# Evaluation of Programmatic Interventions to Improve Postsecondary STEM Education for Students with Disabilities: Findings from SciTrain University

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**Abstract**

This article discusses the evaluation of programmatic interventions to enhance postsecondary STEM education for students with disabilities. SciTrain University, a federally funded project to provide instructor training on accessible teaching according to universal design principles, is presented here as a case study on evaluation for similar programs. This article highlights the evaluation process, including relevant evaluation questions and selection of indicators, use of a mixed-methods approach, and development of instruments. We give particular attention to the utilization of longitudinal participants in order to document the project's effectiveness. Project evaluators used demographic and performance data, classroom observations, and online journals to determine the efficacy of the training provided to these longitudinal participants. For these three activities, we discuss the development and deployment of instruments and offer some preliminary findings. Finally, the article concludes with a brief discussion of internal project assessment and its role in project refinement. Given a dearth of scholarship on the evaluation of programs to enhance STEM education for students with disabilities, this article seeks to provide some practical insights into the potential for mixed-methods approaches.

*Keywords: STEM education, disability, postsecondary, evaluation, universal design for learning (UDL)*

In recent decades, policymakers and educational leaders have emphasized accountability and utilization of evidence-based practices in secondary and postsecondary education (Layzell, 1999; Harvey & Williams, 2010; Shin, 2010). However, researchers have pointed to a continued lack of data on postsecondary students with disabilities and the need for appropriate indicators to document their success (Burke, Hedrick, Ouelette, & Thompson, 2008). Of particular concern is the efficacy of programs to improve enrollment in, retention within, and completion of science, technology, engineering, and mathematics (STEM) degrees at the postsecondary level. Projects sponsored by the National Science Foundation's (NSF) Research in Disabilities Education (RDE) and the U.S. Department of Education's Office of Postsecondary Education (OPE) have prioritized the improvement of postsecondary STEM education for students with disabilities (Burgstahler & Bellman, 2009; Izzo, Murray, & Novak, 2008; Stefanich, Gabrielle, Rogers, & Erpelding, 2005; Stumbo, Lindahl-Lewis, & Blegen, 2008).

The need for more evidence-based practices has been noted in practically every aspect of disabilities education, including the transition to postsecondary education (Webb, Patterson, Syverud, Seabrooks-Blackmore, 2008). As the National Council on Disability (NCD) has observed, "the amount of rigorous, evidence-based research on programs that promote positive outcomes for students with disabilities is severely limited" (Frieden, 2004, p. 6). In addition, there is a dearth of scholarship on how such programs might be evaluated.

In response, this article presents SciTrain University (SciTrain U), an OPE-funded demonstration project at the Georgia Institute of Technology and University of Georgia designed to enhance the abilities of STEM faculty to make instruction more accessible for students with disabilities through a combination of in-person and web-based training (Utschig, Moon, Todd, & Bozzorg, 2011). Using SciTrain U as a case study, we discuss methodologies for evaluating programs to support STEM education for students with disabilities. In the course of highlighting key evaluation findings, this article presents indicators for determining programmatic efficacy, considers methodologies for gauging project performance, and discusses challenges faced by the project and efforts to resolve those difficulties.

## Background Discussion

Scientific leaders and policymakers have called for the cultivation of a diverse STEM workforce in the United States (National Science Foundation, 1996, 2000, 2004). This concern was reiterated by the National Science Board in its 2010 report, "Preparing the Next Generation of STEM Innovators," which offers two interrelated observations. First, American prosperity in STEM in the coming years will rely increasingly upon "talented and motivated individuals who will comprise the vanguard of scientific and technological innovation" (National Science Board, 2010, p. 1). Second, every student in the United States "deserves the opportunity to achieve at his or her full potential" (National Science Board, 2010, p. 1). In summary, excellence and equity in STEM education go hand-in-hand. However, this goal can be realized only if underrepresented groups attain a larger proportion of the nation's STEM degrees.

Americans with disabilities historically have been underrepresented in postsecondary STEM education, particularly because these students face tremendous barriers to access and participation in these programs (Burgstahler, 1994; Wolanin & Steele, 2004). Participation of students with disabilities tends to decrease longitudinally throughout the STEM education process. U.S. census data have shown that people with disabilities constitute 10% of the nation's general workforce, but only two percent of its STEM professionals (Committee on Equal Opportunities in Science and Engineering, 2006; National Center for Education Statistics, 2004; U.S. Department of Education, 2001).

The problem is complex. First, teachers, instructors, and professors are frequently unable, unprepared, or otherwise ill-equipped to recognize and address the needs of students with disabilities (Stefanich, 2007). As a result, course content may be inaccessible, as many faculty fail to develop their courses in accordance with the principles of universal design for learning (UDL) (Burgstahler & Cory, 2008; Rose & Meyer, 2006; Rose, Meyer, & Hitchcock, 2005). Instructors may not be aware of strategies or technologies to help them accommodate students, or they may lack the necessary institutional support or resources to make accessible pedagogy a reality (Stefanich, 2001). In addition to the issue of instructional practice, there is a second matter of social inclusion. Research has demonstrated that students with disabilities, particularly learning disabilities, frequently experience negative attitudes from faculty and peers (Stage & Milne, 1996). By the time some of these students reach college, they are commonly discouraged from pursuing STEM degrees. When they enroll in STEM courses, many are not fully included in more rigorous learning activities such as labs, thus diminishing their potential engagement and prospects for success (DO-IT Staff, 2001). As such, there remains a pressing need for resources to ensure that STEM instruction is accessible and inclusive.

The UDL concept is the philosophical foundation for inclusive teaching, and the literature demonstrates that many inclusive strategies are effective. Orr and Hammig's (2009) survey of pedagogical techniques found that in 21 of 38 studies, inclusive techniques and learner supports were in use. These studies provide evidence for the ability of inclusive instruction to minimize the need for students with disabilities to seek formal accommodations. Nevertheless, there is room for further inquiry. Despite its increasing deployment in K-12 education, UDL is not as widely implemented in postsecondary education. One broad conclusion gleamed from a review of the scholarly literature is a shortage of research on UDL and accommodations as they apply to the university setting (Moon, Todd, Morton, & Ivey, 2011).

## SciTrain University

SciTrain U is designed to enhance the capacity of university STEM faculty and staff to improve learning for all students, including those with disabilities, through the application of UDL practices. In doing so, this project relies on two major components. First, in-person workshops are delivered with the intent of educating faculty about disability awareness and working with students with disabilities. In accord with the project's UDL emphasis, workshops have focused less on disability accommodations and more on using accessible pedagogy to improve learning outcomes for all students. The workshop developer has given particular attention to three STEM learning environments: large lecture classrooms, laboratories, and online learning environments. For each of these, workshops have focused on multiple approaches to make learning more effective for all students. For example, group note-taking activities and personal response systems (PRS, or "clickers") are discussed as means to improve instructional outcomes in lecture-based courses, while the development of inquiry-based labs are discussed for lab-based courses.

