dilemma. *Careers and Colleges Magazine*, 18(2), 14-17, 26. This article reviews the causes and cures for the high rate of college drop outs. The author interviewed a number of people for the article. One of those interviewed and quoted in the article is David Arendale, National Project Director for Supplemental Instruction (SI). Arendale describes how SI and its newest variation, Video-based Supplemental Instruction help students to integrate "what to learn" with "how to learn it"

Hester, B. (1992). Course teaches new skills with video. *Arctic College Dialogue Newsletter*, 6(2), 11.

This newsletter article provides an overview of the use of Video-based Supplemental Instruction (VSI) at Arctic College, Iqaluit, Northwest Territories.

Hurley, M., Patterson, K. L., & Wilcox, F. K. (2006). Video-based Supplemental Instruction: Serving underprepared students. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: New visions for empowering student learning* (pp. 43-54). New Directions for Teaching and Learning, No. 106. San Francisco: Jossey-Bass

This chapter discusses Video-based Supplemental Instruction (VSI), a variation of the SI model that presents options for students who, barring a serious academic intervention, will not be successful in college. Rather than enrollment in developmental-level courses, students enroll in a traditional introductory college course such as Western Civilization or General Chemistry. SI sessions are embedded inside of the lectures rather than waiting until after the lecture periods. Concurrent development of learning strategies along with mastery of rigorous academic content reduces the need for enrollment in prerequisite developmental-level courses.

Hurley, M. A. (2000). Video-based Supplemental Instruction (VSI): An interactive delivery system that facilitates student learning [Ph.D. dissertation, University of Missouri-Kansas City, 1999]. *Dissertation Abstracts International*, 61(04), 1317.

The study focuses on the cognitive and affective results of a small-group learning model called Video-based Supplemental Instruction. There are two hypotheses examined in this study: Students who participate in a Video-based Supplemental Instruction history class will have higher final course grades than a comparable group of students in the same course in a lecture-format class with the same professor. Students who participate in the Video-based Supplemental Instruction class will have greater self-efficacy, self-confidence and mastery of learning strategies than they had before taking the class. Video-based Supplemental Instruction is an interactive informational delivery system that helps students master course content as they develop and refine reasoning and learning skills. Instructors record their lectures on video tape and enroll students in a video section of the course. A trained facilitator uses the taped lectures to regulate the flow of information to the learner. The lectures are stopped and started as needed, allowing the facilitator to verify that students have comprehended one idea before moving on to the next. Students develop essential reading, learning, and study skills while they master content. The major conclusions from the study were the following: A group of 185 Video-based Supplemental Instruction students received a higher percentage of A's and B's than a comparable group of 185 Non-Video-based Supplemental Instruction students in the same history class over 14 semesters. A group of 185 Video-based Supplemental students received a lower percentage of D's and F's than a comparable group of 185 Non-Video-based Supplemental Instruction students in the same history class over 14 semesters. A larger number of first-year students and African-American students were enrolled in the Video-based Supplemental Instruction history class than was expected. Video-based Supplemental

Instruction students learned a variety of strategies which provided them with the academic tools to be successful on their history exams in that class. Video-based Supplemental Instruction students developed a greater sense of self-efficacy in the class. Students developed greater personal confidence because of the Video-based Supplemental Instruction experience. Some Video-based Supplemental Instruction students were unable to sufficiently articulate mastery of course concepts after completing the class.

Hurley, M. P., Kay, Painter, S., & Carnicom, J. (2008). Video-based Supplemental Instruction. In M. E. Stone & G. Jacobs (Eds.), *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed., pp. 67-79). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition. This chapter focuses on Video-based Supplemental Instruction (VSI), an adaptation of the SI model. VSI is an interactive information delivery system that helps students master course content and refine reasoning and learning skills. It provides an alternative to prerequisite or concurrent enrollment in developmental-level courses. Instead, learning strategy practice and mastery is embedded within a course using the VSI learning delivery system. The chapter compares and contrasts SI and VSI, discusses needed implementation steps, and shares VSI evaluation studies.

