Faculty Efficacy in Creating Productive Learning Environments: Universal Design and the Lens of Students with Disabilities

Tristan T. Utschig [1], Nathan W. Moon [2], Robert L. Todd [3], Aaron Bozzorg [4]

Abstract

We present findings from the SciTrain University project, particularly as it relates to faculty development efforts. SciTrain University is a program sponsored by the U.S. Department of Education to improve the accessibility of science, technology, engineering, and mathematics (STEM) education for students with disabilities. In this case study we investigate two broad research questions. First, what do participants learn about creating productive learning environments for all students, including disabled learners, as a result of program participation? Second, what actions have been elicited among various stakeholders toward improving the classroom learning environment, particularly for students with disabilities? In this paper we highlight some of the main features of SciTrain University including workshops and web modules for faculty development. We then introduce the project assessment and evaluation process. Next, we discuss the impact this project has produced for a set of 15 faculty participants. Impacts include transferring ownership of the learning process to students through several classroom activities such as group note taking; creating a greater sense of community through enhanced online communication tools such as forums; and expanding assessment of student learning into the classroom using multiple modes of learning within a class period. Finally, we discuss the potential broader impacts of the SciTrain University project.

Introduction

All students, including those with disabilities, should have equal access to and benefit from postsecondary education. Over 10% of the school-aged population includes students with disabilities. However, this figure decreases as students transition from high school into university education. An even smaller proportion of these students are enrolled as science, technology, engineering, and mathematics (STEM) majors. The numbers become more troubling when one considers that graduation rates for undergraduates run at about half the enrollment rates, and rates for graduate school are much lower.

Part of the problem involves professors and faculty advisors who are unable or unprepared to recognize the problems faced by students with disabilities. They are unaware of the accommodations needed by these students, as well as strategies or technologies available to help STEM students with disabilities. In addition, students with disabilities, including those with learning disabilities, often encounter negative attitudes and perceptions from faculty and other students. In many cases, these students are discouraged from majoring in STEM courses of study, and those who persist are often not taken seriously in their efforts as learners.

In order to address these issues, the U.S. Department of Education's Office of Postsecondary Education (OPSE) has sponsored a number of projects to ensure that students with disabilities receive a quality higher education. One of these projects is SciTrain University, a collaborative effort between the Center for Assistive Technology and Environmental Access at the Center for the Enhancement of Teaching and Learning at the Georgia Institute of Technology, and the Disability Resource Center at the University of Georgia. SciTrain University is designed as a multi-faceted program to enhance the capacities of STEM instructors at the university level and to create a more effective learning environment.

SciTrain University is based around a combination of in-person workshops and web-based training modules for postsecondary STEM faculty, aimed at helping them understand issues of accessibility and the accommodation needs of students with disabilities. In addition to addressing access problems faced by students with disabilities, these resources train teachers to generate their own ideas and solutions for accommodations, with the desired result being improved STEM education for students.

The model for change adopted by the SciTrain University project is consistent with Rogers' diffusion of innovation (2003). This model is described specifically in terms of faculty development both by Bergquist and by Kuhlenschmidt in Gillespie and Robertson's *A Guide to Faculty Development* (2010). In this model the project researchers serve as "innovators/explorers." The project then targets a group of early adopters or "champions" who have displayed an interest in the program. These faculty then participate in the project-sponsored workshops and agree to review materials and/or to participate in a longitudinal study during a period of time in which they work to implement various innovations in their classrooms. It is hoped that the lessons learned from this

[1, 2, 3, 4] Georgia Institute of Technology

group (along with the successes they have in adopting various innovations introduced at the workshops) will diffuse to the early majority as they realize the benefits that can be gained with a reasonable implementation effort.

In this paper we present findings from SciTrain University's work with faculty in these developmental efforts to address the needs of students with disabilities. The results of this case study address two broad research questions. First, what do participants learn about creating productive learning environments for all students, including disabled learners, as a result of program participation? Second, what actions have been elicited among various stakeholders toward improving the classroom learning environment, particularly for students with disabilities?

Below, we outline the problem addressed by the SciTrain University through a brief literature review. We then highlight some of the main features of SciTrain University, including workshops and web course-modules for faculty development. Next, we discuss the impact this project has produced for a set of 15 faculty participants. Finally, we conclude with a brief discussion of the progress to date, future efforts, and the broader picture of what the SciTrain University project is set up to accomplish.

Literature Review

The Lack of Participation of Students with Disabilities in STEM

Professors and faculty advisors are frequently unable or unprepared to recognize the problems faced by students with disabilities (Stefanich, 2007). Faculty and staff are frequently unaware of strategies or technologies that may be used to perform common STEM tasks that would accommodate the needs of students (Stefanich, 2001). In addition, students with disabilities, including those with learning disabilities, often encounter negative attitudes and perceptions from both faculty and other students (Stage & Milne, 1996). These students are frequently discouraged from majoring in STEM fields, and when they take these classes, they are often not fully included in the rigorous work (DO-IT Staff, 2001).

Despite policies and laws to promote inclusion, research in STEM education reveals that teachers are still not providing accommodations in the learning environment for their students with disabilities (Stefanich, 2007). Faculty must be provided with adequate training to recognize, assess, and accommodate the needs of students with disabilities, and be provided with supports to encourage them to adopt the training.