Workshops are developed and delivered by a lead instructional technologist at Georgia Tech's Center for the Enhancement of Teaching and Learning (CETL). The workshop developer has almost 15 years of experience in distance education and has worked closely with faculty regarding the use of technology in conventional and virtual classroom settings. The workshop developer has collaborated with biology and marine sciences faculty at the University of Georgia and chemistry and applied physiology faculty at Georgia Tech to ensure the incorporation of appropriate STEM content knowledge within SciTrain U workshops. Workshops on different topics are offered at each of the two participating campuses three to four times per semester; they are occasionally offered more than once whenever interest is relatively high. As the project has progressed, the workshop developer has revised the face-to-face workshops in response to survey findings as well as to update content. For more information about workshops, please visit http://www.catea.gatech.edu/scitrainU/login.php.

Building upon the workshops, the project website hosts online courses for deployment of project resources at other institutions. Considerations of accessibility, usability, simplicity of design, and visual appeal drive the website's design, as does clear "branding" for the project, simplified page layouts and functionality, and deliberate use of high contrast and white space. The site provides STEM instructors with three types of content: background information on common disabilities, an overview of disability accommodations, and information about inclusive pedagogy. The site provides modules on transitioning from secondary schools, introduction to UDL, learning disabilities, attention-deficit/hyperactivity disorder (ADHD), autism, mobility and dexterity disabilities, deafness and hearing impairments, low vision and blindness, and disability laws. In illuminating the types of disabilities that instructors might encounter, the modules discuss a variety of methods to accommodate learning needs. The web materials also address assistive technologies and how best to integrate their use within classroom and laboratory learning.

## Evaluation and Assessment

To document SciTrain U's effectiveness, considerable project resources are allocated for an evaluation and assessment team. Two lead evaluators are based at Georgia Tech's CETL and Center for Advanced Communications Policy (CACP), and their team has generally included one undergraduate assistant and up to three graduate assistants at any given time. While many of the resources associated with the project typically have been based at CETL, two of the graduate assistants are closely associated with the disability services centers at Georgia Tech and UGA.

### Evaluation Methodology and Approach

Synthesizing data is often difficult for evaluation teams unless a specific approach is utilized. This evaluation team's methodology involves combining two mixed-methods approaches for analyzing data: McConney, Rudd, and Ayres' Results Synthesis Method and Campbell's Pattern Matching method. The Pattern Matching method recommends that evaluators work from a model such as a program logic model and identify whether each aspect of the model enables or prevents the program from reaching its intended impact (McConney, Rudd, & Ayres, 2002). The Results Synthesis Method guides evaluators in working with stakeholders to identify the value of each evidence set, such as classroom observations and focus groups (Campbell, 1966). This allows the evaluators to more accurately depict the strength or weakness of the ties among each block on the logic model.

Aside from the analysis of performance data on students enrolled in project-affiliated courses, SciTrain U's evaluation has rested mainly upon qualitative methods, including classroom observations, faculty workshop surveys, student surveys, website surveys, online journals, and focus groups. Where observational methods are utilized, multiple evaluators have taken part to insure interrater reliability. Likewise, all open-

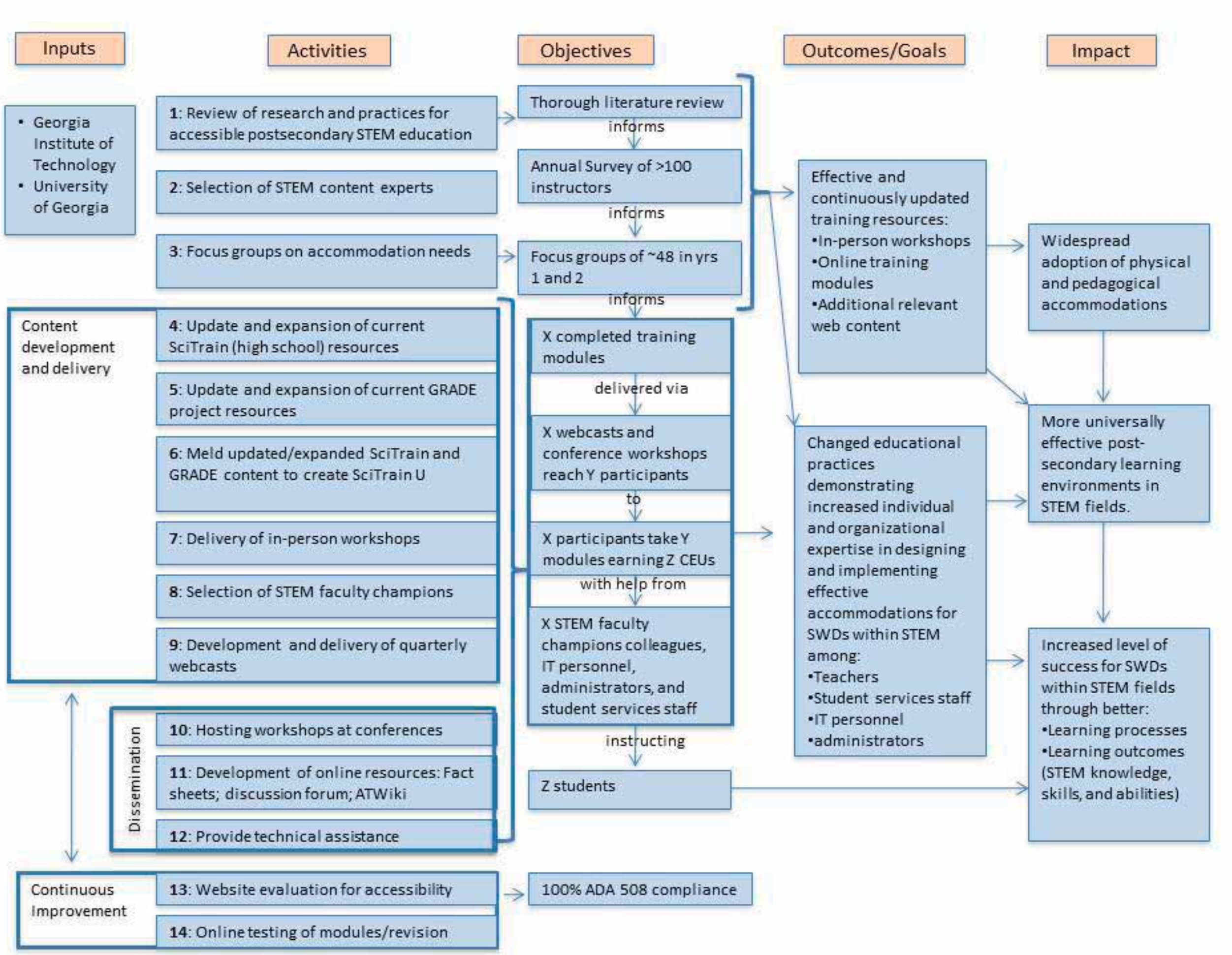


*Figure 1.* SciTrain U Logic Model.

ended responses to surveys and online journal entries have used at least two coders to maximize reliability.

