An Innovative Postsecondary Education Program for Students with Disabilities in STEM (Practice Brief)

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Abstract

Careers in the science, technology, engineering, and mathematics (STEM) fields have many benefits, including decent salaries, a strong employment outlook, and high job satisfaction. Unfortunately, workers with disabilities are underrepresented in the STEM fields. This practice brief describes a program designed to support college students with disabilities in STEM programs. The program, the Alabama Alliance for Students with Disabilities in Science, Technology, Engineering, and Mathematics (AASD-STEM), is a multicomponent program, with a major emphasis on mentoring, and is funded by the National Science Foundation. Preliminary program evaluation data highlighted positive changes in key attitudes and behavior related to STEM degree persistence and success for students participating in the AASD-STEM program.

Keywords: STEM, college students with disabilities, postsecondary programs for students with disabilities

The fields of science, technology, engineering, and mathematics (STEM) are critical to our global leadership and economy (Committee on Equal Opportunities in Science and Engineering [CEOSE], 2013). Employment opportunities in the STEM areas are expanding at a rapid rate. The U.S. STEM workforce surpassed 7.4 million workers in 2012; it is expected that the workforce will increase significantly through 2018, reaching an estimated 8.65 million workers (STEMconnector, 2012). The earnings of workers in many STEM fields are higher than non-STEM workers (Schiavelli, 2011), and there is a high level of job satisfaction of workers.

There is concern, however, that too few people are going in to STEM programs today (Terrell, 2007) and that currently the U.S. economy needs more workers who have high levels of knowledge and skills in STEM (Rothwell, 2014). One strategy to address this supply problem is increasing the number of students from underrepresented groups pursuing STEM (National Science Foundation, 2002, NSF). Persons with disabilities are considered an underrepresented group; in fact, it has been suggested they comprise one of the largest untapped pools of potential American engineers, mathematicians, scientists, technologists and technicians (CEOSE, 2006).

Problem

Even though the percentage of students with disabilities (SWD) enrolled in postsecondary STEM majors has increased, persons with disabilities continue to be underrepresented in STEM programs and careers (National Center for Science and Engineering Statistics, 2015). Barriers to STEM careers for persons with disabilities have been identified and include a range of factors from K-12 educational issues (e.g., lack of encouragement to pursue STEM based on stereotypes,), employment issues (e.g., employers being less likely to hire workers with disabilities), and postsecondary education-related issues (e.g., low rates of individuals with disabilities earning a degree) (Alston, Bell, Hampton, 2002; Eriksson, Welander, & Granlund, 2007; Madaus, Foley, McGuire, &, Ruban, 2002; Price, Gerber, & Mulligan, 2007). Research addressing postsecondary education-related issues underscores the gaps in support services that create barriers for SWD in postsecondary education

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programs and the need to provide support and experiences that (a) help students develop self-efficacy, self-determination, and content knowledge; and (b) provide the opportunity to apply content knowledge (Dunn, Rabren, Russell, Massey, & Martin, 2014; Jenson, Petri, Day, Turman, & Duffy, 2011; Moon, Todd, Morton & Ivey, 2012).

The NSF's Research in Disabilities Education program has funded multiyear Alliances whose purpose is to increase the participation and achievement of SWD in associate, undergraduate, and graduate STEM programs, increasing the number entering the workforce (https://www.washington.edu/doit/RDE/partners.html). The focus of the Alliances vary. The Georgia STEM Accessibility Alliance's approach is using a virtual world as the primary service-delivery model, with the primary interventions including virtual mentoring and teaching, social networking, academic support, transition assistance, and preparation of instructors; whereas, the MIND Alliance for Minority Students with Disabilities in Science, Technology Engineering and Mathematics emphasizes a culturally sensitive student experience and career assessment and counseling approach as primary interventions.

Many of the projects are nearing the end of their support, and, as such there is limited data on the effectiveness of the various interventions. Ohio's STEM Ability Alliance has reported on the effectiveness of student learning communities, the primary intervention in their program (Izzo, Murray, Priest, & McArrell, 2011). Increases in self-determination, self-advocacy, and career development for students who participated in the learning communities were reported. The Pacific Alliance for Supporting Individuals with Disabilities in STEM Fields Partnership reported on five years of findings. The promising practices in their program were mentoring, academic support, and career-related experiences and support. The results indicated a high level of satisfaction with academic, mentoring, and career support. Short-term outcomes included increases in STEM interest and academic and career aspiration (Roberts, Takahashi, Park, Uyehara, & Brown, 2014). The purpose of this practice brief is to describe one of the NSF Alliance's postsecondary education programs designed to increase the quantity and success of SWD in STEM programs. Preliminary program evaluation data are provided.

