Expanding Access to STEM for At-Risk Learners: A New Application of Universal Design for Instruction

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Abstract

Despite a growing demand for a well-educated workforce in science, technology, engineering, and math-related (STEM) careers, fewer American college students are pursuing these majors. Students with disabilities are one of the at-risk groups whose interest in pursuing STEM careers is frequently compromised by systemic barriers to participation. Peer-Led Team Learning (PLTL) is a national peer mentoring model designed to promote student success in STEM courses. The authors found that students with disabilities did not benefit from PLTL as much as students without disabilities. With support from a National Science Foundation grant, the authors adapted the PLTL model by incorporating the Principles of Universal Design for Instruction (UDI) into the peer mentors' training. This article describes the early results on peer mentors' ensuing beliefs and practices and the academic outcomes of participants with disabilities. Implications for replication with at-risk students on other campuses and future research are discussed.

Keywords: STEM, peer-led team learning, universal design for instruction, learning disabilities, ADHD

At a time when the United States faces an increased demand for more scientists to strengthen the economy and enhance national security, the number of undergraduates completing science, technology, engineering, and/or mathematical (STEM) degrees is diminishing. In 1980, nearly 30% of all bachelor's degrees were in STEM areas but that figure had dropped to 23% by 2007 (U.S. Department of Labor, 2007). This trend has particular significance for historically underrepresented groups in STEM majors and careers, including women, minorities, and people with disabilities (Task Force, 1989). Twenty years later, university undergraduates with disabilities continued to reflect limited pursuit of STEM majors. According to NLTS-2 data, only 9% reported majoring in engineering or communications and only 6% reported majoring in either science or computer-related areas (Newman et al., 2011). As a group, undergraduates with disabilities often benefit from the same types of academic supports that benefit students without disabilities but especially other at-risk populations. It is important to explore efficacious academic supports that can address the decline of undergraduates with and without disabilities who can become the next generation of scientists, computer programmers, engineers, and mathematicians.

Undergraduates with Disabilities

This article will focus on STEM barriers that confront postsecondary students with learning disabilities (LD) or Attention-Deficit/Hyperactivity (ADHD). Together, these students represent over half the number of the nearly 11% of U.S. undergraduates who report a disabling condition ("Education Needs," 2009; Harbour, 2004). Many students with these "invisible" disorders, however, do not disclose their disability in postsecondary settings while seeking out campus resources to support their academic goals. Consequently, faculty and campus staff members who coordinate academic skills centers, tutorial services, and peer mentoring programs, frequently encounter a need to provide academic supports for at-risk learners including those who do not disclose their LD or ADHD. Disability services offices continue to seek ways to provide effective accommodations and academic services to students with identified disabilities while taking rigorous STEM courses.

Overall, students with disabilities (SWDs) participate in higher education in lower rates than high school graduates without disabilities (Newman, Wagner, Cameto, & Knokey, 2009). College SWDs also take longer to graduate and graduate less frequently than peers without disabilities ("Profile," 2006). In addition to these problematic trends, SWDs also appear to have access to fewer role models (i.e., mathematicians and scientists with disabilities) and receive less encouragement to pursue STEM majors/careers compared to peers without disabilities (Bonetta, 2007; Summers, 2009). College students with LD and ADHD can encounter even more explicit attitudinal barriers when pursuing a STEM major. They have reported that professors, teaching assistants, and academic support services staff appear to question, albeit subtly, their academic potential and need for disability-related supports (Jensen, McCrary, Krampe, & Cooper, 2004). Negative perceptions about the "fairness" of accommodations have also been identified in undergraduates without disabilities, especially males (Upton & Harper, 2002). Consequently, a variety of internal and environmental barriers can impede the academic success and persistence of students with LD and/or ADHD in STEM fields, even when campuses provide ample support services such as peer mentoring programs.

These challenges can be exacerbated by the nature of the courses that comprise STEM curricula. For example, calculus courses require a mastery of algebraic principles and the accurate copying, recall, and use of highly symbolic information that can be transposed or recalled in the wrong order by students with sequencing and working memory deficits (Nolting, 2002). Students with LD and ADHD, who can reverse or fail to notice details when reading or writing scientific notations, struggle to recall multi-step formulas or procedures, and chafe at the self-regulation demands of reviewing course content frequently enough to achieve mastery (Allsopp, Minskoff, & Bolt, 2005; Ruban, McCoach, McGuire, & Reis, 2003). These impairments can limit the academic self-efficacy of undergraduates with disabilities while student STEM content (Jensen, Petri, Day, Truman, & Duffy, 2011).

