Impact of Faculty Development on Classroom Accessibility as Measured Using a Classroom Observation Instrument

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Abstract

SciTrain University is a U.S. Department of Education-sponsored program to improve the accessibility of science, technology, engineering, and mathematics (STEM) education for students with disabilities. This paper builds on previous work describing more general issues regarding the efficacy of faculty in creating productive learning environments. Specifically, this new research explores how faculty who are exposed to principles of universal design for learning (UDL) in STEM courses change their observable behaviors in the classroom over time. Through persistent, targeted, personalized attention, these faculty gained experience and expertise in addressing the learning needs of all students, and in particular those with disabilities. We first very briefly highlight some of the main features of SciTrain University, including workshops and web course-modules used for faculty development. Then, we discuss the impact this development has produced in the classroom for a set of 18 longitudinal faculty participants as seen through the lens of a classroom observation instrument developed to assess classroom accessibility and inclusion for learners. Results indicate that accessibility scores increase, on average, about 5-7% per year. We then conclude by offering some recommendations for process educators, based on our research findings, that address ways to improve performance in making one's classrooms more accessible and inclusive.

Introduction

As outlined in Utschig et al. (2011), all students, including those with disabilities, should have equal access to and should benefit from postsecondary education. However, the fraction of students with disabilities who persist through the various levels of undergraduate and graduate postsecondary education shrinks with the level of degree. This is particularly true in STEM fields, where approximately 10% of undergraduates enrolled in STEM fields have a disability, but only 1% of doctorate recipients have a disability. Part of the issue may lie with teaching and learning environments that are not suitable for learners with disabilities, compounded by lack of awareness on the part of instructors about ways to accommodate the learning needs of these students. As such, we address the following research question: **In what ways do faculty who are exposed to principles of universal design for learning in STEM courses change their observable behaviors over time to produce more accessible and inclusive learning environments?**

In particular, we are interested in the levels of *accessibility* and *inclusivity* of learning environments for all learners, especially as they pertain to students with disabilities.

"Accessibility" can be defined as the degree to which materials such as text, websites, images, audio, or video are usable. This includes factors such as the readability of text in terms of contrast or color choice on PowerPoint® slides; whether handouts or other visuals are well organized and uncluttered; whether the instructor's voice is clearly audible, whether major points are clearly summarized or identified, etc. "Inclusivity" can be defined as an attribute of a learning environment such that is does not exclude any student from full participation in learning processes or activities. This includes things like reminding students about classroom etiquette, avoiding the use of stereotypes, providing multiple ways to learn, being proactive in facilitating student participation during activities, etc. Both accessibility and inclusivity naturally fall under the broader concept of universal design for learning (UDL). UDL is a set of principles for curriculum development that gives all individuals equal opportunities to learn (See http://www.udlcenter.org/aboutudl for a very brief introduction). Thus, the UDL philosophy undergirds choices one makes for instructional goals, methods, materials, and assessments (Burgstahler & Cory, 2008; Rose & Meyer, 2006; Rose, Meyer & Hitchcock, 2006). A more complete description of UDL follows, in the section, Background on Universal Design for Learning (UDL).

SciTrain University, sponsored by the U.S. Department of Education's Office of Postsecondary Education award No. P333A080022, is designed as a multi-faceted program to enhance the capacities of STEM instructors at the university level to create more accessible and inclusive learning environments. In this paper, we specifically address the impact of SciTrain University as measured using our classroom observation instrument to score classroom accessibility. The results obtained from analysis of classroom observation data address several of the key evaluation questions for SciTrain University:

- What percentage of SciTtrain University-trained faculty incorporate elements of training into their classrooms?
- What do participants learn as a result of program participation?
- What actions are the various stakeholders taking toward improving content/pedagogical knowledge, organizational capacity, and available resources?

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The SciTrain University classroom observation instrument can be a valuable tool to facilitate self-assessment for those who would like to improve their performance in making their learning environments more accessible and inclusive for all students. Further, the broad use of this tool aligns with the goal of continuous improvement from an institutional perspective, and with the development of Process Education™ practices such as self-assessment, peer assessment, and an intentional focus on the learning environment.

For the benefit of the reader, we provide context for our current work first by very briefly summarizing the content of our previous work (Utschig, Moon, Todd, Bozzorg, 2011) regarding faculty efficacy in using the concepts of universal design to create productive learning environments. Next, we provide an in-depth review of approaches to classroom observation. We then discuss in detail how we implemented classroom observation in our context, and we review the design of our instrument. Next, we present results produced using our classroom observation instrument over a three-year period. Finally, we offer some concluding thoughts about how the results of our study can inform the process educator in finding ways to improve accessibility in the classroom.

Background Discussion

Brief Description of SciTrain University

SciTrain University has been a three-year project that involved a total of over 100 STEM faculty at Georgia Tech and the University of Georgia. Of these, 18 faculty have participated as *longitudinal study participants* who interacted intensely with the project over multiple semesters. These participants were typically non tenure-track faculty or tenured faculty who taught large introductory courses, so there was little impact on promotion and tenure processes. Each participant received a stipend of between $600 and $1200, depending upon the specific actions in which they agreed to participate. The activities undertaken by all longitudinal study participants are described in Table 1.