Koch, E., & Snyders, M. (1997). *The effect of Video Supplemental Instruction on the academic performance in mathematics of disadvantaged students*. Unpublished manuscript. University of Port Elizabeth, South Africa. Port Elizabeth, SA.

This paper examines the effect of Video-based Supplemental Instruction (VSI) on the mathematics performance of students whose metric marks did not enable them to be directly admitted to the Science Faculty at the University Port Elizabeth (South Africa). These students were enrolled in Ethembeni Community College in Port Elizabeth which serves as a preparation area before admission to UPE. Fifteen students who enrolled in VSI math were matched with 14 students enrolled in a similar math course that required attendance at Supplemental Instruction (SI) sessions. Research suggests that VSI was a more useful instructional delivery system for students with a minimum level of pre-knowledge in mathematics and who study in a consistent and responsible manner. In addition, the researchers suggested the usefulness of VSI in distance learning venues where experienced and trained faculty members are unavailable to deliver live instruction.

Koch, E., & Snyders, M. (1998). *The effect of Video Supplemental Instruction on performance in mathematics in the second semester mathematics special course*. Unpublished manuscript. University of Port Elizabeth, South Africa. Port Elizabeth, SA.

This paper examines the effect of Video-based Supplemental Instruction (VSI) in the second semester mathematics course which enrolled students from Ethembeni Community College in Port Elizabeth which serves as a preparation before admission to the University of Port Elizabeth (South Africa). Students who enrolled in VSI math were matched with students enrolled in a similar math course that required attendance at Supplemental Instruction (SI) sessions. Research suggests that VSI was a more useful instructional delivery system for students with a minimum level of pre-knowledge in mathematics and who study in a consistent and responsible manner.

Landwehr, R. (1995, 1995, July 21). Age of reason: Older students propel universities to shift boundaries, *Kansas City Business Journal*, pp. 21-22.

This newspaper article discusses how a variety of universities are adjusting to the needs and requirements of older students. In an interview with Dr. Kay Blair of the University of Missouri-Kansas City, a short overview of the Video-based Supplemental Instruction (VSI) program is

given. Blair listed the following benefits of the VSI program for students: bridges the gap between lectures and learning; helps students to prepare for the rigor of traditional undergraduate courses; fosters collaboration and team-building which are critical skills for the world of work; and taps the individual expertise of the students.

Martin, D. C. (Writer). (1994). Video-based Supplemental Instruction panel discussion [Videotape]. In K. Blair (Producer). Kansas City, MO: Center for Supplemental Instruction, The University of Missouri-Kansas City

This videotape panel discussion provides an overview of the Video-based Supplemental Instruction (VSI) program. Moderated by the creator of SI and VSI, Deanna Martin, the panel was composed of an administrator, faculty member who placed his course on video, former VSI student, and academic advisor who places students in VSI.

Martin, D. C. (1994). *Video-based Supplemental Instruction: An alternative to remedial courses*. Conference Proceedings of the Freshman Year Experience Conference on the First-Year Experience, Columbia, SC. Available online: ERIC database. (ED370895).

This article describes the use of Video-Based Supplemental Instruction (VSI) at the University of Missouri-Kansas City. Both a basic overview of the VSI model and a data study of the pilot study at UMKC. Though the VSI students are less prepared academically than the students in the large lecture class, the VSI group received higher mean final course grades (3.64 vs. 2.41), higher overall reenrollment rates (94 percent vs. 85 percent), and higher reenrollment rates for academic probationary students (100 percent vs. 45 percent).