Difficulties Learning STEM Content

All college students must develop independent problem-solving skills to succeed in STEM coursework. Undergraduates have reported that rigorous high school STEM prep programs, characterized by reliance on memorization and ready access to teachers for individualized reviews, can fall short of equipping them with the caliber of problem-solving skills they need in college (Cracolice & Deming, 2005). STEM courses at the postsecondary level impose formidable challenges to those who lack this proficiency. For example, course exams often include items never before seen by students who are expected to generalize prior knowledge in harmony with effective test-taking strategies. Many students become better problem-solvers in college by enhancing their use of "self-talk." This form of private speech is a cognitive mediation strategy used to organize and guide one's thinking (Depape, Hakim-Larson, Voelker, Page, & Jackson, 2006; Whittington, Lopez, Schley, & Fisher, 2006). Students with executive function disorders such as ADHD and LD, however, have been found to struggle with the development of this skill area unless direct instruction can be provided (Barkley, 1997; Brown, 2005; Kray, Eber, & Lindenberger, 2004).

Research on the general student population at the authors' university has shown that many students, with and without disabilities, struggle with performance and persistence in large lecture introductory STEM courses. In first-semester general chemistry (Chemistry 111), for example, about 40% of the general student population received grades of C+ or lower in the course between Fall 2005 and Spring 2007. In introductory calculus (Calculus 1), approximately 20% received grades of C+

or lower during the period, not counting the nearly 10% of students who withdrew from the course. While the general student population on the authors' campus and other institutions can find these large STEM courses challenging, too, students with documented disabilities have even more difficulty in them. Among SWDs, nearly 50% of students who enrolled in Chemistry 111 and about 25% of those enrolled in Calculus 1 earned a C+ or lower despite their comparable coursework in high school, SAT/ACT scores, and the ability to meet the same university admissions criteria.

Peer-Led Team Learning

For more than a decade, many U.S. campuses have utilized Peer-Led Team Learning (PLTL) to help undergraduates with and without disabilities overcome some of these challenges (http://www.pltl.org/). Developed by a consortium of four universities in the 1990s, PLTL is an academic mentoring program that trains juniors and seniors who have performed well in STEM courses to facilitate study groups comprised of undergraduates taking these courses (Quitadamo, Brahler, & Crouch, 2009). Unlike content tutoring models, PLTL places greater emphasis on helping students work collaboratively to strengthen their use of the problem solving process. Peer mentors do not provide answers to weekly problem sets. Instead, they guide study group members in the use of various activities to promote their ability to think more effectively while solving those problems. Peer mentors are trained in group techniques that facilitate team learning, including structured exercises such as "Round Robin" where study group members take turns writing the next step in a problem. While PLTL is a requirement on many campuses, it is voluntary at the authors' campus. Over half of all students taking STEM courses participate in this popular program at this university (Hockings, DeAngelis, & Frey, 2008; http://pltl.org/MoreCritical-Components.php).

Whether mandatory or voluntary, the PLTL model varies little from campus to campus. Weekly group meetings last approximately two hours and take place throughout the semester. Typical PLTL groups are comprised of six to eight students with one peer mentor acting as facilitator. Students are expected to have completed assigned course readings, attended recent lectures, and prepared problems before that week's session so they can utilize this knowledge during PLTL. The facilitator often asks students to take turns talking through a problem aloud, working out steps at the board, and/or recording potential solutions developed by the group (Hockings et al., 2008). These conditions create a learning environment that in many ways mirrors a classroom learning experience.

PLTL is the primary academic support model for gateway STEM classes at the authors' university and previous research has found that students who participated in PLTL earned higher grades (one-third a letter grade on average) than those who do not (Hockings et al., 2008). However, limited data suggested that SWDs who participated in PLTL did not achieve similar boosts to their academic performance in STEM courses. Between Fall 2005 and Spring 2007, students with identified disabilities who participated in PLTL earned a mean course GPA of 2.68 ($n = 26$). Students with disabilities who took the same STEM courses during the same time period but did not participate in PLTL earned a mean course GPA of 2.71 ($n = 73$). In addition, SWDs had greater difficulty with STEM persistence than their peers without disabilities. Between 2005 and 2007, a large number of all students who initially declared an interest in STEM majors subsequently changed to a non-STEM discipline after a disappointing academic performance in those gateway courses. During this time, the migration rate away from STEM for all undergraduates was 40%, but was much higher (55%) for students with documented disabilities. This difference is statistically significant using a student T-Test, $t(712) = 3.45$, $p < .01$, to compare the average rate of migration for the two samples. The Cohen's D Effect Size value of 0.26 is considered a small effect size with the percent of overlap in samples between 14.7 % and 21.3 %. It is these performance disparities that the authors endeavored to address with an NSF grant-funded project.