Description of Practice

The Alabama Alliance for Students with Disabilities in Science, Technology, Engineering, and Mathematics (AASD-STEM) is comprised of five colleges and universities, and local school systems in central Alabama. Table 1 provides demographic information on the 247 students participating in the program since its inception in 2009 through 2016. The sample was predominantly from Auburn University (54.3%), White (53%), female (51.4%), and undergraduate (92.3%). In addition, participants were most likely to disclose their condition as Attention Deficit Disorder (ADD)/Attention Deficit Hyperactivity Disorder (ADHD) (26.3%) or as a systemic health/medical condition (21.1%). Finally, students were most likely enrolled in STEM programs related to the Biological/Life Sciences (32.8%) or Engineering (25.1%).

The AASD-STEM program is a multicomponent program, with a major emphasis on horizontal and vertical mentoring. Horizontal mentoring occurs twice a semester within three distinct groups (or bridges) and is facilitated by a faculty member, who also provides individual mentoring as needed. Vertical peer mentoring occurs with clusters of ten or fewer students across the bridges. Each cluster is facilitated by a Graduate Bridge mentor. Clusters meet at least once a week (see Table 2 for a more in-depth description of the Mentoring Bridge Model). Students are expected to participate in a minimum of two hours of mentoring activities each week. The project is overseen by a Principal Investigator, who is an Assistant Provost, and two Co-Principal Investigators from other participating institutions. Co-investigators come from a range of backgrounds (e.g., STEM fields, special education). While mentoring occurs at each individual institution, students from the different institutions have the opportunity to interact with each other via the annual Student Research Conference. Students also have the opportunity to participate in research internships. Table 3 describes additional program components.

Outcomes

The evaluation plan includes an internal and external evaluator. The internal evaluator focuses primarily on formative issues, providing feedback to the AASD-STEM partners about the implementation of project interventions; whereas, the external evaluator provides oversight on the process and is focused on outcomes and alliance-wide issues. The evaluation plan is designed to examine the extent to which the project components, called interventions, are implemented to achieve project goals. Information pertaining to students' interest in STEM, Alliance activities, self-advocacy behaviors, and self-efficacy was collected through surveys.

Student Surveys

Several surveys were designed to assess constructs related to student quality. More specifically, these surveys included measurement scales constructed to represent the constructs of interest in STEM careers, benefits of being involved in AASD, issues and challenges faced in college, self-advocacy knowledge and behaviors, academic efficacy, and intention to persist in their degree program (see table 4). Reliability estimates were very supported of these scales ranging from .617 to .931, with a median of .840. Student surveys were administered twice each year (fall and spring) since Fall 2011 to examine changes in students over each academic year. The following results are restricted to the first three full years of the program (2011-2014).

Results

Table 5 summarizes the responses of AASD-STEM participants who participated in the program over multiple years between Fall 2011 to Spring 2014. Changes were also examined with each academic year and will be reported in this section.

Changes within each academic year. In general, students reported their greatest improvements over the 2011-12 academic year, generally remaining stable the next two years.

2011-12. A matched sample of 76 students was used to examine changes over the 2011-12 academic year. Statistically significant changes ($p < .001$) were reported pertaining to students' ability to deal with issues and challenges faced in college and self-advocacy behaviors. More specifically, 94.7% of participating students indicated improvement in their use of effective self-advocacy skills and 88.2% in their ability to face issues and challenges. An increase in the ability to face issues and challenges pertaining to academic and social issues that confront them was reported by 94.7% and 89.3%, respectively. Also, over 80% of students reported increases in their ability to face issues and challenges pertaining to accommodations and disclosure, time management, social issues, and general college adjustment.

2012-13. The examination of a matched sample (n=78) of participants from the 2012-3 academic year, revealed that student quality generally remained stable. While average self-advocacy knowledge score declined somewhat in 2011-12, an increase occurred during 2012-13 with 69.2% of matched students' scores equal or better at the end of the year. AASD-STEM participants also reported being better able to face issues and challenges, with over 50% of them improving in all areas and over 60% when facing academic or accommodations/disclosure issues. Furthermore, over 60% of students reported improvements in terms of their academic self-efficacy and intention to persist in their current degree program.