Individuals with disabilities make up about 13.7% of the school-aged population based on numbers reported by IDEA (National Center for Education Statistics, 2002). But in 2003-2004, students with disabilities made up only 11% of students enrolled in undergraduate education and 9-10% of the students enrolled in STEM (National Science Foundation, 2006). This group included over 173,000 students, a significant number who could be at risk for inadequate accommodations. The numbers drop further in graduate school to 5%. Since the late 1990s, only 1% of STEM doctorate recipients have had a disability. As a whole, students with disabilities tend to perform less well in college than might be predicted by their high school performance, and significant numbers of them do not follow through to the completion of their STEM educations (Wilczenski & Gillespie-Silver, 1992). To further illustrate the problem, national studies have shown that, compared with their non-disabled peers, students with disabilities enroll in and complete postsecondary education programs at half the rate, and, up to two years after leaving high school, about 4 in 10 youths with disabilities are employed as compared with 6 in 10 same-age out-of-school youth in the general population (National Center for Education Statistics, 2002; National Longitudinal Transition Study, 2005). This data indicates that readily available accommodations could make a substantial difference in success rates for these students.

The Need for Readily Available Accommodations

Most students with disabilities need accommodations to participate equally in STEM educational activities (Stefanich, 2007). While some institutions have learned to provide accessible textbooks, note takers, and exams, they are rarely as successful in providing accommodations for students in STEM classes, particularly those involving laboratories (Stefanich, 2007).

Accommodations and models to include all students in STEM education do exist, and are growing in range and effectiveness (Burgstahler, 1994). Georgia Institute of Technology's NSF-funded *Developing Accessible Laboratory Experiments* and *SciTrain* projects have created important resources in STEM education that benefit all students. Many accommodations are relatively simple and low-cost and are easily implemented by STEM instructors with the proper knowledge and training (Stefanich, 2001). Accommodations can include providing magnifiers and measuring devices with large or raised numbers for students with low vision, or tactile graphics to document equipment setup or the shape of a mathematics formula (Milchus, Goldthwaite, McKelvy, & YiLeon, 1999). Students with dexterity limitations can be assisted by virtual dissection materials and lab tools with large handles. Students with learning disabilities can gain from cooperative endeavors among students, peers, tutors, and faculty (Stage & Milne, 1996). However, none of these accommodations will be successful without faculty who are ready and able to implement them. Such abilities are not present a priori in most cases, and must therefore be developed and cultivated.

Faculty Development Activities

The training and professional development services provided by the SciTrain University project are designed to lead to improvements in classroom instructional practice among recipients of those services. SciTrain University has initially offered all faculty development services in person, with the eventual goal of providing all of these resources online. These services support the project's primary participants and/or other interested faculty. They are described in Table 1, below:

Table 1 Faculty Development Activities

Faculty Development Activity	Mode of Delivery	Current Target Audience
Workshops	in person	study participants and other interested faculty
Journal reflections	online	study participants
Classroom observations	in person	study participants
Focus group discussions	in person	student participants

In the long run, online education may be the most effective way to train the maximum number of postsecondary faculty and staff. With the exception of classroom observations, each of the services above will eventually be provided online. The online environment provides a cost-effective means of reaching the target audience, which is a large, diverse, and geographically widespread population. Online teacher training is growing in acceptance for many reasons, chief of which is its 24/7 availability to teachers nationwide who may have limited time and budgets for training (SciTrain, 2001). Online courses are especially appropriate for teachers in rural settings who are often far from urban training centers and who are without access to in-person training. Although we recognize that no educational effort is guaranteed to be successful (especially without careful program or activity design), several studies have suggested that participants in online education actually score higher than those in traditional classrooms (National Center for Education Statistics, 2002; Allen & Seaman, 2007). Nonetheless, participants in the initial group were offered primarily in-person activities because materials were still being developed for placement online. These same participants then reviewed the online materials once they were available.

Participant Selection

The SciTrain University project operates as a partnership between the Center for Assistive Technology and Environmental Access and the Center for the Enhancement of Teaching and Learning at the Georgia Institute of Technology, and the Disability Resource Center at the University of Georgia. In order to ensure its success, project leaders have targeted instructors at both institutions who can serve as participants longitudinally over the project's three-year term. Selecting participants from 4-5 STEM disciplines, especially those that have multiple teaching assistants under them, helped jump start our initial efforts to bring STEM classes into an accessible format. As described in the introduction, the project targeted a group of interested early adopters or "champions" from among these disciplines to form this initial group. These faculty then participated in the project-sponsored workshops. They also agreed to review drafts of online training materials and/or serve as longitudinal study participants during a period of time during which they would work to implement various innovations in their classrooms.

Much of the long-term success of the project depends upon the involvement of the study participants who have committed to participating in the program on a long-term basis. In addition to their important role as a base of support for expanding our efforts to reach larger numbers of faculty, their commitment allows us to gauge the effectiveness of the program in meeting the needs of the students it ultimately serves. Longitudinal study participants take part in all of the workshops and complete the online course modules. The longitudinal study participants are assessed in a number of ways to foster their development and gauge the overall impact of the program. Assessment activities include periodic classroom observations to determine the inclusion of programmatic elements in instructional activities, online journal reflections tied to the workshops, and participation in occasional focus groups.