Universal Design for Instruction

Universal Design for Instruction (UDI) may hold great promise for helping peer mentors increase access to learning in PLTL sessions for students with disabilities. Adapted from earlier work in the fields of architecture and product design, UDI seeks to make learning environments as useable by the greatest numbers possible by anticipating diverse learning needs and proactively building in accessibility features that can meet those needs (Burgstahler & Cory, 2008; "History of," 2011). The Nine Principles of UDI©, developed at the University of Connecticut, address issues of pedagogy (e.g., making information perceptible), affective tone (e.g., creating a welcoming environment), and collaborative learning (e.g., promoting interaction among students) (Embry, Parker, McGuire, & Scott, 2005). UDI has been defined as:

> an approach to teaching that consists of the proactive design and use of inclusive instructional strategies that benefit a broad range of learners including students with disabilities. The nine Principles of UDI provide a framework for college faculty to use when designing or revising instruction to be responsive to diverse student learners and to minimize the need for "special" accommodations and retrofitted changes to the learning environment (Scott, McGuire, & Embry, 2002).

While UDI was developed for use by college faculty in the classroom, its utility has been recommended more recently for disability service providers when they offer instruction or facilitate learning during one-on-one student sessions (Parker, White, Collins, Banerjee, & McGuire, 2009). Recognizing that PLTL sessions were in many ways an instructional environment, the authors hypothesized that students' ability to learn more effectively in the sessions could be enhanced if the peer mentors infused their facilitation strategies with the UDI principles.

Adapting PLTL with UDI

A demonstration and training grant from the National Science Foundation (www.nsf.gov/funding/pgm_summ.jsp?pims_id=5482&org=EHR&from=home) supported the authors' efforts to create Mastery PLTL (MPLTL). MPLTL's goal is to enhance the accessibility of traditional PLTL groups with UDI principles, thereby improving academic outcomes of SWD in STEM courses and increasing the proportion of SWDs who complete STEM majors over time. In this article, we report the early impact of MPLTL on the academic performance and satisfaction levels of participants with LD and/or ADHD. Their course grades and persistence in STEM courses are compared to students with the same disabilities who did not participate in MPLTL as well as all students in the same STEM courses. Formative data from the MPLTL peer mentors about their training and group facilitation experiences are also reported.

Methodology

Participants

In order to accomplish the project's objectives, the grant team developed, piloted, and evaluated procedures and products for (1) training peer mentors and (2) conducting MPLTL groups comprised of SWDs enrolled in chemistry and calculus MPLT groups while (3) disseminating products and findings through a website created for this project (www.mpltl.org) (Parker & Getty, 2009). All students with a documented LD and/or ADHD who were registered with the University's Disability Resources office and enrolled in the project's courses were invited to participate in MPLTL. The first and last authors conducted the recruitment activities. All potential participants received identical invitation emails twice in the three weeks leading up to a given semester. The same authors then contacted these students via email or phone to discuss the project and ascertain their interest in participating.

The interventions took place during two semesters and involved a total of 16 students, all of whom were freshmen or sophomores. During Spring 2008, five students participated in Chemistry 112 MPLTL and three students participated in Calculus 3 (advanced) MPLTL. In Fall 2008, five students participated in Chemistry 111 MPLTL and six students participated in one blended section of Calculus 2 (intermediate) and Calculus 3 MPLTL. Three of these students were in both MPLTL groups that semester; a total of eight students participated in MPLTL in Fall 2008. Following the PLTL model, students in MPLTL sections attended 60 minute sessions each week during the semester beginning with the first full week of classes.

Training Peer Mentors

While MPLTL peer mentors utilized the essential tenets of the PLTL model, several modifications were made to address project goals. MPLTL sections were restricted to students with LD and/or ADHD only. Whereas traditional PLTL groups are led by only one peer mentor, the MPLT groups were led by teams of two mentors who would take turns running the group from one week to the next. This decision created a small community of practice for project peer mentors and permitted ongoing, informal observations and data collection during each session. Peer mentors were required to have had at least one semester of experience running PLTL groups and a recommendation from the

Chemistry or Calculus PLTL coordinator. In addition, all applicants were interviewed by the Project Director to ascertain their interest levels and abilities relative to working with SWDs.

The Project Director conducted a day-long orientation workshop one week before the MPLTL sessions began. The workshop included an icebreaker, an overview of the MPLTL project's conceptual framework and goals, introduction of the Principles of Universal Design for Instruction (UDI), a video-prompted discussion of learning characteristics of college students with LD and/or ADHD, and an introduction to instructional templates. The workshop concluded with a discussion of logistics, confidentiality and disclosure issues, and suggestions about how/when to contact students.