Martin, D. C., & Arendale, D. R. (Eds.). (1994). *Supplemental Instruction: Increasing achievement and retention*. New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass

This monograph features nine chapters concerning: overview and foundation of the Supplemental Instruction (SI) program; use of SI for faculty development; SI in the content areas (humanities, mathematics, chemistry); research studies concerning SI; and the newest innovation of SI called Video-based Supplemental Instruction (VSI).

Martin, D. C., & Arendale, D. R. (1997). *Video-based Supplemental Instruction: Interactive video courses*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/VSI%20Interactive%20Video%20Course.pdf>

This report reviews the Video-based Supplemental Instruction (VSI) program initiated at the University of Missouri-Kansas City. The report provides a descriptive overview of VSI as well as numerous data studies concerning its use with high school and college students. Data studies suggest that among college students the VSI participants receive higher final course grades and reenroll at higher rates than the non-participants. VSI at the college level is targeted for students who have a history of academic difficulty (e.g., probation or dismissal) and have lower academic predictors (e.g., lower standardized entrance scores, lower high school percentile rank). As measured by the Learning and Study Strategies Inventory (LASSI), VSI participants show positive gains at the end of the academic term. Data studies of high school students who enroll in VSI courses suggest that they earn higher mean final course grades than college students who do not participate in VSI but enroll in the live section of the same class.

Martin, D. C., & Arendale, D. R. (1997). *Mainstreaming of developmental education: Supplemental Instruction and Video-based Supplemental Instruction*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/MainstreamingDE97.pdf>

This paper describes the development of Supplemental Instruction (SI) and Video-based Supplemental Instruction (VSI) to serve an effective way to mainstream the best features of developmental education into traditional college-level courses. The historical development and modern day implementation of both programs are described

Martin, D. C., Arendale, D. R., & Blanc, R. A. (1997). *Mainstreaming of developmental education: Supplemental Instruction and Video-based Supplemental Instruction*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO. Available online: <http://www.arendale.org/storage/pdf-documents/peer/MainstreamingDE97.pdf>

This manuscript was originally delivered as a paper at a special conference in January 1998 on "Alternatives to Developmental Education" that was sponsored by the U.S. Department of Education funded National Center for Lifelong Learning based at Stanford University (CA). The conference was convened to deal with the growing concern by some states regarding traditional developmental education credit courses. The conference was designed to identify several alternative ways of accomplishing the same purposes as developmental courses (e.g., linked courses, critical thinking courses, SI, VSI). This paper first provides an overview of SI and VSI. Then it concludes with the pedagogical basis for both. In developmental education, research scholars embrace the reductionist approach by seeking first to identify the separate and distinct skills required for academic success, then to measure the degree to which these are present or absent in the individual, and finally to isolate and teach those skills that are in deficit. Practitioners assume that mastery of a series of independent skills lead to academic competency. SI and VSI break with this view and provide a holistic approach to education. Given sufficient efficiency on task, effective guidance, and the time and opportunity to do so, any serious student can learn.

Martin, D. C., & Blanc, R. (2001). Video-based Supplemental Instruction (VSI). *Journal of Developmental Education*, 24(3), 12-14, 16, 18, 45.

Developed at the University of Missouri-Kansas City, Video-based Supplemental Instruction© is an interactive information processing and delivery system that helps academically at-risk students master rigorous course content as they concurrently develop and refine reasoning and learning skills. Rather than requiring prerequisite enrollment in a traditional developmental course, VSI is a learning system that mainstreams the best practices of developmental education into historically-difficult core curriculum courses. Research suggests the efficacy of VSI for improving academic achievement for students of diverse levels – from elementary school for children studying mathematics through professional school for future doctors studying to pass the first step of their medical license examination boards. VSI is presented as a holistic alternative to traditional approaches of developmental education

Martin, D. C., & Blanc, R. A. (1994). Video-Based Supplemental Instruction: A pathway to mastery and persistence. In D. C. Martin & D. Arendale (Eds.), *Supplemental Instruction: Increasing achievement and retention* (pp. 83-92). New Directions for Teaching and Learning No. 60. San Francisco, CA: Jossey-Bass, Inc.