Longitudinal participants were asked to take part in faculty development workshops approximately three times per semester. The workshops focused on improving accessibility and inclusion of STEM instruction. SciTrain University initially offered all workshops in person, and slowly transformed the resources used such that they were available online by the end of the project. At the end of the project, the content of the in-person workshops was expanded and converted into online course modules, which were piloted by key participants (see http://www.catea.gatech.edu/scitrainU/). Longitudinal participants also agreed to take part in several assessment activities to document the efficacy of these efforts. These included weekly entries into online journals and participation in focus groups. Finally, the longitudinal participants agreed to allow project personnel to observe their classrooms twice per semester. Following the observations, project evaluators offered feedback during post-observation face-to-face discussions in the form of an “SII assessment” in which they described the strengths of the instructors’ performances, areas of performance that could be improved, and insights gained from the assessment process (Wasserman & Beyerlein, 2007). In addition, participants received scanned copies of completed classroom observation forms from each evaluator via email for later reference. These feedback sessions were scheduled to occur as soon as possible after the observations. Activities such as online journals and classroom observations, while ostensibly used for the purpose of project evaluation, also functioned as professional development tools through the reflective experiences they offered to participating faculty.

Longitudinal Participants for SciTrain University are included in Table 2.

Table 2 Participant details by department and university

School	Department	# of Participants	Total
Georgia Tech	Chemistry	2	9
	Health Sciences	3	
	Mathematics	3	
	Biology	1	
University of Georgia	Biology	4	9
	Chemistry	1	
	Computer Science	2	
	Physics	1	
	Mathematics	1	

Table 1 Activities of study participants

Faculty Development Activity	Mode of Delivery	Target Audience
Workshops	In person	Longitudinal study participants and other interested faculty
Journal reflections	On line	Longitudinal study participants
Classroom observations	In person	Longitudinal study participants
Focus group discussions	In person	Longitudinal study and student participants

Again, in our previous paper (Utschig, Moon, Todd, Bozzorg, 2011), we discussed additional details about the faculty development process, and reported some early results of the project.

> By the end of the first year, SciTrain University's workshops had reached a total of 30 unique faculty members at Georgia Tech 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 in the first year. If one only counted longitudinal participants, who provided the greatest impetus for the program's success, a total of 2,204 students have received exposure to SciTrain University based on data from the first year of the project.

Background on Universal Design for Learning (UDL)

Certain accommodations are simply that—accommodations for overcoming or minimizing a certain barrier encountered because of an individual student's disability. As such, accommodations work primarily as interventions customized to a student's specific learning needs. However, the broader goal of accessible and inclusive pedagogy can benefit all students in the classroom, regardless of disability, and it is this principle that underpins UDL. These "design for all" principles can work to the benefit of all students in the STEM classroom or laboratory, while also fulfilling the role of accommodations for students with disabilities. In the area of STEM education, Steele (2008) expresses a preference for classroom modifications and learning accommodations based on UDL concepts, with the intention of improving learning for all students in the mainstream classroom. For example, classroom pedagogy and activities based around a single, unifying theme in science may benefit students with learning disabilities who have memory, attention, or organizational skill deficits. At the same time, quality activity design from a UDL perspective will improve performance for the class as a whole.

There are a number of ways in which UDL may be realized in the classroom. As one of the hallmarks of UDL, presenting material through multiple means has long been established as one of the most efficacious methods for accommodating students with disabilities and ensuring inclusive learning for all students. Research supporting the use of multiple formats to provide access to course content, especially for the benefit of students with learning disabilities, is relatively robust (Orr & Hammig, 2009; Fuller, Bradley & Healey, 2004).

In the area of lectures, a number of studies have pointed to the use of supports such as guided notes to improve student learning. Most of these studies relied on student reporting of outcomes, but some studies have employed a more rigorous approach to determine their impact. Among these was an early case study design employed by Lazarus (1993) and a more recent investigation by Ruhl and Suritsky (1995).

Backward design, a pedagogical method that involves structuring activity design, facilitation, and assessment around desired learning goals and objectives, represents a relatively new approach in UDL, and an approach more aligned with Process Education. Only 4 of the 38 studies referenced by Orr and Hammig addressed this theme. Research on the usefulness of this method for students with disabilities has been conducted via surveys (Hill, 1995), focus groups (Madaus, Scott, & McGuire, 2003), and case studies (Brothen & Wambach, 2003; Sullivan, 2005), all of which suggest the potential of the approach.

Review of Classroom Observation Approaches for Faculty Development

The use of classroom observation as a tool for enhancing instructional effectiveness is well-documented at the K-12 level (McCutcheon, 1981; Desimone, Porter, Garet, Yoon & Birman, 2002). Yet, interest in and methods to support their implementation have increased substantially over the past two decades. Two factors explain this development. First, in the wake of reform-oriented mandates such as the 2001 No Child Left Behind Act, school system administrators have utilized classroom observations alongside standardized "high-stakes" evaluation to document teacher effectiveness (Smith, Desimone, & Ueno, 2005). Second, there has been a concomitant increase in interest regarding the use of peer observations as a mechanism for professional development (Supovitz & Turner, 2000). This is consistent with peer coaching in Process Education (Cordon, 2007). In response to these two drivers, the literature on classroom observations has grown tremendously over the past decade.

Comparatively less has been written about the application of instructor observations at the postsecondary level, particularly in the United States. University systems in other nations, especially the United Kingdom, have institutionalized the process of classroom observations (commonly known as peer observation of teaching, or PoT, in the UK) as part of formal evaluation criteria for higher education (Quality Assurance Agency, 2000; Hammersley-Fletcher & Orsmond, 2004).