2013-2014. Using a matched sample (n=70), the greatest improvement in 2013-14 was in the reported use of services provided through the Office for Students with Disabilities with 79.7% reporting increased use of such services. Consistent with the prior year, over 50% of students reported being better able to face challenges, with over 60% in relation to facing academic or accommodations and disclosure issues. Furthermore, over 70% of students reported improvements in terms of their academic self-efficacy, while 60% reported improved study skills and 50% reported increased intention to persist in their current degree program.

Changes over multiple years. Table 4 provides a summary of a matched sample of AASD-STEM participants from Fall 2011 to Spring 2014. These results are limited to the 11 measures of student quality that have been part of the project for a minimum of a two-year period. Matched data were available for 25 to 29 participants over this three-year period of time. Over 50% of these students reported improvement on each of the 11 student quality measures. This improvement was statistically significant ($p < .001$) for 8 of the 11 measures. One hundred percent (100%) of those students participating in the project over three years (2011-2014) reported improvements in use of self-advocacy behaviors. In addition, over 90% reported increased ability to face issues and challenges pertaining to academic and social issues, while over 75% of students reported being better able to deal with issues related to their accommodation and disclosure or time management issues. Furthermore, over 80% reported improved study skills behaviors and the use of services provided through the Office of Disability Services. Finally, 76% improved their knowledge of self-advocacy, and 67% reported increased levels of academic efficacy.

Implications and Portability

A serious issue relative to STEM advancement and education is the underrepresentation of SWD in STEM degrees and careers. In fact, the NSF has made increasing the number of persons with disabilities in STEM a national priority. Even though there are several limitations associated with preliminary project evaluation data, the results of this study are encouraging and have implications for future program development.

One potential limitation is the nature of surveys, which were used to collect much of the data. First,

these data were self-reported. Participant responses could have been influenced by the fact they received a stipend for program participation. Additionally, the program model includes several components. It is not possible from the survey results to identify which of the program components (e.g., mentoring, outreach activities) were most influential. Finally, the response rate ranged from 67% to 97% over the three academic years. While this is a good rate, perhaps those who completed the surveys were more invested in the program and more successful in their area of study. After the first year, to increase the response rate several of the institutions changed procedures for awarding stipends. Instead of awarding stipends at the beginning of the semester, stipends were awarded at the end of the semester, contingent on program evaluation completion.

A second limitation was the challenge of including a control group. As such, it is difficult to discern if the improvements experienced by program participants were actually a result of their participation in the program or consistent with typical skill improvement that occurs as students adjust to college. Researchers are challenged in finding control groups when working with special populations. The pool for potential control group students was greatly limited due to the limited number of eligible students at participating institutions. To be eligible, a student needed to have GPA of 2.7 and disclose his or her disability.

While the noted limitations should be considered when interpreting the results, the results are quite promising and provide direction for the development of programs to support SWD at the postsecondary level. The results highlighted positive changes in key attitudes and behavior related to STEM degree persistence and success for students participating in the AASD-STEM program, a program designed to support SWD in STEM programs.

The AASD-STEM program was designed specifically to facilitate increased academic and social integration to increase students' chances of persistence (Tinto, 1975) in STEM preparation programs and likelihood to enter STEM fields. To date, 66 students have graduated. Of those, 43% have secured jobs in STEM fields and 43% have continued on to graduate school. Five percent have obtained employment in non-STEM fields. Of all students who ever participated in the program, only one did not continue in the program due to lack of interest.

The areas of greatest improvement in student quality were not the STEM-related constructs; although, there were improvements in all of these areas too. The greatest areas of improvement were in participants' ability to handle challenges faced in college across several areas, including accommodations and disclosure, time management, social and academic issues, as well as self-advocacy. While these are not STEM-specific, the literature has consistently identified these skills and attitudes as factors important to student success in postsecondary education settings (DO-IT, 2014; Dunn et al., 2014; Izzo et al., 2011).

The AASD-STEM program assumes that students admitted to STEM discipline programs have an aptitude for basic science and mathematics and are committed to STEM professions. Students who were struggling academically were provided support through tutoring, counseling, mentoring, and other means. However, attending to the social integration of students is likely just as important as the academic dimension and probably reinforces it. Previous research has shown that faculty mentors provide an important support and peers can provide guidance by example and serve as a resource for information about services, supports, advocacy (Stodden, Dowrick, Anderson, Heyer, & Acosta, 2005). As well, social and professional networks have the potential to strengthen achievement and interest in STEM endeavors (Izzo et al., 2011).