## Indicator Selection

Scholars concerned with the evaluation of postsecondary STEM education have observed that the basic availability or, more frequently, unavailability of data should not dictate the approach for undertaking evaluations (Coates, 2007). These same principles hold true for programmatic interventions to support students with disabilities. If evaluation is to determine educational efficacy, then it must be considered from the beginning through the development of meaningful indicators and the provision of data collection and analysis for such ends. With this guiding principle in mind, evaluators sought to determine the appropriate indicators at the outset of the project and then formulated data collection efforts in response. Evaluation questions and corresponding indicators emerge from the logic model (see Figure 1), which governs the evaluation process and details the prospective inputs, project activities, objectives, outcomes and goals, and impact.

Evaluation of SciTrain U provides data for formative and summative feedback along three key tracks. In the first track, the Referenced Program Performance Indicators specifically address the U.S. Department of Education's Government Performance and Results Act (GPRA) Goal #3, *Ensure the accessibility, affordability, and accountability of higher education, and better prepare students and adults for employment and future learning*. The referenced program performance indicators provide critical information on student course completion patterns and on faculty adoption of SciTrain U resources. The second track, Knowledge Synthesis, combines SciTrain U's research findings with institutional knowledge developed from prior projects. These include SciTrain: Science and Math for All, which is oriented at improving science and

Table 1

*SciTrain U Evaluation Questions*

Track 1: Referenced Program Performance Indicators

a. What is the rate at which students with documented disabilities complete courses taught by SciTrain U-trained faculty? What is the rate at which students without documented disabilities complete courses taught by SciTrain U-trained faculty? What, if any, is the difference in these two rates?
b. What percentage of SciTrain U-trained faculty incorporates elements of training into their classrooms?

Track 2: Knowledge Synthesis

Based on current literature and recent SciTrain and GRADE findings, what learning environments will prove most successful for program stakeholders?

Track 3: Program Implementation Measures

a. Which stakeholders are provided with what resources?
b. What do participants learn as a result of program participation?
c. What actions are the various stakeholders taking toward improving content/pedagogical knowledge, organizational capacity, and available resources?
d. Who adopts which aspects of inclusive instruction?
e. What organizational barriers or accelerators hinder or promote inclusive instructional practice adoption?

mathematics instruction for students with disabilities in secondary education, and Georgia Tech Research on Accessible Distance Education (GRADE), which focuses on accessibility of distance education for students with disabilities. The third track, Program Implementation Measures, provides necessary formative assessment feedback for program benchmarking and improvement as the program is being implemented. This track culminates with a loop back to Track 1. The process for each track is addressed by the project evaluation team through the use of a set of targeted evaluation questions designed to elicit meaningful data collection and analysis (see Table 1).

The GPRA-derived indicators comprising Track 1 were ascertained through data collection efforts involving longitudinal participation by affiliated faculty at Georgia Tech and UGA. In order to determine completion rates of students with disabilities taught by SciTrain U-affiliated instructors, evaluators analyzed demographic and performance data collected by the disability services centers and registrar's offices at both institutions. In order to establish the percentage of SciTrain U-trained faculty incorporating elements of training into their classrooms, as well as the nature of those practices, longitudinal participants participated in classroom observations and kept online journals detailing their experiences in the project.

**Instrument Creation and Use**

A "development" mixed-methods approach was used to generate evaluation instruments, including workshop surveys, focus group protocols, and classroom observation instruments (Greene, 2007). Information from a baseline literature review informed the evaluation team in its development of these instruments. The knowledge synthesis effort also resulted in a list of characteristics the program expected to see transferred from instruction into practice. This "transfers list" assisted in the creation of these instruments. Also, Greene's "complementarity" mixed-methods approach was applied, which means that the classroom observations served to complement other data collection efforts by providing a deeper description of how faculty apply what they have learned into their classrooms and also to confirm or disconfirm the self-reported information from surveys and focus groups (Greene, 2007).

## Longitudinal Participants

In order to evaluate the effectiveness of the project, longitudinal participants were recruited from both participating institutions. A total of 15 faculty members, nine from Georgia Tech and six from UGA, were recruited for this project. Collectively, they represented departments of biology, chemistry, mathematics, astronomy, marine sciences, and applied physiology (i.e., health). In order to ensure their continued involvement for the duration of the project, the longitudinal participants were compensated with modest stipends, as well as additional honoraria for taking part in supplemental project activities. As discussed below, their retention for the duration of the project posed a challenge. Nevertheless, most of the participants continued for at least four terms, or two years, of the project period.

Relying upon a mixed-methods approach, three types of data specific to longitudinal participants were collected in order to evaluate SciTrain U's effectiveness and document change-over-time impacts. First, performance and demographic data for enrolled students with disabilities were collected in order to satisfy the GPRA-derived indicators. Second, classroom observations were undertaken twice a term for each of the participants in order to assess the accessibility of classroom and laboratory instruction. Third, participants were required to submit entries for an online journal that recorded their experiences in the project. In addition to these data collection efforts, participants also attended workshops.

### Performance and Demographic Data

In order to determine the effectiveness of SciTrain U as a programmatic intervention to improve the learning outcomes of students with disabilities, evaluators collected both performance and demographic data on students with documented disabilities enrolled in SciTrain U-affiliated courses. These data are collected in order to determine the rate at which students with documented disabilities complete courses taught by faculty trained in project activities, and the rate at which other students without disabilities complete those courses.

In order to assess these outcomes, evaluators developed collaborative partnerships with the disability services centers and registrar's offices at both participating institutions. Graduate research assistants tasked to the disability services centers at Georgia Tech and UGA facilitate identification of students with documented disabilities enrolled in project-related courses. Because of a lack of systematized data reporting at these institutions, a project-specific spreadsheet instrument was developed that allows identification numbers for all students on file with disability services to be compared against enrollment rosters for each of the courses. Once students are identified, queries are submitted to the registrars to provide pertinent demographic and performance data immediately following the end of the term. Demographic data gathered include students' gender, race, disability, class standing, and major, and performance data includes course grades (including incompletions and withdrawals), semester grade point averages (GPA), and overall GPA.