A second set of faculty served as project "scholars" who reviewed the online course modules, and reflected on module relevance within specific disciplines; they attended in-person workshops, and helped to disseminate project resources. This group was not offered support for specific implementation of innovations in their own classrooms.

Training Workshops

A key element of SciTrain University has been the development of 1-2 hour workshops designed to engage STEM instructional faculty at Georgia Institute of Technology and the University of Georgia on the learning needs of their students and strategies for making the coursework more accessible. While SciTrain University is ostensibly designed to address the needs of students with disabilities, we stress the applicability of the workshops for all students. The workshops are facilitated with a focus on learner needs (Minderhout, 2007) and on constructive intervention (Liese, 2007).

During the workshops, participants apply the concepts and techniques to their own courses. For example, when addressing the use of electronic forums, the same electronic learning management system used for regular courses is applied in the workshop so that participants can see the techniques modeled for them during the workshop itself, and can immediately apply their new knowledge. Partners or small groups of 3-4 are often used to assess each other's implementation strategies during the workshops.

Post-workshop support is provided through mentoring via one-on-one consultations and through sharing of data from assessment and evaluation efforts (described below). In this way, buy-in is dramatically increased, and faculty participants are met wherever they are at on their educational journeys so that their growth can be facilitated effectively.

To date, we have conducted 9 workshops at Georgia Institute of Technology and 6 one-hour workshops at the University of Georgia. Key topics have included maximizing the institutions' online course components to improve student-instructor rapport, group note-taking with peer review of notes as a learning strategy, the use of electronic forums for student communication and reflection, the best use of images, tables, and charts in the classroom and online, and addressing electronic obstacles to learning.

Website

SciTrain University has also developed an extensive website containing information modules on how STEM faculty can provide accommodations for students with specific disabilities, a literature database containing over 200 journal references addressing STEM education at the university level for students with disabilities, and online workshop modules to complement (or to fully take the place of) the in-person workshops. The information modules have been designed to provide STEM instructors with some basic background on the types of disabilities they might encounter in the classroom, as well as to provide them with strategies for making material accessible to students with disabilities. Information categories addressed include transitioning from high school, universal design for learning environments, learning disabilities, attention deficit hyperactivity disorder, mobility disability and dexterity, deaf and hard-of-hearing, vision impairments and blindness, and disability laws. The workshop modules are designed around specific pedagogical accommodations that address the learning environment for all students, and particularly those with disabilities. Online workshop modules addressing large lecture classes, laboratories, and online learning environments have been created.

A robust documentation process has been necessary to capture what we have learned from our faculty who have been participating longitudinally in our study, our project scholars, and other stakeholders as they have attended workshops, struggled through the process of classroom implementation, and reviewed website materials. We have worked to document what these participants have learned about accommodating students with disabilities, and what types of actions have been elicited from participants as they transform various pieces of their classroom environments. The collection and analysis of this data are part of the project assessment and evaluation.

Project Assessment and Evaluation

Throughout the project, formative assessment has been used to provide iterative feedback regarding process, materials, and performance to ensure the most appropriate and effective project implementation. Evaluation of project outcomes against the standards set out in the project proposal has also been regularly addressed. The project assessment and evaluation plan is carried out by a separate team from those directly implementing the project in order to provide an objective perspective. The team consists of two assessment and evaluation professionals, each from a different department, along with several student assistants.

Criteria

Performance criteria for the project tied into 10 activities that have been conducted over a period of three years. These activities are shown below where those addressed specifically in this paper are shown in *italics*:

Research review, recruitment of STEM content expert consultants, focus groups on accommodating students with disabilities in STEM courses, integration with secondary education web resources, *delivery of in-person workshops, recruitment of STEM faculty participants, delivery of online workshops*, dissemination via conference presentations, *materials review by users*, materials revision.

The evaluation team is responsible for the process of data collection and analysis as these activities have been carried out. This process is guided by the use of a set of targeted assessment and evaluation questions pertaining to the activities and criteria. (Note: they are also designed to provide data for potential independent evaluation). These assessment and evaluation questions emerged from a logic model developed for the project.

Results of the assessment and evaluation process have been documented in regular quarterly reports that specifically address either how collected data can be used to improve the level at which project outcomes are met, or at what level the program has been performing relative to the originally proposed criteria. We are concerned here primarily with data related to our faculty participants and their development.

Users

Assessment and evaluation data are reported to the project team on a schedule that maximizes their use (Greene, 2007). In our case, this has been in the form of quarterly reports such that we can capture and synthesize knowledge during and after each semester of the project. Ongoing performance data (from event feedback forms, surveys, focus groups, and classroom observations) is offered to program staff as soon as it can be analyzed and communicated. In addition, program performance indicators detailing student course enrollments, completion, and grades are reported semester-by-semester; quarterly assessment feedback is synthesized and provided internally to the project team, and annual synthesis of the data is produced for external reporting needs. This evaluation team synthesizes data by combining two mixed methods approaches for synthesizing data: McConney, Rudd, and Ayres' Results Synthesis Method (2002) and Campbell's Pattern Matching method (1966).