Classroom Observations in General Higher Education

While classroom observations may not necessarily be prescribed within colleges and universities in the United States, many institutions of higher learning include offices or departments to advance the professional development of instructional faculty. Supporting these efforts has been a nascent, yet focused literature on improving postsecondary instruction through the application of observations (Braskamp & Ory, 1994; Seldin, 1999; Brent & Felder, 1997). There has also been a complementary push to adapt frameworks and methodologies for K-12 classroom observations, including seminal texts such as Amidon and Flanders' (1967) *The Role of the Teacher in the Classroom*, for the postsecondary environment (Gilbert & Haley, 2010). In lieu of formal preparation for university-level instructors, and given the lack of evaluation tools to document effectiveness, interest in the potential of classroom observations has increased in recent years, whether such observations are conducted by faculty peers, as in the concept of peer coaching or peer assessment, or by outside evaluators.

Coinciding with growing interest in observations are concerns about their purpose and approach. Hatzipanagos and Lygo-Baker (2006) criticize the use of observations as "managerial" devices by university administrators, suggesting that the evaluative (or summative) nature of such observations may amount merely to "ticking boxes." Conversely, an assessment mindset (referred to as "formative approaches" in the literature here) for observations focused on deepening of understanding, critical reflection, and enhancement of teaching practice, may provide a more effective rationale for their adoption. In any case, elements that are pivotal to the success of these efforts are supportive and non-intimidating environments, feedback and interactive discussions, and conceptualizations of these observations as being ongoing, developmental processes rather than single occurrences. Hammersley-Fletcher and Orsmond (2005) have framed this same concern somewhat differently by arguing that the most effective observations tend to be more concerned with "reflective practices" than "best practices." For the authors, reflective practice involves the "process of teaching and the thinking behind it, rather than simply evaluating the teaching itself" (p. 214). They contend that observations and other teaching evaluations are most effective when addressing the "why" of instructor practices rather than the "how."

In certain contexts, observations may be utilized by administrators to ensure a certain quality of instruction (Hatzipanagos & Lygo-Baker, 2006; Lawson, 2011). However, it is their use for professional development (i.e. peer coaching in the context of Process Education) that is most common in colleges and universities in the United States. A number of studies have indicated the effectiveness of classroom observations as tools for the improvement of teaching. In their study of Australian university tutors (i.e. equivalent to teaching assistants or postgraduate adjunct professors in American universities), Bell and Mladenovic (2008) found that peer observations held great potential for improving teaching practices, transforming perspectives about the role of faculty, and facilitating collegiality. Their study of 32 observations found that 94 percent of participants found the practice valuable, while 88 percent indicated that they would change their pedagogical practices as a result of findings from evaluations.

Despite their potential worth, other studies have noted considerations that make their blanket adoption more difficult. Of particular concern is the need for strong rapport between the observer and teacher being observed. Though there are differences according to discipline, Hammersley-Fletcher and Orsmond (2004) suggest that formal procedures for conducting peer observations may be most effective. Structured or standardized processes for conducting observations may help ensure shared understandings by everyone involved and maximize the potential for faculty development, as echoed in the Process Education literature (Jensen, 2007; Apple, 2007; Utschig, 2007; Utschig and Apple, 2009). Another aspect that may prove beneficial is the participation of experienced or recognized instructors on observation teams. Observations, especially when deployed for the process of faculty development, are essentially assessment processes that require teachers to question or interrogate the effectiveness of their own pedagogies (Hammersley-Fletcher and Orsmond, 2004; Hammersley-Fletcher, 2005). For this reason, observations may become more meaningful when a junior faculty member receives the benefit of feedback from more experienced peers. Such practices may reinforce the formality of observations and ensure that professional boundaries are maintained for the benefit of faculty being observed. Kohut, Burnap, and Yon (2007) presented findings from a study indicating that both observers and observees (or assessors and assessees in the context of Process Education) consider the process of peer observation valuable. Interestingly, the same study suggested that observers may experience higher levels of stress than the instructors being observed.

Appropriate feedback and interpretation of findings matter tremendously. Dresel and Rindermann (2011) have underscored the importance of context for teaching evaluations. In their study of student evaluations of their instructors, the authors found that counseling instructors on the interpretation of these evaluations was essential for the improvement of teaching quality. In Process Education, this is indicative of the skill of turning evaluative feedback into assessment feedback. As the use of student evaluations of teaching effectiveness continues to increase, other authors have reached similar conclusions regarding the importance of consultations or counseling to help interpret evaluation findings and maximize their utility for faculty development (Penny & Coe, 2004). Similarly, immediate constructive feedback is fundamental for the success of peer observations (Hammersley-Fletcher & Orsmond, 2004). Observed teachers may benefit not only from post-observation discussions, but also from pre-observation sessions that help to reinforce shared understandings between observer and observed, as well as permit observers to understand some of the key concerns that instructors may have about their own pedagogies.

Regardless of the motivation for undertaking classroom observations—whether as an evaluative measure of teaching quality or as an assessment process for facilitating faculty development—implementation and methods also matter. One study has underscored the need for a variety of instruments for observations, though written narratives may be most effective (Kohut, Burnap & Yon, 2007). Nevertheless, a number of authors have offered varying instruments and procedures for undertaking observations (Washer, 2006; Trujilo et al., 2008; Sawada et al., 2002). The effectiveness of each of these instruments and protocols is limited to the studies in which they are presented, making it difficult to prescribe any one of them as ideal.