In spring 2009, the evaluation team collected its first set of performance data from the courses of four longitudinal participants at Georgia Tech. This dataset established a baseline for evaluating subsequent progress, and it revealed that in courses taught by SciTrain U-trained faculty, 94.45% of students with disabilities (17 of 18) successfully completed the courses in question. The one student who withdrew did so due to circumstances not related to the student's disability or academic performance in the course. More specifically, 88.24% of students who completed a course under evaluation (15 of 17) received a passing grade in the course (Grade distribution: A=9; B=4; C=2; D=0; F=2). More widely, 16 of the 18 students evaluated were in good academic standing, with one on academic warning and another on probation at the time.

In fall 2009, there were a total of 21 students with documented disabilities across six courses at Georgia Tech taught by SciTrain U-trained faculty. In the Math 1711 course, there were four students with disabilities. Their average grade for the course was a B- (2.75) (utilizing a four-point grading scale, A=4, B=3, C=2, D=1, F=0). Math 1113 had one student with a disability, who earned an A in the course. The first section of Chemistry 1510 had three students with disabilities, with an average of C+ (2.33), while the second section of Chemistry 1510 had one student who earned a C in the course. The first section of the freshman-level health/wellness seminar, Health Performance Science (HPS) 1040, included three students with disabilities, with an average of a B (3.00) in the course. The second section of HPS 1040 included 9 students with disabilities, with an average of a B (3.00) in the course. In addition, overall GPAs and semester GPAs were tracked.

The comparison between fall 2009 and the spring 2009 baseline suggests a complementary set of conclusions. First, while a course-by-course comparison may not reflect an improvement in student performance, overall, the project does appear to be making a broader impact in terms of the numbers of students with documented disabilities reached, their course completion rates, and passing grades earned. As noted, the number of students impacted by the project at Georgia Tech to date, in terms of longitudinal participants and students enrolled, makes statistical significance difficult. This suggests a second point, which is that qualitative data may be just as relevant as indicators of student success as performance data.

**Classroom Observations**

Drawing upon the scholarly literature on UDL approaches to postsecondary classroom instruction (Fahsl, 2007; Fuller, Bradley, & Healy, 2004; Higbee, 2003; Orr & Hammig, 2009), project evaluators developed a classroom observation instrument (see Figures 2 and 3) to conduct beginning-of-term and end-of-term observations for each longitudinal faculty participant. This 48-item instrument considers six elements of inclusive and accessible pedagogy: classroom environment, visual aids, oral communication, "clickers" (i.e., electronic personal response systems), classroom notetakers, and electronic learning support (i.e., course management software). Observations are made by two raters, which always include at least one of the two lead evaluators. Graduate research assistants tasked to the project also participated in observations, and training was provided in person and reiterated through the development of an evaluation team manual. During an observation, observers mark the item as "Yes," "No," or "N/A," depending on whether the behavior was observed. An affirmative answer is generally meant to indicate that the instructor adheres to the principles of UDL, where a negative generally suggests that such adherence was not observed. While the polar nature of the observation form permits scoring, both individually and as a group, notetaking is also done to provide clarification and feedback for participating instructors, as well as to allow for more detailed explanations or descriptions of the observations.

Faculty participants are observed twice per term, and the same two scorers are involved in both beginning-of-term and end-of-term observations. (In order to expedite scheduling of observations and avoid potential conflicts with tests or special activities, faculty participants were provided with advance notice of the days they were observed.) Use of the same observers, as well as discussion of findings at the end of each observation to resolve any inconsistencies, ensures some degree of reliability. The team also has developed an observation guide that accompanies the instrument, and it contains an item-by-item explanation to assist raters in making their observations. Both the instrument and guide have been subject to periodic review, and slight refinements have been made in response to prior experiences.

As of fall 2010, evaluators had completed 80 observations of 15 longitudinal participants. Four of the participants had been involved continuously throughout the three terms of the study, and five of the participants had been involved for two terms. At the time of the analysis, the remaining six participants only had a baseline measure. As previously noted, the instrument consists of 48 items (three items were simple counts and 45 were categorical) that probe six aspects of instruction. A corresponding "accessibility score" is derived from the 45 coded items. The scores are a sum/composite of these items, allowing for a maximum of 45 and a minimum of -45. "Yes" responses are coded as a 1, and "no" responses are coded at a -1, while "N/A" responses are coded as 0 {Y = 1, N = -1, N/A = 0}. A corresponding scoring rubric was devised, in which a score of < 0 denotes "poor," 1-15 is "fair," 16-30 is "good," and 31-45 is "excellent." The underlying rationale for the scoring rubric was that any score below 0 was undesirable from an accessibility standpoint.

The following graph (see Figure 4) presents longstanding participants' accessibility scores averaged across all their observations. A corresponding graph (see Figure 5) shows the aggregate change-over-time results from the observations. The regression line suggests a trend of increasing accessibility scores over the project's course. When examining accessibility across

SCITRAIN U

**Classroom Observation Form**
**Date:**
**Time Start:** **End:**

**Teacher:** **Course:** **Student #**

| **Classroom Environment** | **Y** | **N** | **N/A** |
|---|---|---|---|
| Closes door and/or blinds | ☐ | ☐ | ☐ |
| Welcomes or greets students | ☐ | ☐ | ☐ |
| Reminders given about electronics during class | ☐ | ☐ | ☐ |
| Reminders given about acceptable classroom etiquette | ☐ | ☐ | ☐ |
| Action taken to motivate students in class or in general | ☐ | ☐ | ☐ |
| Language used does not stereotype students | ☐ | ☐ | ☐ |
| Flexibility to address individual needs demonstrated | ☐ | ☐ | ☐ |
| Students provided with multiple ways to learn | ☐ | ☐ | ☐ |
| Content is made personally relevant to student lives | ☐ | ☐ | ☐ |

**Notes:**

| **Visual Aids** | **Y** | **N** | **N/A** |
|---|---|---|---|
| Class outline presented/provided | ☐ | ☐ | ☐ |
| Handouts provided | ☐ | ☐ | ☐ |
| Handouts highly readable | ☐ | ☐ | ☐ |
| Materials easily visible from back of classroom | ☐ | ☐ | ☐ |
| Materials uncluttered | ☐ | ☐ | ☐ |
| Materials well organized | ☐ | ☐ | ☐ |
| Variety of types of visual aids used | ☐ | ☐ | ☐ |

Number of Student questions on visual aids: ______
Clarity:________ Comprehension:______

| **Oral Communication** | **Y** | **N** | **N/A** |
|---|---|---|---|
| Uses student names | ☐ | ☐ | ☐ |
| Faces class to speak when not writing on board | ☐ | ☐ | ☐ |
| Clearly audible from back of room | ☐ | ☐ | ☐ |
| Makes eye contact while speaking to students | ☐ | ☐ | ☐ |
| Clearly explains visual aids | ☐ | ☐ | ☐ |
| Gives clear instructions for student activities | ☐ | ☐ | ☐ |
| Instructions for student activities repeated | ☐ | ☐ | ☐ |
| Student interaction actively facilitated | ☐ | ☐ | ☐ |
| Summarizes major points | ☐ | ☐ | ☐ |

Number of Student questions in general: ______
Clarity:________ Comprehension:______

*Figure 2.* SciTrain U Classroom Observation Instrument, Page 1.