The Video-Based Supplemental Instruction (VSI) delivery system using Supplemental Instruction that is described here combines developmental studies with core curriculum courses, offering an alternative to remedial/developmental instruction. Students that are least prepared at the institution need a more powerful academic support service. The difference between the VSI approach and those traditionally used in postsecondary education lies in the centrality of students to the process as opposed to the centrality of the material to be learned: students conduct the preview; students determine the pace of the lecture; students assure their own mastery as the lecture progresses; students select the key points for immediate review; and students identify misconceptions and modify and adapt their conceptions to achieve, eventually,

more complete understanding. VSI was designed to allow such students to both earn credit for core curriculum courses while they develop the requisite learning strategies needed for academic success. This provides an alternative way to provide developmental education.

Martin, D. C., & Hurley, M. (2005). Supplemental Instruction. In M. L. Upcraft, J. N. Gardner & B. O. Barefoot (Eds.), *Challenging & supporting the first-year student: A handbook for improving the first year of college* (pp. 308-319). San Francisco, CA: Jossey-Bass

This chapter provides an overview of Supplemental Instruction (SI). After providing guiding principles of SI, evidence of effectiveness is cited from the original developing site, University of Missouri-Kansas City as well as several other representative institutions. Two adaptations of the SI model are cited: Video-based SI and the Advanced Preparation Program. The chapter closes with recommendations for increasing the effectiveness of SI.

Maxwell, M. (Ed.). (1997). *Improving student learning skills: A new edition*. Clearwater, FL: H&H Publishing

Supplemental Instruction and Video-based Supplemental Instruction are described in several sections of this comprehensive book on developmental education and learning assistance programs. Short selections are contained in Chapter 7, successful programs and strategies for teaching high-risk college students and Chapter 12, increasing science skills.

Nel, P. P. C., Beylefeld, A. A., & Nel, M. M. (1997). *Video-based Supplemental Instruction as an integral part of an academic support and development program*. Conference Proceedings of the Medical education and assessment: Advances in medical education, Maastricht, The Netherlands.

Video-based Supplemental Instruction (VSI) is being used at the University of the Orange Free State (Bloemfontein, South Africa) for academic development and parallel-medium instruction. The paper provides an overview of the VSI program. A study was conducted in the Department of Anatomy and Cell Morphology, Faculty of Medicine with nursing students enrolled for a course in this department. Many of these nursing students are from educationally deprived backgrounds. Data suggests that VSI participants performed at the same level, or higher, than students who do not come from an educationally deprived background.

O'Donnell, L. E. (1995). *Inclusion for learning disabilities: Technology with learning variables research and Supplemental Instruction*. Conference Proceedings of the Empowering children with special needs: Practices around the world, Brighton, United Kingdom.

Learning Variables Research and Supplemental Instruction (LVR/SI) provide an innovative approach to inclusion for intellectually normal and gifted students with learning disabilities. The original Supplemental Instruction (SI) model is generally used with traditional college undergraduate and graduate students. Video-based Supplemental Instruction (VSI) allows enrolled high school or college students view the videotaped lectures of a college level course (e.g., Western Civilization, General Chemistry) and allow them opportunity to control the flow of information (e.g., stop, repeat, discuss material before proceeding). SI, and especially VSI, can be very helpful for students with learning disabilities since they can be served inside the same content class rather than requiring an additional class for the students to attend to deal with their specialized learning needs. The LVR/SI approach refines either the SI or VSI model with individualized learning variables and computer technology for application in junior high, senior high, and higher education. Rather than using video tape with VSI, computer technology might be substituted. In addition, the SI leader or VSI facilitator is provided critical information about students with disabilities. This technology-based program allows individuals with learning disabilities to succeed academically in integrated, inclusive classrooms.