The Project Director also conducted a weekly hour-long seminar with the MPTL peer mentors throughout the semester. The Calculus PLTL coordinator and the Assistant Director of Academic Programs in the grant team's academic services center (who holds a Ph.D. in Chemistry) frequently joined these seminars as content experts. Peer mentors took session notes while observing their partner work with students each week in MPLTL. The MPLTL peer mentors' seminars began each week with discussions about these observations and examples of effective practice from the MPLTL sessions. Additional training continued as team leaders provided further instruction about the Principles of UDI, LD/ADHD learning characteristics, and how these concepts could be applied in MPLTL sessions.

Time, materials, and support also were provided to the peer mentors as they created "templates" during the seminars. Templates were defined as *any tool or strategy that enhances students' understanding, retention, or application of course concepts, formulas, or procedures.* Peer mentors created written templates (i.e., paper-based charts, lists, or diagrams) as well as video templates. Each written template used one Principle of UDI. For example, a chemistry MPLTL peer mentor photographed the white board she had used to create the template, "Getting Session Started." Before students arrived, she had written relevant formulas in red so students would not have to recall them from memory or look them up while solving that day's problems, which were then written on the board in blue. This template used UDI Principle 8 (Community of Learners) by promoting the communication of important information between students and peer mentors. To make the video templates, the peer mentors talked aloud while solving problems similar to those worked on by students in MPLTL. These videos became universally accessible models of proficient problem-solving strategies through the use of self-talk (Whittington et al., 2006).

MPLTL Intervention

The peer mentors also attended the weekly PLTL training meetings required of all peer mentors, which involved reviewing that week's problem sets to be worked out by students in PLTL (or MPLTL) meetings. Although the MPLTL sections were restricted to students with LD and/or ADHD, no notation to this effect was connected to how the sections were listed in course registration software. MPLTL sections covered the same material at the same time as PLTL sessions. While maintaining these overall similarities, MPLTL peer mentors were trained to present information in ways that were more sensitive to students' information-processing and/or attentional needs. For example, they used colored markers and a 2-column format to write problems with corresponding written reminders on the board and often gave students a five-minute stretch break mid-way through the two-hour sessions.

Assessment Activities

To assess the impact of MPLTL on student outcomes, the authors gathered both quantitative and qualitative data at several stages. Course GPA, cumulative GPA, and STEM persistence data were gathered for all students registered in those STEM courses. The data were obtained from the University's Student Information System to ensure conformity of collection. Course and cumulative GPA were gathered as soon as grades were available after the end of the relevant semester. "Persistence" was defined as registering for the next course in the calculus or chemistry sequence or, if the student had completed the sequence, maintaining an earlier declaration to major in a STEM area. A third measure came from pre- and post-intervention scores on the Learning and Study Strategies Inventory ([LASSI], 2nd edition) (Weinstein & Palmer, 2002). In addition, students in MPLTL were asked to complete a brief course evaluation created for this project during their last session. This brief instrument included Likert-type measures of satisfaction and open-ended response items. Finally, SWDs who did and did not take MPLTL were invited to participate in a focus group for their respective groups each semester.

Results

Impact on MPLTL Students

Notwithstanding limitations due to the small sample size, the quantitative measures indicated overall positive trends in STEM persistence and the use of effective learning strategies. Descriptive statistics were used to compare mean averages in course GPA data (see Table 1). In Spring 2008, the inaugural semester for this project, MPLTL students had lower course GPA means compared to SWDs who did not take MPLTL as well as the overall GPA in that STEM course. Average course GPA's in Chemistry 112 were 1.75 (MPLTL students), 2.44 (SWDs who did not take MPLTL), and 2.81 (course average for all students in Chemistry 112). Overall, GPA's were higher in Calculus 3; however, MPLT students still demonstrated the greatest academic challenge. Average course GPA's in this course were 3.28 (MPLTL students), 3.7 (SWDs who did not take MPLTL), and 3.34 (overall course average for all students in Calculus 3).

The Chemistry 112 MPLTL was offered during the first semester of this intervention program. Two of the students who participated had been placed on academic probation during the first semester; both became academically ineligible to return to the University at the end of that semester. One of these students was ranked last in his school among the entire freshman class. It may be that MPLTL was offered too late to assist these second-semester freshmen who were already at significant academic risk when the program began.

Comparisons of course GPA's during Fall 2008 demonstrated more positive outcomes. In Chemistry 111, MPLTL students did better (average course GPA of 2.8) than non-participating SWDs (average course GPA of 2.33), while the overall GPA average for all students in that course was 3.06. Students with disabilities outperformed students overall in Calculus 2, regardless of their participation in MPLTL. The course average for MPLTL students was 3.33; non-participating SWDs earned an average course GPA of 3.5. Average GPA for all students taking that course that semester was 3.11. Clearly, chemistry appears to create more academic challenges for all students compared to calculus courses[1].