**Classroom Diagram**

# SCITRAIN U

**Teacher:** **Course:**

| **Clickers** | **Y** | **N** | **N/A** |
|---|---|---|---|
| "clickers" are used in the classroom | ☐ | ☐ | ☐ |
| If used, students are able to easily connect | ☐ | ☐ | ☐ |
| If used, how much ____ #instances | | | |
| _____/ ______/ ______ # items per instance | | | |

| **Classroom Notetakers** | **Y** | **N** | **N/A** |
|---|---|---|---|
| Class note takers used | ☐ | ☐ | ☐ |
| Offers printed materials that facilitate note taking | ☐ | ☐ | ☐ |
| Gives reminders of important points to include in notes | ☐ | ☐ | ☐ |
| Gives appropriate pauses for students to take notes | ☐ | ☐ | ☐ |
| Offers feedback or instruction on good note taking | ☐ | ☐ | ☐ |

| **Electronic Learning Support** | **Y** | **N** | **N/A** |
|---|---|---|---|
| Majority of students come to class with proper materials | ☐ | ☐ | ☐ |
| Online communication with instructor encouraged | ☐ | ☐ | ☐ |
| Online communication with other students encouraged | ☐ | ☐ | ☐ |
| **--- to be observed outside of the classroom ---** | | | |
| Materials available at least 24 hours before class | ☐ | ☐ | ☐ |
| Materials provided in accessible format(s) | ☐ | ☐ | ☐ |
| Online communication with instructor facilitated | ☐ | ☐ | ☐ |
| Online communication with other students facilitated | ☐ | ☐ | ☐ |
| Options for students to post materials for class | ☐ | ☐ | ☐ |
| Options for students to post their own materials | ☐ | ☐ | ☐ |
| Lectures available by audio file | ☐ | ☐ | ☐ |
| Lectures available by video file | ☐ | ☐ | ☐ |
| Online audio/video materials clear/usable | ☐ | ☐ | ☐ |
| Students know when recordings will be available online | ☐ | ☐ | ☐ |

*Figure 3.* SciTrain U Classroom Observation Instrument, Page 2.

the six sections of the instrument form, the increasing accessibility of class notetaking and electronic learning support, by term, corresponded to when workshops were held on these areas. When examining standardized change in average accessibility by section, the analysis revealed improvements in class notetakers, oral communication, visual aids, and electronic learning support, in that order (see Figure 6).

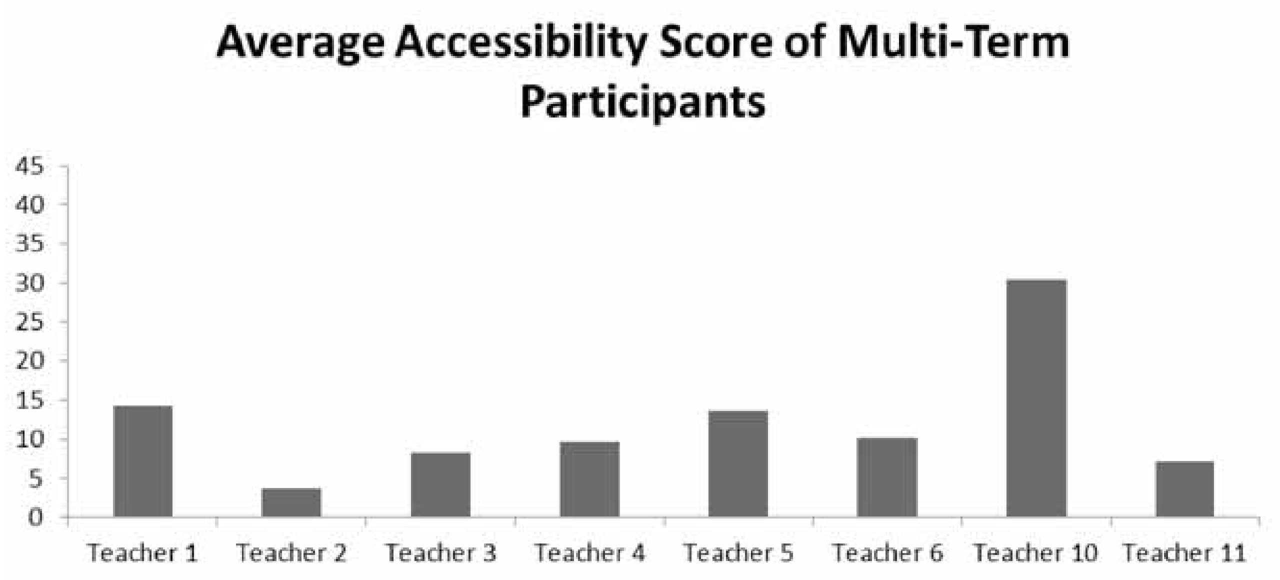


*Figure 4.* SciTrain U Longitudinal Participant Accessibility Scores, Averaged Across All Classroom Observations.