O'Donnell, L. E. (1996). Inclusion for learning disabilities: Technology with learning variables research and Supplemental Instruction. *International Journal of Special Education*, 11(2), 27-32. Learning Variables Research and Supplemental Instruction (LVR/SI) provide an innovative approach to inclusion for intellectually normal and gifted students with learning disabilities. The original Supplemental Instruction (SI) model is generally used with traditional college undergraduate and graduate students. Video-based Supplemental Instruction (VSI) allows enrolled high school or college students view the videotaped lectures of a college level course (e.g., Western Civilization, General Chemistry) and allow them opportunity to control the flow of information (e.g., stop, repeat, discuss material before proceeding). SI, and especially VSI, can be very helpful for students with learning disabilities since they can be served inside the same content class rather than requiring an additional class for the students to attend to deal with their specialized learning needs. The LVR/SI approach refines either the SI or VSI model with individualized learning variables and computer technology for application in junior high, senior high, and higher education. Rather than using video tape with VSI, computer technology might be substituted. In addition, the SI leader or VSI facilitator is provided critical information about students with disabilities. This technology-based program allows individuals with learning disabilities to succeed academically in integrated, inclusive classrooms.

Phillips, K. (1999). *Proceedings of the First National Conference on Supplemental Instruction/VSI*. Kansas City, MO: Center for Academic Development, University of Missouri-Kansas City.

This set of conference proceedings provides an overview to the First National Conference on Supplemental Instruction/VSI here in Kansas City, MO in May 1999. Articles include: SI, an effective program within student affairs, Edit Kochenour and Kenneth Roach; Get creative, working with SI data, Jeanne Wiatr and Barbara Stout; SI supporting quality in higher education in the United Kingdom, Jenni Wallace; Managing an expanding program or SI empire, Valeric Merriwether; Supplemental Instruction with math study skills templates, Paul Nolting and Kimberly Ruble; SI down under, Australian innovations, Martin Murray; Distance PALS in real and virtual classes, Judith Couchman; SI leadership and personal growth, a South African perspective, Linda Smith; Discipline-specific SI strategies for writing, Sandra Zerger; VSI, partnerships, and the transformation of education in South Africa, Paul Du Plooy and Cathy Clark; and SI leaders, the real winners, Maureen Donelan.

Power, C., & Armstrong, L. (2017). A facilitated community of practice: Enabling student success in the blended learning environment. In J. McDonald & A. Cater-Steel (Eds.), *Implementing communities of practice in higher education* (pp. 227-252). Singapore: Springer Singapore

This chapter explains the implementation, facilitation and experiences of a community of practice; video-based Peer Assisted Study Sessions (vPASS), which utilised recorded lectures and collaborative learning methodologies for at-risk undergraduate students studying Mathematics for Engineers. Students who had previously failed this core subject, were invited to enrol in the vPASS mode of Mathematics for Engineers which provided a facilitated, small group learning environment. They found significant benefits in the experiences of learning together and supporting each other's learning trajectory through the challenging content. We consider vPASS through the lenses of 'mutual engagement, joint enterprise and shared repertoire' which Wenger describes as processes that contribute to communities of practice (Wenger in *Social learning systems and communities of practice*. Springer and the Open University, Milton Keynes, pp 179–197, 2010b, p. 72). Although this program was based in a particular subject, the principles and approaches which underlie vPASS are transferable to other discipline areas. Transforming the experience of learning from a lecture into a social meaning making activity provides students with life-long learning skills; a graduate attribute of many institutions. It can

also enable students to take greater responsibility for their learning as their motivation increases and they develop effective study strategies.

Rand, P. (1994). *Video Based Tutorial System for first year nursing students*. Unpublished manuscript. The University of the Orange Free State, South Africa.

This paper describes the use of Video-based Supplemental Instruction (VSI) with nursing students at the University of the Orange Free State in South Africa during 1994. The VSI program was implemented to assist nursing students who were severely academically underprepared. The author reports high satisfaction with the program since low grades were decreased and higher grades were increased in comparison with academic terms that did not have VSI offered.