Future research should examine more specifically the impact of the different components of the program, perhaps identifying which components have the biggest impact on student success, which could then inform program refinement. As well, it would be noteworthy to examine the relationship between student characteristics and specific interventions.

In closing, postsecondary education support programs for students with disabilities need to be multidimensional. It is important to design programs that attend to both the social and academic needs of students (Tinto, 1975). By doing so, we increase the likelihood these students will persist and succeed in postsecondary programs, contributing to positive adult outcomes.

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Table 1

AASD-STEM Participant Demographics (247 Participants as of Spring 2016)

Participant Characteristic	**Number**	**Percentage**
Site/Institution:		
Auburn University (AU)	134	54.3
Tuskegee University (TU)	39	15.4
Alabama State University (ASU)	26	4.0
Auburn University at Montgomery (AUM)	38	10.5
Southern Union State Community College (SUSCC)	10	15.8
Sex:		
Male	120	48.6
Female	127	51.4
Race/Ethnicity:		
White	131	53.0
Black or African-American	92	37.2
Hispanic	10	4.0
Asian or Pacific Islander	7	2.8
American Indian/Alaska Native	1	0.4
Not Reported	6	2.4
Condition:		
Asperger's syndrome/autism spectrum disorder	7	2.8
Attention deficit disorder (ADD)/attention deficit hyperactivity disorder (ADHD)	65	26.3
Deaf or hard-of-hearing (D/HoH)	15	6.1
Physical impairment/orthopedic/mobility impairment	29	11.7
Systemic health/medical condition	52	21.1
Psychological/psychiatric condition	15	6.1
Learning disorder	28	11.3
Blind or visual impairment	8	3.2
Speech impairment	4	1.6
Acquired/traumatic brain injury	4	1.6
Other condition	20	8.1
Major (area):		
Architecture/Industrial Design	6	2.4
Biological/Life Sciences	81	32.8
Computer/Information Sciences	13	5.3
Engineering	62	25.1
Mathematics/Statistics	9	3.6
Physical Sciences	16	6.5
Psychology	39	15.8
Undeclared – Science & Math	21	8.5
Student Classification:		
Undergraduate	228	92.3
Graduate	19	7.7

Table 2

AASD-STEM Mentoring Model

Horizontal Mentoring	**Vertical Mentoring**
Three groups Bridge to Baccalaureate Peer Mentoring Program • Consists of freshmen and sophomores who plan to obtain a bachelor's or associate's degree in STEM disciplines • Meeting topics include time management, study skills, academic assistance resources, class registration advice, and mentoring • Goal for participants is to move in to the Bridge to Post Baccalaureate Program Bridge to Post-Baccalaureate Peer Mentoring Program • Consists of juniors and seniors who are pursuing a bachelor's degree in STEM disciplines • Meeting topics include co-op opportunities and research internships, class registration advice, and speakers from STEM disciplines, graduate school, industries, or government • Goal for participants is to move into the Graduate Bridge Peer Mentoring Program or join the STEM workforce Graduate Bridge Peer Mentoring Program • Consists of graduate students who have demonstrated a commitment to pursuing a doctorate in STEM fields • Meeting topics include conference presentations, applying for post-doc opportunities, scientific grant writing, and future faculty preparation • Goal for participants is to obtain a doctorate in a STEM discipline and join the STEM workforce • Faculty mentor facilitates Bridge meetings and provides additional individual mentoring Bridges meet separately the second and fourth month of each semester	• Occurs with clusters of ten or fewer students across Bridges • Each cluster had a Graduate Bridge mentor who facilitates the vertical peer mentoring and serves a mentor for the Bridge to Post-Baccalaureate students • The Bridge to Post-Baccalaureate students serve as mentors to the Bridge to Baccalaureate students • Peer mentors provide support, encouragement, and information to their mentees • Clusters meet once a week in informal settings