The quarterly reports delivered by the evaluation team to the rest of the project team are formatted to include the SII model (Strengths, areas for Improvement, and Insights) described by Wasserman and Beyerlein (2007). This same approach is built into many of the instruments used for data collection from the various stakeholders in the project. Finally, Patton (1997) challenges evaluators to understand that assessment and evaluation use must be facilitated; that it rarely, if ever, happens by chance. To ensure that the evaluation plan and findings provide useful, actionable information, the evaluation team has worked with the project staff on an ongoing basis (sometimes daily) between reporting periods. This has allowed for a more robust modification of workshops; for example, workshop outcomes have been revised with each offering to better reflect and to clarify workshop participant performance criteria. It has also allowed smoother communication between project personnel and participants. For example, during a recent workshop, after a classroom observation activity with the evaluation team, one participant indicated that she would like to try a different approach than that agreed upon by others; this was communicated to project staff and quickly supported. This close working relationship has allowed a greater sense of community within the project where everyone is working together.

The results reported below, regarding longitudinal study participants' efforts to transform their classrooms, are consistent with the approach to assessment and evaluation described above. Multiple sources of data are used and compared such that generalizations are more meaningful. Also, after each classroom observation there is a discussion with longitudinal study participants, formatted much the same way that an SII is conducted, about participants' efforts to improve teaching and learning in their courses. The sources of this data are several specific instruments developed by the assessment and evaluation team.

Instruments

Several instruments have been designed that inform the faculty development process for SciTrain University. These are classroom observation forms, online guided journal reflections, focus groups, student surveys, and workshop feedback forms. The focus for this paper is on the classroom observation instrument and its results, though the other sources of data are cited to highlight themes, and demonstrate how the mixed-methods approach can be used to reinforce conclusions.

Classroom Observation Instrument

The classroom observation instrument was developed based on the concept of universal design for student learning (Bergstahler, 2008; DO-IT Staff, 2008). Much of the instrument is general in nature and would apply to any classroom setting (Pendleton-Parker, 2005); however, some items (such of the use of classroom note takers) were included due to their special focus within the SciTrain University project. In all, the instrument consists of 48 items (3 items were simple counts and 45 were categorical) that probe on six aspects of instruction. The full instrument is included in Appendix A. Briefly, the items are divided into the following general categories:

- Classroom Environment – 9 categorical items
- Visual Aids – 7 categorical items, one simple count
- Oral Communication – 9 categorical items, one simple count
- Classroom Assessment – 2 categorical items, one simple count
- Classroom Note Takers – 5 categorical items
- Electronic Learning Support – 13 categorical items

A corresponding "accessibility score" is derived from the 45 categorical items coded as Y, N, or N/A during the observation. Because the instrument and scoring methodologies have been refined at several points, some inconsistencies in the data are present. However, the assessment and evaluation team has determined that these changes that will ultimately lead to an improvement in the quality of data collection are relatively minor in terms of their overall impact on a longitudinal evaluation of the classroom observations. This instrument is the primary mechanism linking longitudinal study participant actions to the classroom environment. However, this tool has been supplemented with several other sources of data.

Other Instruments

Online guided journal reflections were developed to assist longitudinal study participants in documenting their teaching and learning efforts on a weekly basis. Reminders to enter journal entries were sent weekly via email to each participant. The online form provided space for free-form written reflection on the following:

- what innovations or accommodations the instructor attempted
- how the implementation went
- what impact the changes had on student learning

Focus groups were conducted with longitudinal study participants several times during the first two years of the project. The purpose of the focus groups was to bring to light issues that might impact student learning (in particular, for those students with disabilities). The focus group protocol was set up such that participants discussed the current situation on campus for students and then contrasted that with an ideal situation. Ideas relating to both strengths and areas for improvement were solicited regarding the current situation. This was followed by a discussion of potential actions that could be taken to move from the current to ideal situation.

Student surveys were distributed to all students in courses taught by longitudinal study participants. These surveys asked about the general learning environment on campus and how it addresses the needs of students with different learning styles or accommodation needs, particularly students with disabilities. This was followed by a set of similar questions addressing the specific course taught by the longitudinal study participant. Areas addressed in the survey included physical environmental factors, instructor awareness of accommodation needs for students with disabilities, instructor use of multiple approaches to learning when designing activities for students, accessibility of materials (electronic, print, etc.), and use of SciTrain University accommodation techniques addressed in workshops.

Workshop feedback forms were distributed to all workshop participants after each session. Participants first rated the workshop on how well it achieved the stated goals or outcomes. Then they were asked to provide a written SII on the workshop.

Results

In order to provide some context to our discussion about what longitudinal study participants have learned and done, a few general results are provided first. We first address the scope of the project; then the classroom observation form data is discussed. This is our primary set of results for this paper. Finally, the results from the classroom observation form (showing improvement in accessibility of longitudinal study participant classrooms) are supplemented by results of student surveys showing higher accessibility in the classroom, by more insightful comments on workshop feedback forms, in focus groups, and in online journal reflections as time progressed for longitudinal study participants.

Project Outcomes

By the end of the first year, SciTrain University's workshops had reached a total of 30 unique faculty members at Georgia Institute of Technology and the University of Georgia. This number approximately doubled over the next two years. In addition, a total of about 4,000 students had been impacted by the program at the two institutions during the first year. If one only counted longitudinal study participants, who provided the greatest impetus for the program's success, a total of 2,204 students received exposure to SciTrain University based on data from the first year of the project.