Cumulative GPA data reflected a smaller gap between the three groups' academic performances. MPLTL groups that had the lowest cumulative GPAs were those who took Chemistry 112, Calculus 2 and Calculus 3. MPLTL students in Chemistry 111 had a higher cumulative GPA (3.32) compared to SWDs who did not take MPLTL (2.87) but slightly lower than the overall course cumulative GPA of 3.38. Averaging each group across courses, MPLTL students' overall cumulative GPA was 2.96, 3.16 for SWDs who did not take MPLT, and 3.37 for the general course students (see Table 2). These results suggest that the SWDs who voluntarily enroll in PLTL on the authors' campus may be among the most at-risk subgroup of students, hoping to benefit greatly from this academic mentoring program. MPLTL, particularly when offered during the fall semester, seemed to provide useful academic support to SWDs. The data also underscore the challenges SWDs face in STEM courses, regardless of their participation in some version of the PLTL program.

In addition to GPA data, the authors analyzed persistence data. "Persistence" was measured as enrollment in the next course in the Calculus or Chemistry sequence in the subsequent semester or continuation of the STEM major that a student had identified during the admissions process. Prior to MPLTL, SWDs had migrated out of STEM courses in greater numbers (55%) than students without disabilities (40%) during the Fall 2005 through Spring 2007 semesters. MPLTL appears to have helped SWDs persist in STEM coursework at higher rates than at pre-intervention. After removing the two MPLTL students who became academically ineligible to return to the university, the 14 students in this group persisted at a rate of 71% compared to only 61% of the SWDs who did not participate in MPLTL. These migration rate differences are promising, although they do not reach significance using a student t-test at the 0.05 level (probability level = .14), $t(45) = 1.502$, $p > .005$. The Cohen's D Effect Size value of 0.44 is considered a small to medium size effect, though significance was not achieved.

The Learning and Study Strategies Inventory ([LASSI]; Weinstein & Palmer, 2002) was used to measure MPTLT students' pre- and post-proficiency with study skills The LASSI is a well-normed, 80-item online survey that compares students' academic behavior and beliefs to a large sample (n = 1,092) of other college students. Students read a descriptive statement and then select a response reflecting the extent to which that behavior or belief is typical of them. The ten

1 ANOVA tests were performed in initial work and found significant. However, given the mixed course and overall GPA results, the interpretation of that significance does not consistently support performance changes in a consistent direction.

Table 1

Average Course GPA by Student Group

Course	All Students	Students with Disabilities (Not in MPLTL)	Students with Disabilities (In MPLTL)
Chemistry 111	3.06	2.33	2.8
Chemistry 112	3.55	2.44	1.75*
Calculus 1	3.55	3.43	n/a
Calculus 2	3.11	3.5	3.33
Calculus 3	3.34	3.7	3.28

Note: Overall, students with disabilities performed better academically in calculus courses compared to chemistry courses. * Two students who participated in the Chemistry 112 MPLTL were on academic probation at the beginning of the semester and lost eligibility at the end of that semester.

Table 2

Cumulative GPA by Student Group

Course	All Students	Students with Disabilities (Not in MPLTL)	Students with Disabilities (In MPLTL)
Chemistry 111	3.38	2.87	3.32
Chemistry 112	3.31	3.10	2.26
Calculus 2	3.30	3.31	2.88
Calculus 3	3.50	3.41	3.40
Group Mean Across Courses	3.37	3.16	2.96

Note: Overall, cumulative GPA indicates a narrowing of the achievement gap that had previously existed between students with and without disabilities in STEM courses. Early intervention during first-semester Chemistry 111 may be particularly helpful to students with disabilities, rather than waiting until their second semester (Chemistry 112).

scales result in cluster scores in three areas: Skill, Will, and Self-Regulation. For example, four scales create a Self-Regulation cluster score that was used to measure changes in participants' executive function skills. These scales include Concentration, Time Management, Self-Testing, and Use of Study Aids.

Twelve students took both the pre- and post-intervention measures. Their improved post-test scores in all three cluster areas were statistically significant at the .05 percent level. While the MPLTL students demonstrated impressive growth in the Skill cluster (pre- group mean 42nd percentile; post- group mean 66th percentile) and the Will cluster (pre- group mean 42nd percentile; post- group mean 63rd percentile with a probability value of 0.005 for a single-tailed test), their greatest gain was in the Self-Regulation cluster (pre- group mean 29th percentile; post- group mean 56th percentile) at the .001 probability level for a single-tailed test. Self-regulation skills were deemed particularly important given the expectation that students initiate and sustain their own study efforts in STEM courses and utilize effective self-monitoring strategies while solving detailed course problems. Self-regulation skills can be particularly challenging for students with LD and/or ADHD, who often experience executive function impairments (Brown, 2005). The LASSI results indicate that students made important gains in these areas (see Figure 1).