Rowe, J. A. (2019). *Synchronous and asynchronous learning: How online Supplemental Instruction influences academic performance and predicts persistence*. (Ph.D. dissertation), Capella University.

While supplemental instruction (SI) programs have garnered wide support in educational research literature and adoption in higher education, the impact of online Supplemental Instruction (OSI) remains unknown. Using the theoretical framework of social cognitive theory, this study compared the impact of synchronous OSI and asynchronous OSI on academic performance, and in terms of how OSI predicts persistence. The goal was two-fold: to consider if similar academic and persistence benefits predicted from SI extend to OSI, and to investigate how academic performance and persistence of students listening to asynchronous recordings might differ from students attending live synchronous OSI sessions. An ANOVA procedure was used to investigate academic performance, and a logistic regression procedure was used to investigate persistence to test two hypotheses with a sample of 1727 (N = 1727) online graduate students. Results were significant for both synchronous and asynchronous groups, indicating that OSI is comparable to SI in terms of having a positive impact on academic performance when compared to students with no OSI exposure. Persistence results were significant for OSI as a whole and specifically for students who attended synchronous OSI.

Sagna, B. (2019). *Effectiveness of remedial mathematics Supplemental Instruction: A community college study*. (Ph.D. dissertation), Teachers College Columbia University, New York, NY.

The purpose of this mixed method study was to determine if there is a relationship between characteristics of supplemental instructors' personal traits, teaching skills, subject matter, constructive/active, collaborative learning, effective communication, and their practices (as judged by students) and student success in their remedial mathematics course. The college Provost was contacted by email to request an authorization to conduct this study in his college. Once approved, the investigator contacted face to face his colleagues to ask their students to participate in the study because they enrolled in a remedial algebra class where the instructor is assisted by a supplemental instructor (SI leader). Sixteen algebra classes were selected, and each were assisted by supplemental instructors. Students' scores on the pre-test (at beginning of the semester) and post-test (at the end of the semester) were collected to gauge their achievement on both tests. Students completed a questionnaire that asked about their perceptions about their Supplemental Instructors' personal traits, teaching skills, subject matter, constructive/active, collaborative learning, effective communication, and their practices throughout the semester. Students' mean scores difference on the post-test were higher in 62.5% of the sections than on the pre-test. The evaluation of achievement on both tests, the responses to the questionnaire and comments from students showed that SI leader's characteristics associated to effective communication/active learning, teaching skills, and personal traits could be contributor to score achievements. The linear regression in the study

shows that the three factors did not significantly predict the post-test score. However, the pre-test did significantly predict the post-test score in a remedial Math 20 at the end of the semester (Beta = .47, $t(197) = 6.56$, $p < .05$). In addition, the comments in the questionnaire found that students acknowledged their supplemental instructor role in the classroom and during the SI's weekly sessions.

Sharp, D. L. (2016). *Implementation of best practices in developmental education*. (Ph.D. dissertation), Arkansas State University.

Each year, thousands of individuals enter higher education unprepared for college-level work. These students are usually required to spend at least one semester in developmental coursework prior to enrolling in college-level classes such as English composition and college algebra. The purpose of this study was to provide a systematic assessment of the level of implementation of best practice in developmental education at U. S. institutions of higher education. The research questions sought to answer to what extent are the current best practices of developmental education implemented in two- and four-year colleges and universities in the U. S., whether there was a significant difference between the level of implementation of best practices at two- and four-year colleges and universities, and whether the implementation of best practices was influenced by the gender, age, or years of teaching experience (in general and developmental education) of the respondent. A survey to assess the level of implementation of best practices was distributed to 2,540 individuals involved in developmental education at two-and four-year colleges and universities. A total of 659 survey responses were received, yielding a 25.9% response rate. The analysis provided the following. Two-year institutions represented the bulk of the respondents (78.2%). Both two- and four-year institutions demonstrated high levels of implementation of the established best practices. Additionally, all of the best practices (for both two- and four-year) exhibited means above 2.0, indicating agreement with the level of implementation. Four-year institutions demonstrated significantly lower results in five of the best practices, while the two-year responses showed significantly lower results in three. The demographic categories, gender and years of teaching experience (overall and in developmental education) produced several significant findings. Males ranked six of the best practices at lower levels of implementation than females (who only had one significant finding). Those early in their career (1-6 years) ranked four best practices lower than the mid-career (7-25) and late-career respondents. The late-career individuals ranked two best practices significantly lower than the mid-career respondents.