Classroom Observations

We employed a project-specific instrument for classroom observations to evaluate the accessibility of instruction for our longitudinal study participants. Our procedure involves observing each participant twice per term: once within the first 3 weeks of the term, and again with a follow-up observation in the last 3 weeks of the term. This schedule has been generally effective, though some challenges periodically arise in scheduling timely observations. For example, some classes such as labs or those with projects may end typical class instruction a week or two earlier than others. Also, unexpected scheduling changes and conflicts have led to some missing data in our twice-per-term ideal. These challenges have demonstrated the value of careful planning and communication by the team. The process has become more systematic and has steadily improved the quality of our observational data. Of particular note is the utilization of two scorers for each observation. The pairing of observers has provided us with the opportunity to provide some reasonable measure of interrater reliability when presenting results to participants and in analyzing data trends. The same scorers are involved in both the beginning-of-term and end-of-term observations for any individual faculty member.

Over the course of three terms, the team has completed 80 total observations of 15 longitudinal study participants. Four of the participants have been involved continuously throughout the three terms of the study, and five of the participants have been involved for two terms. The remaining six participants have only a baseline measure of one term. This information is summarized in Table 1:

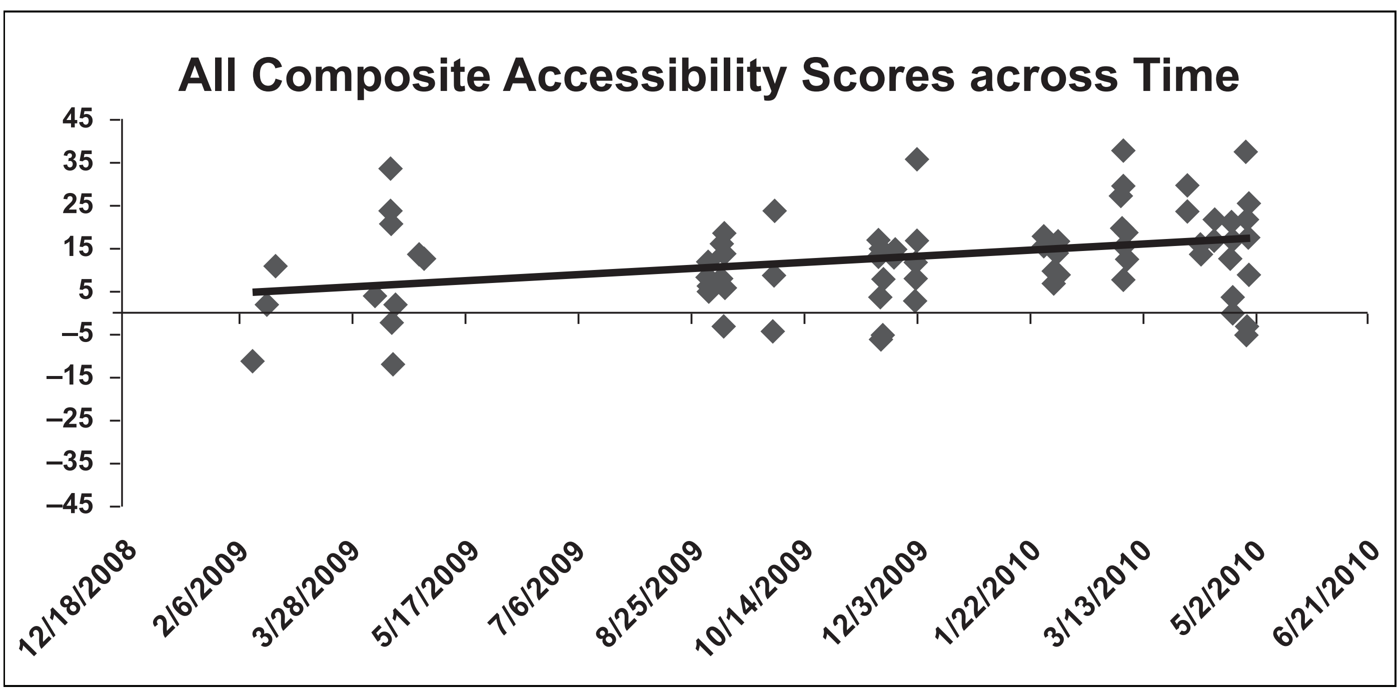
Accessibility scores are calculated as a sum/composite of the 45 items on the observation form (see categories above and individual items in Appendix A) with a maximum of score of 45 and a minimum score of -45. "Yes" is coded as a "1"; "No" is coded as a "–1"; and "N/A" is coded as "0" {Y = 1, N = –1, n/a = 0}. Then we take each individual item and add the numerical values to create a sum by which we can compare participants.