A fourth area of data-based results focused on students' satisfaction with MPLTL sessions. Given the limited research about college SWDs in STEM majors, the authors created a five-item survey instrument that all MPLTL students completed during the last session. This survey included both Likert-scale ratings (1 = Strongly disagree; 6 = Strongly agree) and open-ended prompts. Students' comments indicated high levels of satisfaction with MPLTL. Asked what was most helpful about the project, many students described their development of greater problem-solving proficiency. Open-ended responses included, "I'm better at working through problems and seeing the important part of the question [now]," "I have learned to speak aloud when doing problems," and "Visualizing a problem clearly helped me figure out a problem on the fly during an exam."

Figure 1. LASSI Pre- and Post-Intervention Cluster Scores

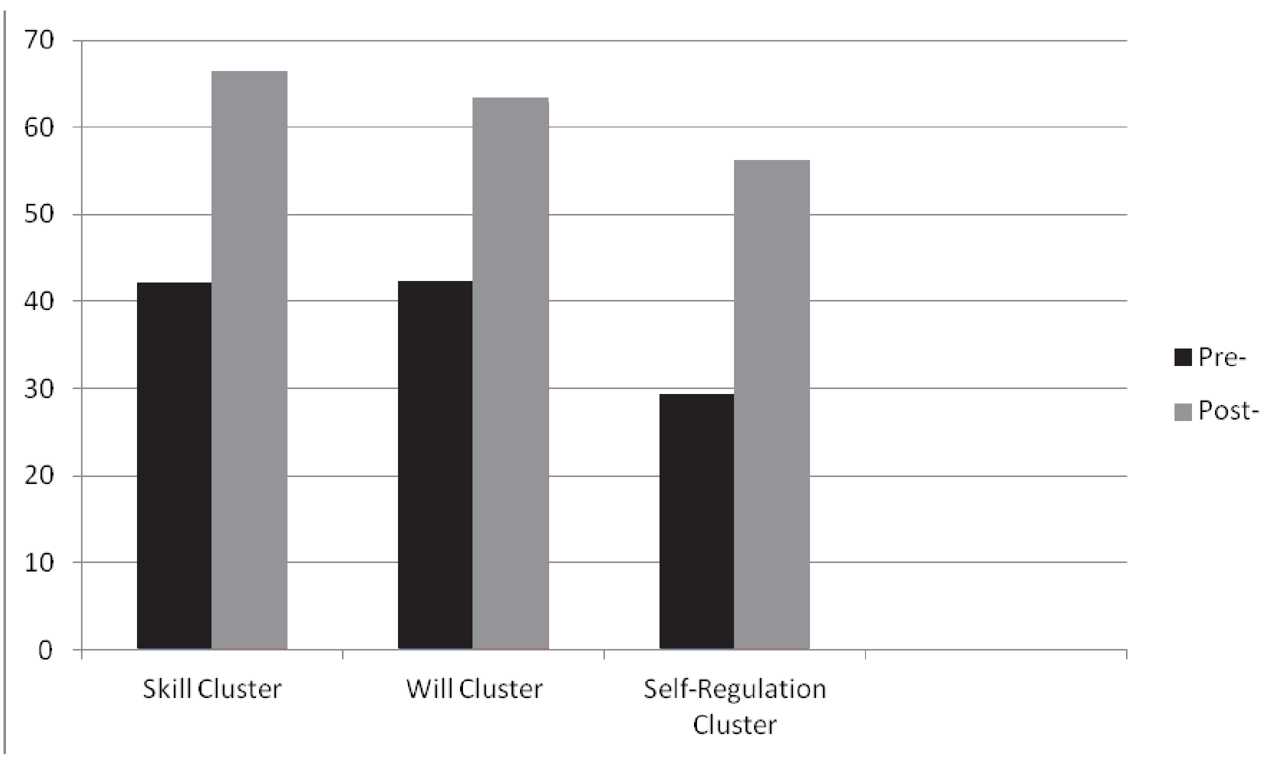

Figure 1. Scores from 12 students reflect statistically significant improvement in all three Cluster areas of the LASSI. The area of greatest improvement (Self-Regulation Cluster) suggests the MPLTL program had a particular impact on students' executive functioning skills.