Table 3

AASD-STEM Program Components

Component	Description
Recruitment	• Varies from institution to institution, but includes letters to parents of all entering freshmen and dissemination of applications through offices of disability services
Financial aid in the form of stipends and/or scholarships	• Students receive a stipend for program participation, dependent on active participation and maintaining a minimum required GPA • $2000/academic year for undergraduate students • $3500/academic year for graduate students
Continuous monitoring and assessment	• Students' grades, program participation levels, and progress toward degree completion are monitored • Students evaluate program, their participation in program, and their own personal growth two times a year
Research internships	• Undergraduate students spend eight weeks doing research with a STEM faculty member at a research lab on the campus of one of the AASD-STEM institutions • Participants have also participated in off-campus research labs at industry locations • Research areas have included a variety of topics in mechanical engineering, psychology, computer science, aerospace engineering, civil engineering, and biology • Students receive $3,500 stipend for summer research participation • 56 completed internships through summer 2014
Student advocacy group	• Open to all students, faculty, and staff and is not exclusive to those with disabilities • Called the "Students Enabling Students Association," monthly group meetings were held on the AU campus • Group members assisted with campus visits for high school students
Student research conference	• Occurs annually • Features research presentations by students, presentations by faculty members on STEM research areas, and breakout sessions on self-advocacy and the use of assistive technologies • The conference provides networking opportunities for faculty, students, and staff within the Alliance • Faculty members mentor students and provide guidance and support for students in preparation for research presentations
Research Presentations	• Students, particularly graduate students, were supported in their efforts to conduct research and present their findings at conferences • Over 120 presentations were given by students at regional and national conferences. • Presentation formats have included both oral and poster presentations
High school outreach	• High school SWD tour postsecondary institutions to learn about STEM, the AASD-STEM project, financial aid, and disability services and interact with college SWD in STEM
Special seminars	• Special seminars are planned throughout the year depending on students' interests and needs • Topics such as summer research opportunities, graduate school admission processes, study skills, assistive technologies, etc. were integrated into monthly Bridge meetings

Table 4

Measurement Scales, Reliabilities, Definitions

Construct/Scale	Items	Reliability (Spring 14)	Description
STEM Interest[a]	6	.704*	Interest in an advanced degree in STEM and STEM careers.
Issues and Challenges[a]	24	.919	
Accommodations/Disclosure	4	.671	
Academic Needs	9	.859	
Time Management	3	.838	
Social Issues	8	.812	
Self-Advocacy			
Self-Advocacy Behaviors[a]	18	.840	Meeting with and making sure faculty are aware of necessary accommodations, knowing and using available resources
Self-Advocacy Knowledge[b]	20	.807	Office of Accessibility (Student Disabilities) services, ADA, self-advocacy knowledge
Academic Skills			
Academic Efficacy[a]	8	.925	Confidence in ability to succeed in classes and overcome academic challenges
Study Skills Behaviors[a]	16	.923	Making good use of study time, avoid procrastination and cramming, managing and prioritizing assignments.
Intent to Persist[a]	9	.931	Intentions to pursue additional coursework, complete degree program and work in STEM.

Note. *Not administered in Spring 2014, reliability reported for Spring 2013. [a] 5-point response scale, [b] multiple choice test

Table 5

Matched Sample (over multiple years in AASD-STEM)-Fall 2011-Spring 2014

Fall 2011-Spring 2014	**Items**	***N***	**F 2011 Mean (*SD*)**	**SP 2014 Mean (*SD*)**	**Change (Matched)**	**Percent Improvement**
Issues and Challenges[a]	24	29	2.89 (.16)	3.89 (.54)	+1.0*	100.0%
Accommodations and Disclosure	4	29	3.21 (.51)	3.81 (.78)	+.60*	82.8%
Academic Issues	9	29	2.82 (.32)	4.05 (.55)	+1.23*	96.6%
Time Management	3	29	2.48 (.60)	3.31 (.88)	+.83*	79.3%
Social Issues	8	29	2.74 (.25)	3.99 (.61)	+1.25*	96.6%
Self-Advocacy						
Self-Advocacy Behaviors[a]	18	25	2.20 (.37)	3.78 (.53)	+1.58*	100.0%
Self-Advocacy Knowledge[b]	20	25	76.6%	78.6%	+2.00%	76.0%
Academic Skills						
Academic Efficacya	8	27	4.23 (.55)	4.29 (.63)	+.06	67.0%
Study Skills Behaviors[a]	16	27	3.18 (.70)	3.57 (.76)	+.39*	81.5%
Fall 2012-Spring 2014	**Items**	***N***	**F 2012 Mean (*SD*)**	**SP 2014 Mean (*SD*)**	**Change (Matched)**	**Percent Improvement**
Disability Services – Planned or Used	14	35	1.54 (2.4)	3.89 (3.3)	+2.35*	82.9%
Intent to Persist	9	38	4.65 (.47)	4.55 (.89)	-.09	57.9%

Note. [a] 5-point scale, [b] multiple choice, *$p<.001$