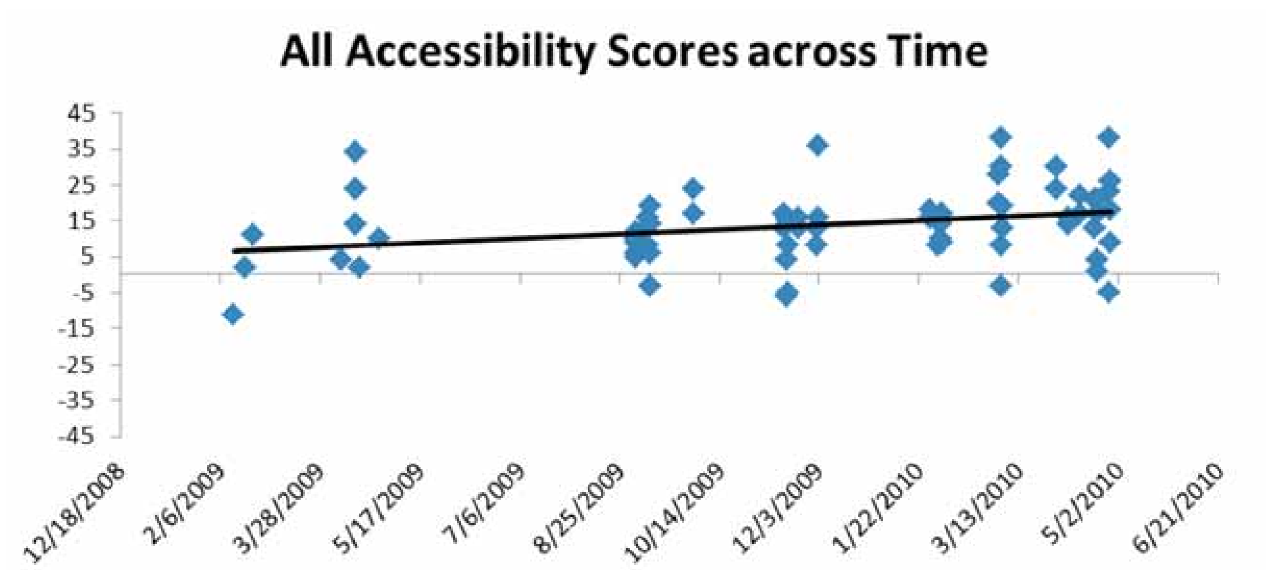


*Figure 5.* Change over Time of SciTrain U Longitudinal Participant Accessibility Scores.

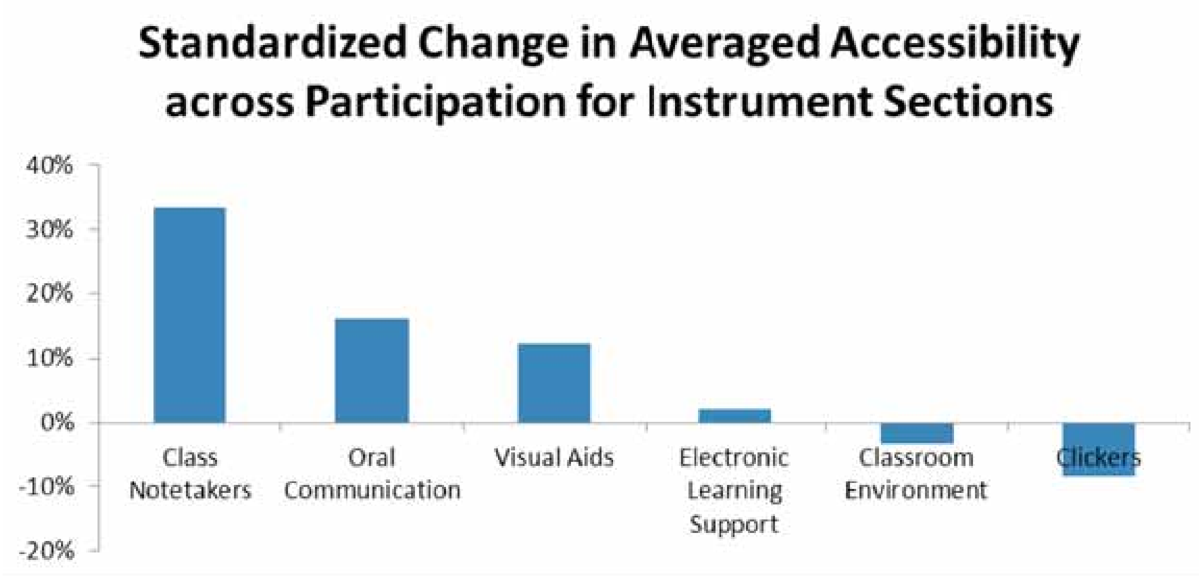


*Figure 6.* Standardized Change in Accessibility Scores for Each of the Six Instrument Sections.

**Online Journal Reflections**

Longitudinal respondents were also required to maintain weekly online journals. Each journal entry involved a response to an open-ended question regarding the relationship between the learning environment in the participant's classroom and students with disabilities. Group workshops conducted in parallel to the journal responses during the spring 2009 term addressed the use of online forums in the classroom, while workshops during the fall 2010 term focused on the use of online forums and collaborative learning activities in the classroom. For this reason, the majority of participant responses for spring 2009 and fall 2010 were concerned with the educational effect of online forums and group learning methods, respectively. Journal entries articulate teaching methods, instructor concerns, student feedback, implementation challenges, and overall learning. The journal entries also discuss specific changes and developments related to all students, particularly students with disabilities.

Analysis of faculty participant responses are conducted based on the following questions: 1) What aspects of inclusive instruction do faculty participants adopt? 2) What barriers or accelerators hinder or promote inclusive instruction practices? 3) What actions have faculty participants been taking toward improving content/pedagogical knowledge, organizational capacity, and available resources? 4) What do faculty participants learn as a result of the adoption of certain inclusive teaching methods? 5) What particular resources and accommodations are provided to SWDs and how are they effective?

In order to answer those questions, evaluators employ a qualitative method to analyze pertinent responses. The main analytical procedure is to do preliminary coding (e.g., open coding), draw out some themes and concepts, and re-code to develop better defined categories and analyze data. This coding is spot-checked by a second researcher at least twice during the analysis process. Journal reflections are analyzed with three focuses: overall themes, change over time, and participant archetypes. By way of example, we present an overview of findings from spring 2010, during which eight participants submitted a total of 44 journal entries. They are referred to below as Participants A, B, C, D, E, F, G, and H (see Table 2).

Entries were first examined to determine overall themes. Discussions of teaching methods were most prominent, particularly group learning methods that were deployed in tandem with SciTrain U workshops on the topic. Five out of the eight faculty participants—Participants A, B, F, H, and G—used various grouping and interactive learning mechanisms as tools for promoting students' learning through collaboration. The variety of formats included group note-taking, group assignment, group class presentation, in-class group work, group-based field experience, and group tests. In addition to group-based learning, participants tried developing better class materials and using other teaching methods in order to promote students' learn-

Table 2

*Summary of Journal Entries by SciTrain U Longitudinal Participants, Spring 2010*

| Participant | Number of Journal Entries | Course Subject | Main Inclusive Instruction Practices Used | School |
|---|---|---|---|---|
| A | 1 | Biology | Group note-taking, Group testing, Lecture podcast, Clickers, Online study materials, Posted PowerPoint (PPT)-slides, Extra exam time, Peer review evaluation | UGA |
| B | 6 | Math | Group note-taking and assignment, Peer review evaluation | GT |
| C | 4 | Health | Annotations, Online forum, Online chat room | GT |
| D | 6 | Biology | Online study materials, Online forum, Annotations, Adjusting physical environment | UGA |
| E | 3 | Chemisty | Extra exam time, Posting extended notes, Lecture podcast | GT |
| F | 2 | Astronomy | Group works in class, Color-coding the contents on ppt-slides. | UGA |
| G | 5 | Health | Group note-taking, Peer review evaluation | GT |
| H | 17 | Biology | A think-share-pair, Group works and assignments, Peer review evaluation, Field trip, Online forum, Inviting guest speakers for lab activity, A weekend work day | UGA |

ing. Participants A, E, and D provided online study materials, including animations, interactive tutorials, video clips, newspaper articles, PowerPoint lecture slides, and handouts. Other strategies to improve student learning included open-book, pre-lecture quizzes, lecture podcasts, making lecture notes available online, enhancement of classroom discussions through online forums and chat rooms, and the use of other instructional technologies.