One survey item asked how comfortable students were in a PLTL study group in which all students had an LD and/or ADHD. Interestingly, while the mean score was a 5.7 (6.0 being "Strongly Agree"), students also recommended more universal applications of the MPLTL model. Sample comments included, "EVERYONE should be allowed to benefit from the HIGHLY TRAINED PLTL leaders," "It should be open to every student. Some may not have certifiable LD's but may learn better with the same style, " and "Not to any student but maybe there should be a group for students without a diagnosed LD or ADHD but clearly show a history of similar difficulties and/or struggles similar to those of students with LD and/or ADHD." Such comments reinforced the provision of the MPLTL model for a wider group of at-risk learners, regardless of their disability status.

Finally, focus groups generated additional qualitative data about students' STEM and MPLTL experiences. One of the authors, a full-time evaluator for the academic center where the grant team works but who was not involved in the implementation of MPLT, conducted a focus group each semester with (a) students who participated in MPLTL and (b) SWDs who took the same STEM courses but chose not to participate in MPLTL. The focus groups were conducted approximately three weeks before final exams each semester.

A total of 14 students participated in the MPLTL focus groups. Five students participated in focus groups for SWDs who did not participate in MPLTL. The research team developed the interview questions, which were semi-structured, open-ended prompts. Examples include, "What warning flags or other signs tell you that you're not doing as well in a STEM course as you'd like?" and "What are some useful aspects of your peer mentors' methods in the MPLTL sessions?" Students who did not take MPLTL were asked the same questions about challenges in STEM courses as well as their reasons for opting not to take MPLTL.

Data from the focus groups highlighted students' generally high levels of satisfaction with MPLTL and provided examples of how the intervention supported their persistence in STEM courses. One student noted, "I improved at performing self-talk while taking tests, which helped me focus on the important details and pretty much stopped me from making any careless errors." Another participant stated, "I learned not to be afraid to ask for help or talk to others about problems I don't understand."

Analysis of the focus group transcripts also identified six types of barriers that students encountered in STEM areas. Identified barriers such as these can assist researchers and campus practitioners in minimizing factors that unintentionally discourage SWDs from pursuing STEM majors and careers. Barriers included class size, the cumulative nature of STEM curricula, the specificity of STEM content, the degree of challenge or competition in STEM gateway courses (heavily filled by pre-med majors), the pace of instruction in large STEM lecture courses, and the qualifications of PLTL peer mentors. Many focus group participants talked about class size, which can no doubt create a barrier for students without disabilities, too. This barrier restricted their willingness or ability to ask questions during lectures or request that information be repeated. Students with LD and/or ADHD may find this barrier particularly challenging as they transition to college. As one participant said, "I went to a small high school and so I could go to the office and ask the teacher for help – just say I didn't understand this very well. It's not really feasible [now] in these classes."

Regarding the specificity of STEM content, students discussed how much easier it was to convey their knowledge on papers or essay exams in courses such as literature or political science. One student commented that STEM courses are "more specialized. Other classes like writing can be about different things – but it's always writing in the same language. Science classes are very specialized." In discussing instructional pace, students again compared college STEM courses to their high school preparation. Several participants talked about the helpfulness of having more time to take notes when high school teachers would write out each step of a problem on the board. In college, professors tended to use static images in PowerPoint presentations to show a complete solution already worked out. This pedagogical approach limited available notetaking time as well as students' ability to watch step-by-step as a solution process unfolded.

Impact on Peer Mentors

The MPLTL peer mentors participated in a weekly, one-hour seminar conducted by three of the authors. As they continued learning about UDI and discussing its application to their weekly MPTL sessions, the peer mentors were also guided and supported as they created instructional templates. Peer mentors used the templates during sessions to help students understand foundational knowledge such as course concepts, formulas, and procedures. The mentors frequently commented on how much they enjoyed creating the templates to address concepts or problem types they had observed students struggling with in MPLTL sessions. All templates were posted on the project's website so that any student could access that tool at any time. The peer mentors collaborated as a community of practice to make course concepts more accessible to students with a variety of learning and attentional needs.

Formal and observational data also suggest that the additional training for peer mentors in UDI enhanced the PLTL model without fundamentally altering it. The three authors who ran the peer mentors' seminar, two of whom are experts in PLTL methodology, found that MPLTL sessions essentially unfolded just as PLTL sessions did. Peer mentors covered the same problem sets at the same rate and utilized the same PLTL techniques. The utility of enhancing the PLTL model with UDI was reinforced by comments from peer mentors and students alike. Peer mentors were asked to respond to a five item mid-semester evaluation survey. This brief instrument included the prompt, "I am learning how to apply UDI to my work with MPLTL students." On a 5-point Likert scale (5 being "Strongly Agree"); the mean score was 4.25 after a month of instruction. One peer mentor's open-ended comment reflected statements made by several peers in the seminars: "Although UDI principles are valuable to use in MPLTL, I think they are all intrinsic in the PLTL model." While UDI was developed for faculty use, its utility appears powerful enough apply to peer mentoring models, too. While further research is needed, this study suggests that students with non-apparent disabilities found a more welcoming environment and more effective learning opportunities in PLTL environments that were infused with UDI principles and practices.