Despite differences in the specifics of classroom observations, scholars tend to agree on general principles for their effective use, such as the importance of making it a formal process, having strong instructor-observer rapport, and the delivery of feedback that is appropriate. Perhaps more helpful than specific instruments or protocols is the more general guidance on the approach and philosophy of conducting classroom observations (Hatzipanagos and Lygo-Baker, 2006; Hammersley-Fletcher and Orsmond, 2005). Siddiqui, Jonas-Dwyer & Carr (2007) offer 12 specific tips in particular that may help maximize the utility of observations for faculty development. In addition to the aforementioned guidelines, the authors' insistence on clarifying expectations, maintaining objectivity, having respect for specific teaching styles, and making the observation a learning experience are notable. More implicit, but equally valid, is their advice that observations be adaptable to the need. Rather than prescribe a particular kind of observer or instrument, they stress that any selection be appropriate to the need or objective at hand.

Application of classroom observations is not free of challenges. One notable issue is the difference between faculty perceptions and actual findings regarding the use of observations to improve teaching skills. In a study involving the use of self-report questionnaires alongside objective structured teaching evaluations (OSTEs) over a three-year period, Julian, Appelle, O'Sullivan, Morrison and Wamsley (2012) found that despite statistically significant improvements in self-reported teaching skills, faculty experienced no corresponding improvement in their teaching evaluations. Despite high acceptance for the use of observations among faculty, as well as their incorporation of lessons and feedback from the OSTE process, participation in observations do not necessarily guarantee improvements in pedagogy. Similarly, Tournaki, Lyublinskaya, and Carolan (2011) have pointed to the limitations of observations as part of professional development programs to improve instructor practices. In a study involving 153 teachers, professional development involving observations resulted in improvements in only one of three domains of teacher effectiveness. While teachers' scores regarding instruction improved through the application of observations, planning and preparation and classroom environment scores failed to improve. The authors concluded that even high-quality professional development, including observation, does not always address all domains of teaching.

Classroom Observations for STEM Instruction in Higher Education

The application of classroom observations in science, technology, engineering, and mathematics (STEM) teaching environments has received attention by educational researchers. The National Science Foundation (NSF) has sponsored a number of projects to improve STEM instruction, several of which have involved faculty observations at some level. Sawada et al. (2002) reported on 22 NSF-funded Collaboratives for Excellence in Teacher Preparation. Despite a remarkable allocation of resources to this effort, the authors noted the difficulty of assessing the projects' effectiveness for collaborative reform. In response to this challenge, the Evaluation Facilitation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) developed the Reformed Teaching Observation Protocol (RTOP). The 25-item classroom observation protocol was oriented around three concerns for assessing STEM teaching excellence: adherence to standards, orientation toward inquiry-based teaching, and student-centered approaches for learning. Sawada et al. reported on data collected over a two-year period from 153 public school, college, and university STEM classrooms. A trained team of observers consisting of two faculty members and seven graduate students was able to achieve exceptionally high levels of interrater reliability. Student achievement measures demonstrate that reform, as defined by ACEPT and measured by the RTOP, was effective. Whereas RTOP utilized observations in a more supportive role to document the effectiveness of reform in STEM education, Wainwright, Flick, Morrell and Schepige (2004) have reported on more direct outcomes from observations.

However, it is the application of observations at the institutional and departmental levels that may be more relevant for faculty development. Commenting on the potential of peer observations (or peer coaching in the context of Process Education) for improving pedagogy in chemical engineering, Brent and Felder (1997) tout the potential of such practices to contribute to the evaluation of teaching if well designed and implemented, adding the caveat that they rarely are. To address this concern, the authors pose a number of questions applicable to the use of peer observations for STEM fields. The choice of a formative (assessment) or summative (evaluative) approach should inform the methods for undertaking the observations. In no case, they contend, should both objectives be undertaken in a single review. More practically, Brent and Felder recommend the use of multiple raters, particularly experienced teachers, who work together to reconcile their observations. They also advise several visits in a given term and the use of an instrument that accounts for class organization, presentation, (content) knowledge, and rapport.

Methods

Implementation of Classroom Observations During SciTrain University

Faculty participants were observed twice per term, and the same two raters (including at least one of the two lead project evaluators whenever possible) were involved in both beginning-of-term and end-of-term observations. These observations occurred once within the first 3 weeks of the term, and again with a follow-up observation in the last 3 weeks of the term. Each observation lasted for one entire class period. In order to expedite scheduling of observations and to avoid potential conflicts with tests or special activities, faculty participants were provided with advance notice of the days on which they were to be observed. Use of the same observers, as well as discussion of findings among raters at the end of each observation to resolve any inconsistencies, ensures some degree of reliability. The process has become more systematic in terms of the timeliness and quality of the observations.

The team has also developed an observation guide that accompanies the instrument, and it contains an item-by-item explanation to assist raters in making their observations. This guide is available upon request from the authors, as it is too lengthy to be included here. Both the instrument and guide have been subject to periodic review, and slight refinements have been made in response to prior experiences. 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 observations, raters first greeted the instructor to let them know they had arrived, and then sat in the back of the classroom where they could observe the instructor as they facilitated the class, and also observe student behaviors such as notetaking or the use of computers during the period. During certain learning activities the raters sometimes wandered around to observe what was happening more clearly. Observers marked an 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 response generally suggests that such adherence was not observed even though an opportunity to take action by the instructor was present. It is also important to note here that the design of the learning environment may automatically incorporate some items such that no explicit observable actions by the instructor are necessary and a “Y” cannot be recorded. In these cases, an “N/A” may be used. One example where this might occur in a Process Education classroom might be with the item “lectures to the entire class” (See description of the instrument below). In many cases this will simply not occur in a Process Education environment on a given day, even though all students are experiencing learning through activities or information designed/provided by the instructor. 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.