Another theme involved student receptivity to these inclusive instructional methods. Most faculty participants reported that students gave positive feedback in response to their group-based learning. Participant A cited that about 90% students recommended continuing group tests in the end-of-semester survey because "group test helped them learn the material more effectively, made the class less impersonal, and helped them enjoy the class more." By contrast, some students complained about the group test/work, especially when they felt that their group was dysfunctional. In the same manner, Participant G found that the majority of students felt that group note-taking had an impact on improving their exam score. In the survey, students also remarked that "the group assignment made them attend class, read the information weekly, so that they stayed on track." Participant G cited one student's comment about the positive effect of group-based learning, representing that students learned how to cooperate with others by doing the group assignment. Near the end of term, Participant H contended that students had improvements in their public speaking skills as students reported being far more comfortable in front of class.

Students also responded to overall class materials and learning. Faculty participants A and D reported that students' comments about online course materials were positive as they found it useful. Participant A implemented an open-book pre-lecture quiz in order for students to learn those materials, but some students complained about this pretest. While students wanted to take the exam after all materials were covered in class, the instructor felt that students had been better prepared for class after using pre-tests. Participant C reported that many students had interest in using the online forum in that 70% of students posted at least once, and more than 50% posted five or more times during the semester. In the survey, many of the students answered that the use of the online forum for class discussion was effective in promoting their understanding of the course materials and suggested to continue the use of the forum.

Each faculty participant made comments specific to their students with disabilities. Participants A, G, and E provided students with documented disabilities extra exam time in a quiet room for individual tests in addition to accommodations already provided. Participant E generally allowed all students to have extended time to finish their exam, because "extra time let students have some time to think through the questions rather than to rush through and regurgitate facts that they have learned." Participants C, D, and F expressed concern about visual aids and materials for their students with visual impairments. More specifically, Participant C was worried about the graphical nature of online course materials, since they are very visual, while Participant D raised the serious issue of a poorly arranged classroom:

> There is insufficient control of the amount of natural light entering the room…the fluorescent lighting cannot be controlled at a sufficiently fine-grained level…when it is turned off, it is too dark to clearly read the chalkboard in much of the room…I can't imagine what it would be like for those who are visually impaired.

Participant F used color-coding for information that was left off of posted class slides so that students could easily identify what is missing, assuming that this would be a disadvantage for colorblind students. Interestingly, there were no students with identified visual impairments enrolled in the class.

Four of the faculty participants (B, D, G, and H) have been enrolled in the SciTrain U project since its inception, allowing evaluators to document change-over-time impacts through analysis of the online journals. For example, Participant B noted positive experiences with the group note-taking assignments in fall 2009, especially where student engagement was concerned. This experience, however, shifted after the participant faced a cheating issue in a subsequent term, when one group downloaded other groups' notes and re-posted it as their own work. Although Participant B still believed the effectiveness of the group-based learning, preventing student cheating became a prerequisite and, hence, an implementation challenge for continuing this method. In addition to warnings about the consequences of academic dishonesty, the participant added a peer review component to the grade. After using the peer evaluation system in spring 2010, Participant B found that peer evaluation was not as effective as hoped. Many groups gave perfect scores to the members of the team regardless of their contributions.

Finally, journal entries were analyzed to discern participant-specific development in order to determine whether any archetypes emerged as a result of their participation in the project. Three broad categories of faculty participants were identified: Enthusiast, Skeptic, and Incremental Adopter. During the spring 2010 period, both Participants B and H were recognized as Enthusiasts based on their interest in further developing the group-based learning as effective pedagogy for promoting student learning. Participant B demonstrated particular enthusiasm for implementing group note-taking and group peer evaluation and ended the term with plans to improve the pattern of group study and add group projects to grade components in the future. Participant H found group-based learning to be very effective throughout the one-year period of study. By contrast, Participant D was a consistent Skeptic about the use of online forums to enhance classroom learning for the two semesters. This instructor encouraged students to discuss materials online, but very limited student participation led the instructor to answer most of the questions. In addition, the participant found that the online forum lacked the tools necessary to describe and write mathematical equations, a technical issue that has yet to be remedied. Falling between the archetypes of enthusiast and skeptic, Participant G represented the Incremental Adopter. This instructor found that prescribed group-based learning appeared to work well, as the majority of students commented that group notes were useful. However, the participant showed mixed feelings about the effect of the methods. While the quality of group note-taking as well as interaction in the class was improved, this instructor was not sure if this had a positive impact on students' grades. Participant G noted several implementation challenges stemming from the large, lecture-based course in which the approach was used. Despite these concerns, this instructor ended the term with plans to continue refining the methods in order to make them suitable for the class format.

## Limitations and Challenges

While this article calls attention to the successes of SciTrain U through a discussion of its evaluation methodology and findings, the project was beset by a number of challenges. In addition to evaluating project outcomes, evaluation personnel were also tasked with internal assessment in order to determine challenges in need of resolution. In this article, we highlight two challenges in particular: relatively low enrollment by students with documented disabilities and difficulty securing longitudinal participants and faculty champions. While these challenges persisted throughout the project, the leadership team attempted to resolve these and other issues identified through the internal assessment process.

### Internal Project Assessment

Internal assessment is accomplished through the application of the SII (Strengths, Areas for Improvement, and Insights) model as part of internal quarterly reporting (Wasserman & Beyerlein, 2007). These reports are used to summarize evaluation activity, identify effective programmatic results from which synergy can be built in related areas, pinpoint areas of immediate need along with specific advice to address those needs, and provide data that may be generalized to similar program efforts elsewhere. The SII reporting model is used to provide periodic ongoing assessment of program activities and the evaluation process itself.

Patton (1997) challenges evaluators to understand that evaluation use must be facilitated and emphasizes that it rarely, if ever, happens by chance. To ensure that the evaluation plan and findings provided useful, actionable information, the evaluation team presented timely information to allow for program modifications. As evaluation findings through the SII process have surfaced, the principal investigator and other personnel have worked to address identified challenges. Some of these improvements have included modifications to curriculum, instruction, and delivery methods; changes in technical assistance approaches and other dissemination methods; targeting specific support communities for more extensive training and assistance; and identifying potential new resources and partnerships not currently apparent. As these challenges are resolved, some have come to constitute project strengths.