Snyders, A. J. M. (1999). *Foundation mathematics for diversity: Whose responsibility and what content?* Conference Proceedings of the Delta '99 symposium on undergraduate mathematics, Whitsunday Coast, Australia.

This article describes the issues facing the University of Port Elizabeth in South Africa regarding instruction in foundation mathematics for an increasing diverse student body. Video-based Supplemental Instruction (VSI) and Supplemental Instruction (SI) have been implemented as part of a comprehensive approach. An extensive review of the professional literature concerning mathematics instruction composes the majority of the article.

Sommerfeld, M. (1995). Who's responsible? Taking sides on remedial classes. *Education Week*, 14(29), 1, 14.

This article discusses alternatives to traditional remedial and developmental education programs. Included in the article is a short interview with David Arendale concerning the use of Supplemental Instruction (SI) and Video-based Supplemental Instruction (VSI). One of the difficulties for first-time students is that they concentrate on the wrong things as they prepare for their first examinations.

Staff. (1997, October 17). Jim Falls: Fun on tape and in person, *UMKC Inside (University of Missouri-Kansas City Newsletter)*, p. 1.

This newsletter article describes a report concerning the VSI program. Dr. Jim Falls, one of the professors who has placed his course on video, is featured in the article. Dr. Falls' VSI section of his on-campus introduction to western civilization history class is also accepted for dual high-school credit as well.

Staff. (1996, January 18). Stet R-XV participates in VSI, *Stet Newspaper*, p. 8.

This newspaper article describes the involvement of the Stet High School (MO) with the Video-based Supplemental Instruction (VSI) program. Several Missouri state congressional leaders observed the VSI program operating at the high school.

Stone, M. E., & Jacobs, G. (Eds.). (2006). *Supplemental Instruction: New visions for empowering student learning*. New Directions for Teaching and Learning, No. 106, San Francisco: Jossey-Bass

This sourcebook includes the following chapters: 1. The impact of Supplemental Instruction on teaching students "how to learn," Sandra Yancy McGuire. 2. The basic SI model, Maureen Hurley, Glen Jacobs, Melinda Gilbert. 3. Supplemental Instruction at community college: The four pillars, Joyce Ship Zaritsky, Andi Toce. 4. A credit-bearing course for training SI leaders, Sally A. Lipsky. 5. Video-based Supplemental Instruction: Serving underprepared students, Maureen Hurley, Kay L. Patterson, F. Kim Wilcox. 6. Benefits to Supplemental Instruction leaders. M. Lisa Stout, Amelia J. McDaniel. 7. How Supplemental Instruction benefits faculty administration, and institutions, Sandra Zerger, Cathy Clark-Unite, Liesl Smith. 8. New directions for Supplemental Instruction, Sonny L. Painter. 9. TeamSI : A resource for integrating and improving learning, Carin Muhr, Deanna C. Martin. 10. The New vision for SI: Where are we heading ? Glen Jacobs, Marion E. Stone, M. Lisa Stout.