Finally, after the observation, the two raters discussed their findings with the instructor face-to-face. Feedback was provided in the format of “Strengths, Areas for Improvement, and Insights,” or SII assessment (Wasserman & Beyerlein, 2007) and, in addition, scanned copies of each evaluator’s results from the classroom observation form were provided to participants via email for later reference. This helped to build a culture of assessment rather than an evaluative interaction between project personnel and the instructors involved.

Description of the Classroom Observation Instrument

The classroom observation instrument itself was published in 2011 (Utschig, Moon, Todd, Bozzorg). As described there, the instrument was

> based on the concept of universal design for student learning (Burgstahler, 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 as the use of classroom notetakers) were included due to their special focus within the SciTrain University project.

Further, we drew upon the scholarly literature on UDL approaches to postsecondary classroom instruction (Orr & Hammig, 2009; Fahsl, 2007; Fuller, Bradley & Healy, 2004; Higbee, 2003). The resulting product thus represents many essential elements of accessible pedagogy. However, because the instrument and scoring methodology have been refined at several points, some inconsistencies in the data are present. These changes were made, in part, to lead to an ultimate improvement in the quality of data collection, and are relatively minor in terms of their overall impact on a longitudinal evaluation of the classroom observations. As described previously (Utschig, Moon, Todd, Bozzorg, 2011), the final version of the instrument was designed as follows:

> In all, the instrument consists of 48 items (3 items were simple counts and 45 were categorical) that look into six aspects of instruction. The items are divided into the following general categories:
>
> - Classroom Environment (primarily physical factors and relating to others): 9 categorical items
> - Visual Aids: 7 categorical items, one simple count
> - Oral Communication: 9 categorical items, one simple count
> - Classroom Assessment (“clicker” or personal response systems were of particular note here): 2 categorical items, one simple count
> - Classroom Notetakers: 5 categorical items
> - Electronic Learning Support (i.e. use of learning management system software): 13 categorical items
>
> A corresponding “accessibility score” is derived from the 45 categorical items coded as Y, N, or N/A during the observation.

Results

Classroom observation data are discussed as our primary set of results for this paper. We first present an overall perspective for the group of longitudinal participants as a whole. This is followed by information about how accessibility scores varied for individual participants.

Classroom Observation Results for All Longitudinal Participants Combined

Over the course of five terms, the team has completed 168 total observations of 18 longitudinal participants. Three of the participants have been involved continuously throughout the five terms of the study, three participants have been involved for four terms, three different instructors participated for three terms, and five participants were in two terms. The remaining four participants have only a baseline measure and are excluded in the multi-term analyses that follow, due to their low number of observations. This information is summarized in Table 3:

Table 3 Number of observations and active terms for each participant

Participant	# of Observations	Terms Involved
1	18	5
2	6	2
3	10	3
4	8	2
5	16	4
6	16	4
7	11	4
*8	1	1
*9	1	1
10	15	5
11	15	5
*12	2	1
*13	1	1
14	9	3
15	11	3
16	8	2
17	8	2
18	8	2

* excluded in multi-term analyses due to a low number of observations

Accessibility scores are calculated as a sum of the aforementioned 45 items on the observation form, with a maximum of 45 and a minimum of -45. “Yes” is coded as “1,” “No” is coded as “–1,” and “N/A” is coded as “0” {Y = 1, N = –1, n/a = 0}. The sum of these individual items is then categorized by simple ranges of “accessibility” in Table 4:

Accessibility scores ranged from –12 to 40.5 with the number of instances for each category displayed in the table above. If we were to look at the average score for all observations for each instructor included in our longitudinal sample, the range is 20 to 37 with the number of instructors showing average scores in each category also shown in Table 4.

Table 4 Distribution of accessibility scores

Score	Rating	Number of Instances	Number of Participants with Instances in this Range
–45 to –10	Poor	2	2
–10 to 10	Fair	23	10
11 to 30	Good	47	15
31+	Excellent	17	6

Figure 1 presents the multi-term participants' accessibility scores averaged across all of their observations. Here, "multi-term" refers to those participants with a minimum of six observations recorded. Hence, all single-term participants are excluded. This graph suggests that, when compared to the scoring rubric, all multi-term participants have "Good" or "Excellent" accessibility ratings in their classes.

We can see, in Figure 2, a trend of increasing accessibility scores over the duration of SciTrain University. Also, note the increased number of observations through time, as typically one or more longitudinal participants were added to the project each semester. With two exceptions, these participants continued to the end of the project, and so the general increase in scores indicates, primarily, improvement in scores for the individual participants over time rather than new participants who came into the project with higher scores than previous participants.

In Figure 3, we see the percent change in accessibility with respect to the six sections of the observation form. Each of these sections probes a particular aspect of classroom pedagogy: 1) classroom environment, 2) visual aids, 3) oral communication, 4) assessment techniques, 5) class notetakers, and 6) electronic learning support (i.e. course management software). Change over time is demonstrated by section-specific scores of all longitudinal participants in a given term. Positive change shows an increase in the end-of-term accessibility score when compared to the beginning of term. Negative change shows a decrease in the accessibility score for a term. The percentage comes by dividing the changes in score for each section by the number of items (or the highest possible score) in each section.