Table 2 Number of Faculty Observations

Participant	1	2	3	4	5	6	*7	*8	*9	10	11	*12	*13	*14	*15
# of Observ	10	6	10	8	8	8	3	1	1	7	7	2	1	4	4
Terms Involved	3	2	3	2	2	2	2	1	1	3	3	1	1	1	1

*excluded in mutli-term analyses, too few observations

Figure 1 Change in Accessibility Scores across Time



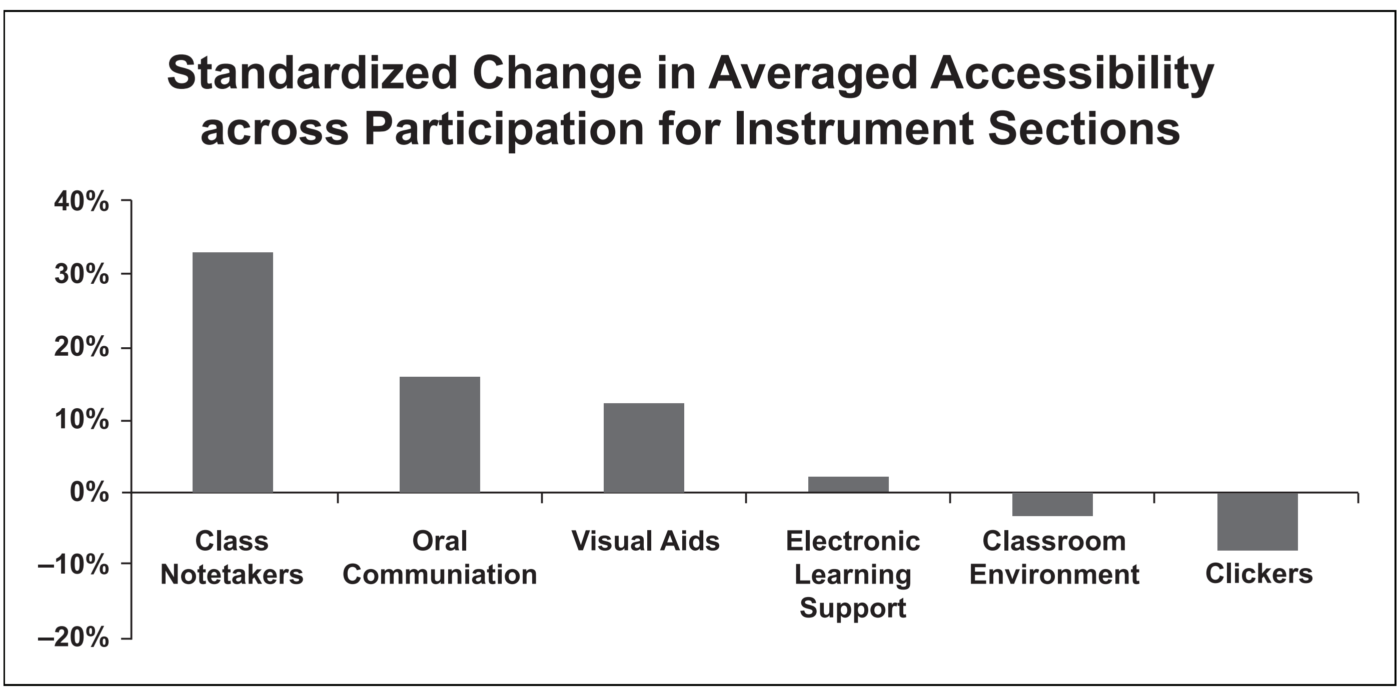
The graph in Figure 1 presents the long-standing participants' accessibility scores averaged across all of their observations. "Long-standing" refers to those participants with a minimum of six observations recorded; hence, Participant 7 did not qualify, even though he/she was technically a "multi-term" participant. All single-term participants are excluded as well. The data collected clearly illustrates a trend of increasing accessibility scores over time as our longitudinal study participants have developed over the course of the SciTrain University project. Also, note the increased number of observations through time. This is due to the addition of new participants as the project has grown.

The next stage of analysis requires that we break down what has happened to cause this increase in accessibility scores among longitudinal study participants. Below, we see the percent change in accessibility across the participant pool as a whole with respect to each of the six sections of the observation form. As described above and as shown in Appendix A, each of the sections of the classroom observation instrument probes on a particular aspect of classroom pedagogy: 1) classroom environment, 2) visual aids, 3) oral communication, 4) "clickers" (i.e. electronic personal response system), 5) class note takers, and 6) electronic learning support (i.e. course management software). Change over time is demonstrated by section-specific scores of all longitudinal study participants in a given term. The change in accessibility was calculated by comparing the first to the final observation on record for each participant. Positive change shows an increase in the final accessibility score as opposed to the beginning. Negative change shows a decrease in the accessibility score. The percentage values shown in the graph come from dividing the raw change in section item scores by the number of items (or the highest possible score in each section).

SciTrain University held workshops throughout the run of the project. The themes for each workshop revolved around specific accommodation techniques consistent with the principles of universal design for student learning. For example, one focused on in-class note taking, in which students worked in teams to produce, share, and review their notes during each class period or over a set of class periods. Another focused on electronic learning support, where students were guided to reflect on difficult course concepts, discuss issues that they were facing, or interact with the instructor and other team members to help form a sense of community — something especially important for some students with disabilities who may normally feel excluded. Because of the workshop emphasis in these areas, one might expect significant positive changes in these areas. However, post-observation meetings with instructors may have focused on other parts of the form as well. Oral communication and visual aids are particularly easy to observe, for example. Nonetheless, we see mixed results.