Discussion

The results of this demonstration and training project underscore a number of areas that merit further consideration. Additional research involving larger numbers of students is needed to carry out more robust statistical analyses of the quantitative methods piloted in this study. Compared to undergraduates without disabilities, it appears that students with LD and/or ADHD may be at increased academic risk due to curricular aspects of STEM courses and environmental components of large "gateway" lecture courses. Increased efforts that help students identify these risk factors early enough to seek academic supports appear warranted, given project data collected to date. This appears particularly true for students enrolling in gateway chemistry courses. Based on survey and focus group data, these students may experience high degrees of satisfaction with PLTL groups that are led by peer mentors who utilize the Principles of UDI.

In addition, peer mentors appeared to enhance their perceived instructional self-efficacy by creating instructional tools, or "templates," that directly utilized UDI principles. The written and video templates are widely accessible at www.mpltl.org and create opportunities for additional research. To date, 4752 "hits" have been recorded on the website. The three most popular sections (in descending order) include the Video Templates page (1782 hits), Templates overview page (1580 hits), and the MPLTL Conceptual Framework page (1402 hits). The manner in which students use these templates should be studied to determine their impact on students' access to course concepts and their use of cognitive strategies to enhance their problem-solving proficiency. Feedback from peer mentors, program administrators, and SWDs provides preliminary evidence that the Principles of UDI hold a clear promise of enhancing access to the PLTL model without fundamentally changing it.

All findings from this project should be considered within the context of several limitations. First, the MPLTL sections were generally smaller than typical PLTL group size (n = 8). As noted, five students signed up for the Chemistry 112 MPLTL and three students signed up for the Calculus 3 MPLTL in Spring 2008. In Fall 2008, nine students participated in MPLTL. Some students participated in more than one group that semester, including five in Chem 112, three in Calc 2, and three in Calc 3. Second, this limited number of participating students restricts the ability to conduct robust statistical analyses of GPA, persistence, and survey data. Third, MPLTL has been offered only to SWDs to date. Other at-risk learners, including students for whom English is not a primary language or who have limited preparation in STEM coursework, may benefit from MPTLT but project activities do not provide data that can inform this question. Finally, more formal measures are needed to understand the extent to which project training enhances the instructional self-efficacy of peer mentors.

Future Directions

In providing MPLTL, the authors have learned more about barriers that can unintentionally limit STEM participation and persistence for SWDs. The authors have begun to explore, through data-based evaluation procedures, minimal adaptations to the PLTL model that hold the promise of providing maximum benefit to diverse learners, including those with disabilities. On the campus where the study took place, information about the use of UDI principles has been infused into PLTL peer leader training. One of the authors is also the Coordinator of the Calculus PLTL program. As she noted:

> Working on the MPLTL project enabled me to become more aware of ways in which an instructor or student leader could easily make the learning experience (including space and accessibility of materials) more inclusive while maintaining the core principles of his/her teaching philosophy. During the fall weekly seminar meeting with new PLTL leaders, I introduced the concept of UDI to them as a way to make their group meetings more productive for all students. The students were given a short presentation and then split into groups to discuss various scenarios in which UDI could be applied. This segment of the course will be repeated in fall (L. Kuehne, personal communication, August 19, 2011).

This promising development is a tangible indicator of systems change. Peer mentors who have been trained in the MPLTL project also contribute to systems change by taking UDI knowledge and skills into future PLTL sessions they run and, ultimately, careers that may include university teaching. From its inception, this project has been an active and positive partnership between disability service providers with expertise in LD/ADHD issues and UDI, faculty with expertise in STEM courses, and departmental leaders with expertise in peer mentoring and the PLTL model. A related area for future exploration is the "exporting" of the MPLTL model to other campuses. Colleagues at other institutions of higher education that offer PLTL or similar peer mentoring programs in STEM areas can adapt the project materials available on the www.mpltl.org website. More formally, regional alliances could be organized to share training activities and outcome data across multiple project sites. As the U.S. continues to compete in a global marketplace and UDI broadens educational access to a wider range of learners, the MPLTL project offers the seeds of new approaches to enhancing students' success in STEM majors and careers.

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