This analysis is shown for each of five terms at Georgia Tech and the University of Georgia. SciTrain University held workshops throughout the run of the project. Of note, the themes for each workshop for the first three terms displayed revolved around class notetaking and electronic learning support, while post-observation meetings with instructors and workshops in later terms evolved to also focus on other parts of the form. We see mixed results. Visual aids, oral communication, and class notetakers show the most consistent improvements. There is a steady increase in class notetaking across the entirety of the project, though there is a drop in the amount of improvement after the workshop focus changed to become more broad based in the last two terms of the project. Nonetheless, the consistent improvement in class notetaking suggests that the workshop was effective, since this was a key focus for the workshop developer during the terms under consideration. The quality of assessment techniques began to decline, but this might have been due to the lack of workshop focus or confusion for the rater, since the "how-to" manual was not updated after the observation tool was modified. Some inconsistency in the early data (meaning a mix of increasing scores and decreasing scores) may have been due to changes in personnel performing the observations. As a result, SciTrain University created an observation "how-to" manual to increase reliability in the use of the instrument.

Figure 4 shows that the greatest areas of improvement, by category, in average accessibility scores among our longitudinal participants are in class notetakers and electronic learning support. The change in accessibility was calculated by comparing the first to the final observation on

Figure 1 Average accessibility scores for multi-term participants across the entire length of their participation

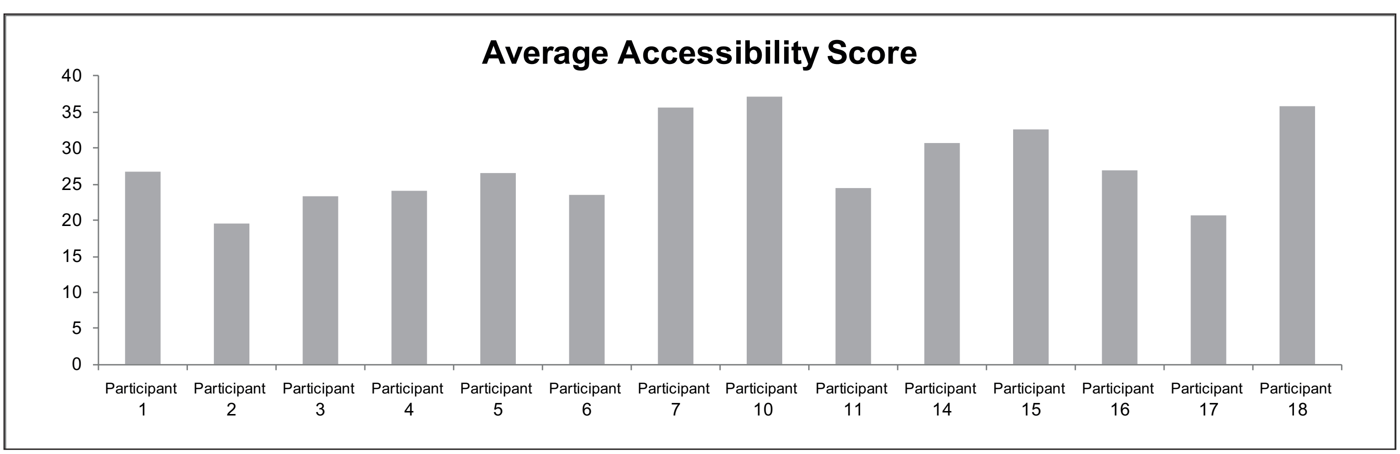


Figure 2 Individual accessibility scores recorded for all participants as a function of project duration.

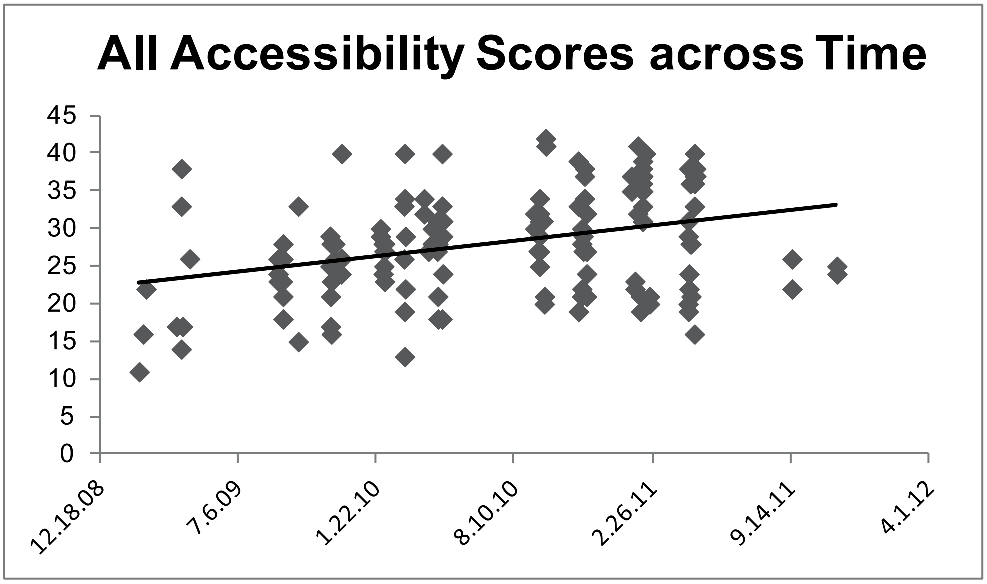


Figure 3 Percent Change in accessibility score by instrument section over all terms