**Student-Side Engagement**

SciTrain U is designed primarily as an instructor-oriented project in the sense that faculty training represents its main focus. Nevertheless, engagement of students, especially those with documented disabilities, remains fundamental. More practically, the enrollment of students with disabilities in SciTrain U courses is vital for evaluation of the project's efficacy. Enrollment was lower than expected during the first two years, complicating the generalizability of performance evaluations. Relatively low numbers of students in SciTrain U-affiliated courses undermined the statistical significance of data gathered through the evaluation process. In addition, there was a more fundamental need to determine the broad impact of the project on students.

In order to address recruitment of students, particularly at Georgia Tech, a GRA was tasked to the disability resource center. In addition to gathering demographic and performance data on behalf of the evaluators, the GRA served as a student liaison. During the summer, the head of disability services and the GRA held events at all six of the freshman and transfer orientation sessions. They met with incoming students with disabilities and parents regarding SciTrain U and the possible benefits it could offer, as well as pre-registering any students expressing an interest. As a result of these efforts, enrollment in project affiliated courses has grown substantially. Though the data have yet to be analyzed, a total of 44 students were enrolled for the fall 2010 term, substantially more than the baseline enrollment of 18 students with disabilities.

An online survey instrument for evaluating student perceptions of the accessibility of SciTrain U courses was also developed and distributed. Collecting self-report data from students enrolled in the courses of participating faculty, the survey gauges student perceptions about inclusion within the university and classroom environment as well as the accessibility of instructional methods and materials. While written ostensibly to obtain feedback from students with disabilities, the survey was designed to be administered meaningfully to all students in a course. Another key rationale of the survey is to collect data that can be roughly correlated to the findings of SciTrain U's classroom evaluation instrument. While this survey does not ask the same specific questions as that instrument, it broadly probes the same areas: the physical classroom environment, professor awareness of student needs, written materials (i.e. textbooks, course packets, handouts), oral communications (i.e., lectures, discussions), and evaluation of student learning (tests, exams).

While such student feedback has the disadvantage of not probing specific items of interest in the SciTrain U classroom evaluation instrument, the instrument does confer a number of potential benefits. First, it provides some measure of the impact of SciTrain U on students themselves. While evaluators may assess through classroom observation how well instructors are putting workshop and online course module lessons into practice, this instrument provides a means for comprehending, if only in a rudimentary fashion, what such practices mean for the student. As this survey can be given at both the beginning and end of a course, it is also possible to gauge change over time. Second, the instrument is open-ended so that students can elaborate on issues that are important to them, allowing direct evaluation of programmatic impact on STEM education for students with disabilities and indirect evaluation of the program's impact on all students. While student-self reporting was not listed as an original evaluation tool, this instrument and its findings will help augment the evaluation of the effectiveness of SciTrain U through its correlation with classroom observation findings and by probing other dimensions of the program.

**SciTrain U Scholars Program**

One persistent challenge identified through the SII process has been a need for more faculty involvement in the SciTrain U project, especially at Georgia Tech. To address this need, project leadership developed the SciTrain U Scholars program to improve outreach through the use of faculty champions. A total of eight faculty members at Georgia Tech participated in the SciTrain U Scholars program during fall 2010. Among their primary activities, the group was tasked with making faculty contacts on behalf of the project (including individuals to pilot the online materials), giving presentations on their activities, and providing feedback on their involvement with the project.

A total of 32 contacts were made during this period, including six tenure-track faculty, eight non-tenure track faculty (i.e. academic professionals), and nine teaching assistants. Of this number, 27 were confirmed as online course participants. The main departments represented in these activities included mathematics, biology, mechanical engineering, aerospace engineering, computer science, applied physiology (i.e. health/

wellness), and learning services. Also, a total of 14 presentations were made, including five department meetings and three external conferences.

Scholars noted that the online tutorials provided significant feedback on their teaching and led to the adoption of more inclusive teaching methods in many cases. In terms of engagement with administration, they reported some success, including school chairs, curriculum committees, and several deans. When asked about challenges, a lack of time was the overwhelming response. In particular, there was a constant call to shorten the online course modules. Budget cuts and the continued lack of involvement by tenure-track faculty were also identified as challenges. Despite these issues, however, the project leadership has found this program to be relatively successful in boosting outreach efforts.

### Discussion and Relevance for Practitioners

As a large-scale project designed to support and enhance postsecondary STEM education for students with disabilities, SciTrain U is representative of similar projects sponsored by National Science Foundation's (NSF) Research in Disabilities Education (RDE) and the U.S. Department of Education's Office of Postsecondary Education (OPE), and other federal agencies. Such projects are mandated to demonstrate their efficacy and potential for improving outcomes for these students, yet there is relatively little published on the evaluation of such projects. The evaluation approach discussed in this article may be of use for investigators seeking novel means to discern the effectiveness of these projects.

In order to maximize evaluation efforts, our project took a mixed-methods approach that may be relevant for similar projects. Several of our instruments are now being deployed at the beginning and end of each term. In addition, reliability is enhanced, where possible, through the use of multiple raters. The use of these instruments has allowed for data triangulation, whereby the various instruments provide different perspectives of the same project element under consideration. Feedback forms and focus groups provide unique insights into the workshops, while classroom observations, student surveys, and online journal reflections allow for a multi-perspective examination of longitudinal participation. In short, our use of multiple instruments that permit for triangulation has facilitated richer data analysis.

### Conclusion

As a case study for the evaluation of programmatic interventions to enhance postsecondary STEM education for students with disabilities, the authors believe that SciTrain U contributes to scholarship and practice. The multi-faceted approach taken by the project evaluators, characterized by a mixed-methods approach that documents project effectiveness through longitudinal participants, may be of use for similar projects. Given a dearth of scholarship on the evaluation of programs to enhance STEM education for students with disabilities, this article seeks to provide some insights into the potential for mixed-methods approaches.

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## Authors' Note

This research is sponsored by the Office of Postsecondary Education, U.S. Department of Education, under grant number P333A080022. The opinions contained in this publication are those of the grantee and do not necessarily reflect those of the U.S. Department of Education. The authors wish to thank Melissa Ann Crane, Chris Langston, Brendan Leahy, Katie McNulty, David Morton, Stephen Rehberg, Esther Shin, Devon Thompson, Margaret Totty, Laura Waters, Joyce Weinsheimer, and Jungwon Yoon for their contributions. In addition, we wish to acknowledge that NSF Grant No. HRD-0929006 facilitated the publication of this article.

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