The graph in Figure 2 is ordered to reflect the greatest areas of improvement, by category, in average accessibility scores among our longitudinal study participants. The improvement in class notetaking

Figure 2 Change in Accessibility Scores by Instrument Section



suggests faculty efficacy has positively shifted regarding using student teams to produce high quality notes. This was a key focus for the workshop developer during the terms under consideration. The data for classroom environment suggests a slight decrease in accessibility, but the classroom location is typically not within the control of the instructor, and therefore these scores are sometimes difficult to increase despite the best intentions of the instructor. In addition, a few instructors showed decreases in their accessibility scores. At least two of these decreases were due to initial scores on the instrument that were very high. The assessment and evaluation team had suspected errors/noise generated in data from inconsistent observations between observers and between institutions. The ratings for these instructors decreased in subsequent observations after the observers had the chance to discuss the use of the instrument with the assessment and evaluation leadership team. It should also be noted that some of the participants had more data available than others because of longer participation, and thus had more time to “improve” their scores. This accentuates the need for an increase in consistency of measures across institutions for more accurate capture of the intervention’s success.

Of note, when the same data is analyzed within terms the changes are very small. Thus, for the most part, it seems that the changes in the accessibility scores are happening between terms and not within them. One possible reason for this includes the fact that instructional design changes can be difficult to implement once a course has started, so instructors wait to begin anew the following term. Another possibility could be changes in class locations between terms, which would lead to differences in the classroom environment section.

Lessons Learned

Although overall accessibility scores trended up, variability in the trendlines for change in accessibility scores of individual participants above is supported by analysis of those longitudinal study participants’ journal reflections. Three archetypes representing different types of participants were developed from the journal reflections: the “enthusiast” (these tend to have high positive changes in accessibility scores), the “incremental adopter” (these tend to have slow but steady increases in scores), and the “skeptic” (these may show decreases when new classroom approaches are tried, but then abandoned or changed quickly when difficulties arise).

Workshop attendance and feedback about the topics addressed (electronic forums and classroom note takers, in particular) reflect strong views about an area which tends to show perhaps the most variability in scores among individual instructors: electronic learning support. Part of the classroom note-taking activities implemented by instructors involves online learning support for that activity, and the electronic forums are conducted completely within the electronic learning support items from our instrument. Thus, it is no surprise that scores vary a bit wildly in the electronic learning support area while instructors implement their innovations.

Focus group discussions tended to focus on electronic learning support and aspects of the physical classroom environment. In early focus group discussions, and with those who attended workshops but did not join as longitudinal study participants, there tended to be a view that these areas were ripe for positive change but were somewhat out of their control. When one looks at the standardized change in accessibility scores for the classroom observation instrument (meaning across all participants for initial and final observation accessibility scores), these two areas were the most stable. That is perhaps consistent with the view that these areas are out of one’s control.

Finally, student surveys show that students generally feel quite satisfied with the learning experiences at their respective institutions, but feel slightly more positive about their experiences with longitudinal study participants. This is consistent with the positive (and increasing) accessibility scores generally shown previously.

Conclusions and Recommendations

Detailed analyses of classroom observations, workshop feedback forms, student surveys, journal reflections, and focus group results are ongoing. Preliminary analyses have provided some insights to compare classroom observation data to other data sources. In particular, data from this faculty development effort has shown an overall positive trend in faculty efficacy regarding accessibility in their classrooms. The use of classroom note takers working in teams has perhaps shown the most consistent positive gains in producing learning environments that accommodate all students, and especially those with disabilities. However, significant variation in levels of success has occurred and not all areas of accessibility have increased. Some faculty have even displayed decreases in their accessibility scores over their first few semesters of participation as they work with new techniques. Thus, a prolonged and consistent relationship with the faculty participants is essential if long-term positive results are desired for all. Exposure to alternative techniques can get participants motivated, but that excitement does not automatically translate to success. The teaching and learning journey has peaks and valleys that cannot be easily predicted.

Through a robust internal process of continuous assessment across both web and in-person training materials, the SciTrain University project has now created a tested set of online tools including information modules about specific disabilities and faculty development workshops utilizing the concept of universal design. These tools can be accessed by individual faculty anywhere, any time. However, it is our belief that a community working together to implement concepts of universal design will more effectively address the needs of students with disabilities (and all students) in STEM courses. Further, many sources of data are needed to illuminate changes in faculty efficacy when aiming to create quality learning environments. We provide one tool here, the classroom observation instrument, and describe the components of several others that can be used in conjunction with the SII approach to analyzing performance. Overall, these tools support faculty development efforts with an eye towards universal design that can, in particular, empower the learning of our students with disabilities.

References

Allen, I. E., & Seaman, J. (2007). *Online nation: Five years of growth in online learning.* Needham, MA: Sloan Consortium. Retrieved 3/13/08 from http://www.sloan-c.org/publications/survey/pdf/online_nation.pdf

Bergquist, W. H. (2010). *Afterword*. In K. J. Gillespie and D.L. Robertson (Eds.) *A guide to faculty development*. (2nd ed.) (397-418). San Francisco: Jossey-Bass.

Burgstahler, S. (1994). Increasing the representation of people with disabilities in science, engineering and mathematics. *Information Technology and Disability*, *1*(4).

Burgstahler, S. (2008). *Equal access: Universal design of instruction: A checklist for inclusive teaching*. Seattle: DO-IT, University of Washington.

Campbell, D. T. (1966). Pattern matching as an essential in distal knowledge. In K. R. Hammond (Ed.), *The psychology of Egon Brunswik* (81-106). New York: Holt, Rinehart, & Wilson.