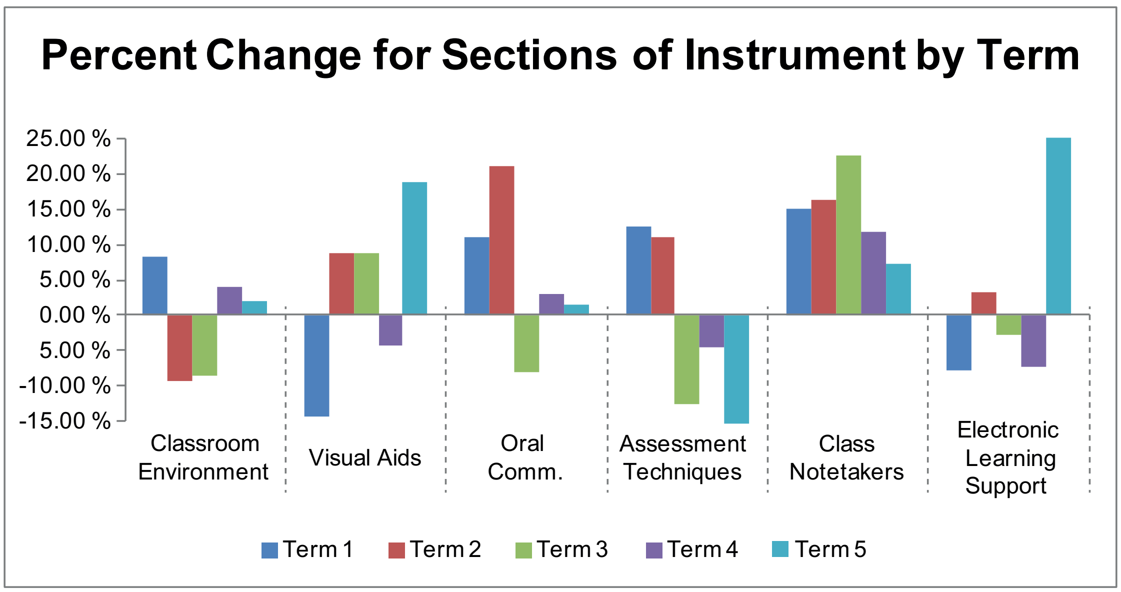
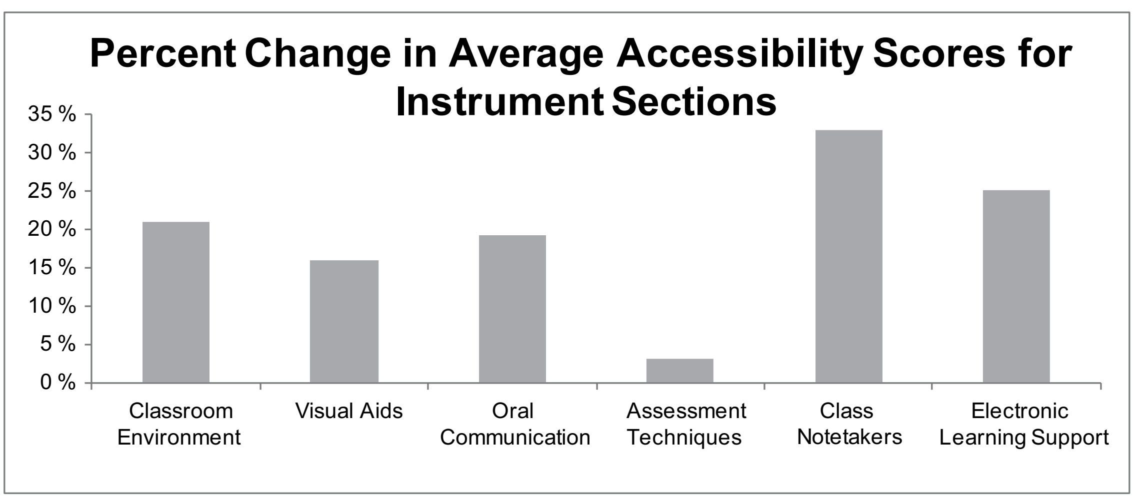


Figure 4 Percent change in average participant accessibility scores during the project, separated by instrument section.



record for each participant. Then these scores were ranked and converted to percents to control for the differing item numbers in each section, as discussed for the previous graph. Again, the item "class notetakers" has the greatest increase in accessibility score.

In Figure 5, we look at the individual instructors and see that non-longitudinal study participants responded equally to SciTrain U's interventions (i.e. in-person workshops and online course modules) designed to improve the accessibility of instruction. For the most part, we can see enhancements in accessibility. However, a few instructors showed decreases in their accessibility scores. 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 leadership team and began use the "how-to" guide. It should also be noted that some of the participants have more data available than others due to their longer participation, and thus had more time to "improve" their scores.

In each previous case, the accessibility score for the first (baseline) observation was subtracted from the last observation of each participant. Then, this change in accessibility was pooled and averaged for each institution. Again, we see a small but consistent increase in accessibility scores. There were two outliers in the data, one from each institution. When these two participants are removed, the average change in accessibility is +9% for Georgia Tech and +6% for University of Georgia. Both institutions have an increase in scores. This graph accentuates the need for increased consistency of measures across institutions for more accurate capture of the intervention's success.