Stone, M. E., & Jacobs, G. (Eds.). (2008). *Supplemental Instruction: Improving first-year student success in high-risk courses* (Monograph No. 7, 3rd ed.). Columbia, SC: University of South Carolina, National Resource Center for the First-Year Experience & Students in Transition. ERIC Document (ED559247) Available online:

https://archive.org/stream/ERIC_ED559247#page/n0/mode/2up

This monograph explores the Supplemental Instruction (SI) model through the following chapters: (introduction) 35 years of SI, F. Kim Wilcox and Glen Jacobs; (1) basic SI model, Maureen Hurley and Melinda Gilbert; (2) research on the effectiveness of SI, Maureen Hurley and Melinda Gilbert; (3) theoretical frameworks that inform the SI model, Sandra Zerger; (4) implementing a new SI program, F. Kim Wilcox; (5) recruiting and training SI leaders, Amelia McDaniel; (6) strategies for adapting SI to specific academic disciplines, Sandra Zerger; (7) Video-Based SI, Maureen Hurley, Kay Patterson, Sonny Painter, and Jennifer Carnicom; (8) SI international adaptations and future directions, Glen Jacobs M. Lisa Stout, and Marion E. Stone; (9) Concluding the first 35 years, Amelia McDaniel; (appendix a) glossary of terms; (appendix b) selected annotated bibliography for SI, David R. Arendale

Stratton, C. B. (1998). Transitions in Developmental Education: Interviews with Hunter Boylan and David Arendale. In P. L. Dwinell & J. L. Higbee (Eds.), *The Role of Developmental Education in Preparing Successful College Students* (pp. 25-36). Columbia, SC: The National Association for Developmental Education and the National Center for the Study of the Freshmen Year Experience and Students in Transition

In this book chapter the author interviews two leaders in the field of developmental education. Hunter Boylan directs the National Center for Developmental Education. David Arendale directs national dissemination of Supplemental Instruction. Both have served as past presidents of

NADE. Arendale talks about how developmental education must be "mainstreamed" into the college curriculum rather than continuing with the current model of separate tracks of courses and support for students who need academic assistance. Supplemental Instruction and Video-Based Supplemental Instruction are cited as examples for embedding academic assistance into college-level courses. Brief overviews are provided for both programs. He suggests that SI and VSI present an acceptable way for accomplishing the mission of developmental education which is politically acceptable to policy makers at the institution, state, and national level.

Summers, D. (1995, 1995, December 12). Video-based instruction offers alternatives, *University News (University of Missouri-Kansas City Student Newspaper)*, p. 11.

This campus newspaper article describes the use of Video-based Supplemental Instruction (VSI) to deliver a college introductory history course to students at the University of Missouri-Kansas City. The article provides a brief overview and a few statistics about the higher grades and lower course withdrawal rates for VSI students as compared with students who enroll in the identical course taught by the same professor who previously placed his class lectures on the VSI videotapes.

Villén, V. (2002). *How to prevent student drop outs? An example from Lund University*. (Master's of Arts thesis), Pedagogical Institution, Lund University, Lund, Sweden.

This Master Thesis (written in Swedish) describes how Lund University in Sweden is implementing a variety of programs to deal with student drop outs. Two programs featured in the manuscript are Supplemental Instruction and Video-based Supplemental Instruction.

Whiteside, D. (1995). Capitol News Release of Work. pages of Work. Department. Jefferson City, MO.

This news release provides information about Missouri State Representative Whiteside's visit to see the Video-based Supplemental Instruction (VSI) program as was viewed by a delegation led by him. The VSI program was reviewed at the Mendon, Norborne, and Stet high schools.

Wilcox, F. K., & Jacobs, G. (2010). *Video-based Supplemental Instruction as an alternative to traditional developmental courses*. Unpublished manuscript. University of Missouri-Kansas City. Kansas City, MO.

Video-based Supplemental Instruction (VSI) is a non-traditional course delivery system designed to improve developmental students' academic performance in difficult courses that typically have high failure and withdrawal rates. This paper describes the VSI model and examines data from VSI applications.