DO-IT Staff (2001). *The winning equation: Access + attitude = success in math and science*. Seattle: DO-IT, University of Washington.

DO-IT Staff (2008). What are some hints for communicating with individuals who have disabilities? How teachers can fully include students with disabilities. DO-IT article #102. Seattle: University of Washington.

Gillespie, K. J., & Robertson, D. L. (Eds.). (2010). *A guide to faculty development* (2nd ed.). San Francisco: Jossey-Bass.

Greene, J. C. (2007). *Mixed methods in social inquiry.* San Francisco: Jossey-Bass.

Kuhlenschmidt, S. (2010). Issues in technology and faculty development. In K. J. Gillespie & D. L. Robertson (Eds.), *A guide to faculty development* (2nd ed.) (259-274). San Francisco: Jossey-Bass.

Leise, C. (2007). Constructive Intervention. In S. W. Beyerlein, C. Holmes, & D. Apple (Eds.), *Faculty guidebook: A comprehensive tool for improving faculty performance* (4th ed.) (369-372). Lisle, IL: Pacific Crest.

McConney, A., Rudd, A., & Ayres, R. (2002). Getting to the bottom line: A method for synthesizing findings within mixed-method program evaluations. *American Journal of Evaluation, 23*(2) 121-140.

Milchus, K., Goldthwaite, J., McKelvy, G., & YiLeon, C. (1999). *Developing accessible science experiments*. Atlanta: Center for Rehabilitation Technology, Georgia Institute of Technology.

Minderhout, V. (2007). Identifying learner needs. In S. W. Beyerlein, C. Holmes, & D. Apple (Eds.), *Faculty guidebook: A comprehensive tool for improving faculty performance* (4th ed.) (363-364). Lisle, IL: Pacific Crest.

National Center for Education Statistics (2002). *Digest of education statistics.* Retrieved 9/1/04 from http://nces.ed.gov/programs/digest/2006menu_tables.asp

National Center for Education Statistics (2000). *Digest of education statistics.* Retrieved 9/1/04 from http://nces.ed.gov/programs/digest/2000menu_tables.asp

National Longitudinal Transition Study-2 (NLTS2). (2005). Retrieved 5/04/08 from http://www.nlts2.org/

National Science Foundation (2006). Women, minorities and persons with disabilities in science and engineering. Retrieved 5/19/08 from http://www.nsf.gov/statistics/wmpd/disability.htm

National Center for Education Statistics (2003). *Distance education for public elementary and secondary school students: 2002-2003*. Retrieved 5/02/08 from http://nces.ed.gov/surveys/frss/publications/2005010/

Patton, M. Q. (1996). *Utilization-focused evaluation: The new century text* (3rd ed.) Thousand Oaks, CA: Sage.

Pendleton-Parker, B. (2005). *Observation protocol: Teaching through lecture*. Atlanta: Center for the Enhancement of Teaching and Learning, Georgia Institute of Technology.

Rogers, E. M. (2003). Diffusion of innovations (5th ed.). New York: Free Press.

SciTrain (2007). SciTrain online knowledge base. http://www.catea.gatech.edu/scitrain/

Stage, F. K., & Milne, N. V. (1996). Invisible scholars: Students with learning disabilities. *Journal of Higher Education*, *67*(4), 426-45.

Stefanich, G. (Ed.). (2007). *The ontogeny of inclusive science*. Self-published.

Stefanich, G. (Ed.). (2001). *Science teaching in inclusive classrooms: Theory and foundations.* Self-published.

Wasserman, J. & Beyerlein, S. W. (2007). SII method for Assessment reporting. In S.W. Beyerlein, C. Holmes, & D. Apple (Eds.), *Faculty guidebook: A comprehensive tool for improving faculty performance* (4th ed.) (465-466). Lisle, IL: Pacific Crest.

Wilczenski, F. L. & Gillespie-Silver, P. (1992). Challenging the norm: Academic performance of university students with learning disabilities. *Journal of College Student Development*, *33*(3) 197-202.

Appendix A: Classroom Observation Instrument

SCITRAIN U

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

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

Classroom Environment	**Y**	**N**	**N/A**	**Notes:**
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 students' lives	☐	☐	☐	
★ Attempt to link to or build upon previous content	☐	☐	☐	
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 students' names	☐	☐	☐	
★ Lectures to the entire class	☐	☐	☐	
Clearly audible from back of room	☐	☐	☐	
Clearly explains visual aids	☐	☐	☐	
Gives clear instructions for student activities	☐	☐	☐	
Instructions for student activities repeated	☐	☐	☐	
Student interaction actively facilitated	☐	☐	☐	
★ Student activities are relevant to class	☐	☐	☐	
Summarized major points	☐	☐	☐	
Number of student questions in general: ______				
Clarity:________ Comprehension:______				

Note: Starred items were modified from the original version of the instrument and implemented in Fall 2010.

Classroom Diagram

SCITRAIN U

Teacher: **Course:**

Assessment	**Y**	**N**	**N/A**
Assessment techniques/tools used	☐	☐	☐
If used, students are able to easily connect	☐	☐	☐

If used, how much _____ #instances
______/ _______/ _______ # items per instance

Classroom Note Takers	**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	☐	☐	☐

Note: Starred items were modified from the original version of the instrument and implemented in Fall 2010.