If we look more closely at the observation, we can see changes in accessibility scores by institution and by sections of the instrument (again the two institutions are shown as different colors: Georgia Tech is blue, University

Figure 5 Percent changes in accessibility score during the project by each participant, ordered by magnitude of percent change

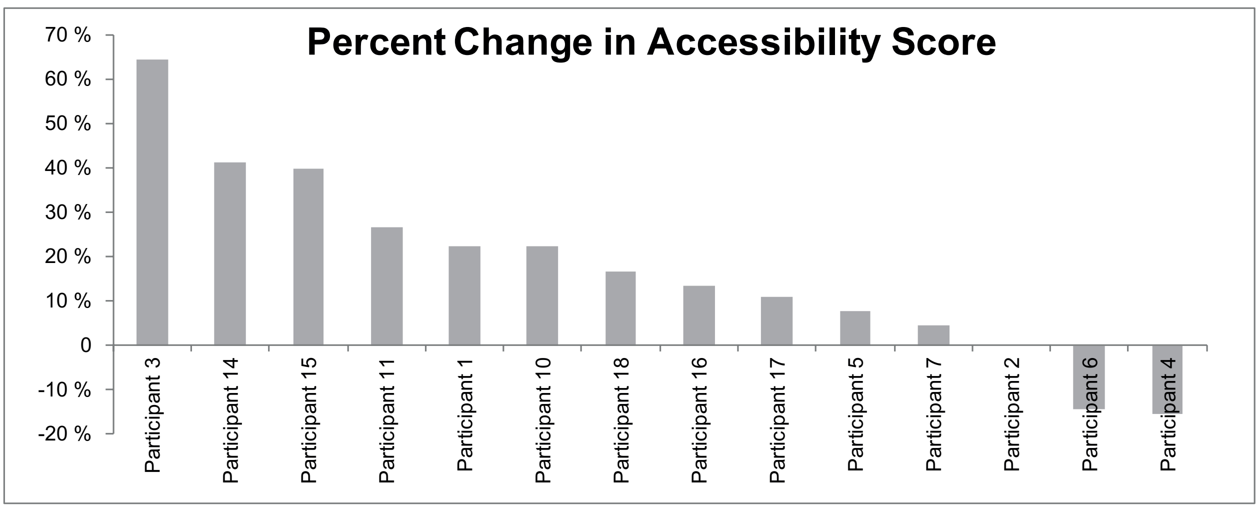
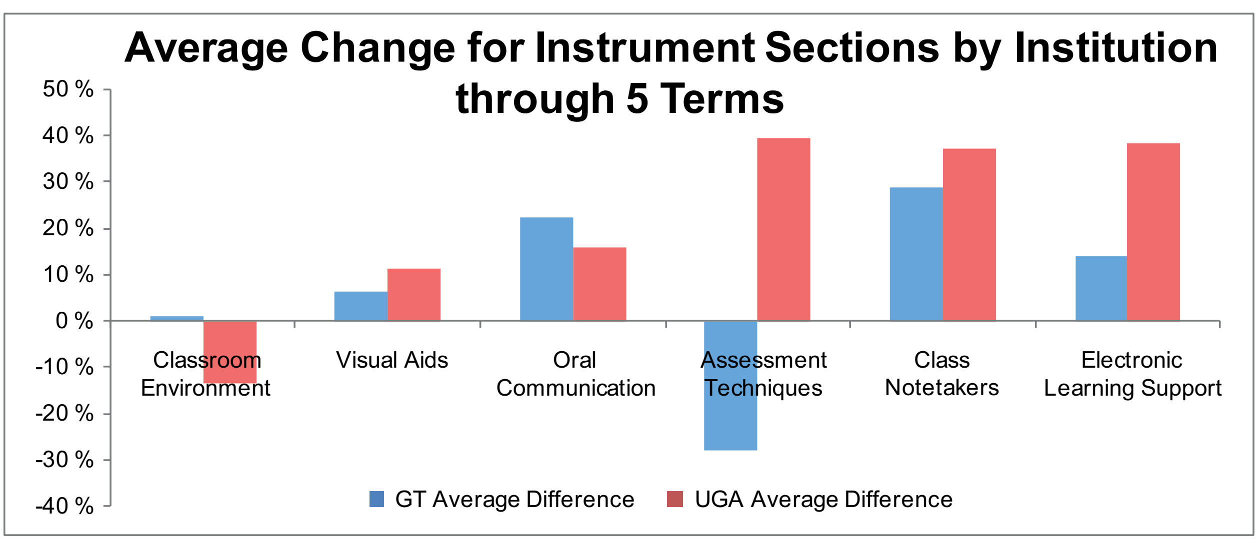


Figure 6 Percent change in accessibility scores by instrument section and by university through all 5 terms of the project



of Georgia is red). This shows more specifically where the gains and losses in observations originate and lead to a new focus for training of our instructors specific to the institution.

Classroom Observation Results for Individual Longitudinal Participants

We now present the graphs of three participants that have had at least 6 observations throughout their participation. Each of the following pages is an overview of an individual longitudinal participant with a table of useful information at the bottom of the page and a summary of the observer comments for that participant. The changes visualized in the second graph highlight changes within the term, the difference between the end-of-term and start-of-term observations.

Of note, participants begin with a very wide range of initial accessibility scores (ranging from poor to excellent). There is also a wide range of change, from highly positive for Participant 3 to slightly negative for Participant 4. In Participant 4's case, this change is due in part to frustration over technical difficulties with online tools for mathematics, causing that participant to abandon earlier efforts. This is noted in the decreases for electronic learning support for this instructor. Conversely, Participant 3 showed the greatest positive change in accessibility score, due in part to the large increase in electronic learning support utilized by that individual.

Conclusions and Recommendations

Our research findings suggest a number of issues relevant to Process Education. Based on those, we offer some broad recommendations for the development of more accessible and inclusive pedagogy and instructional environments. Although UDL focuses on both physical classroom design and facilitation techniques, we mainly address facilitation techniques for UDL in this section.

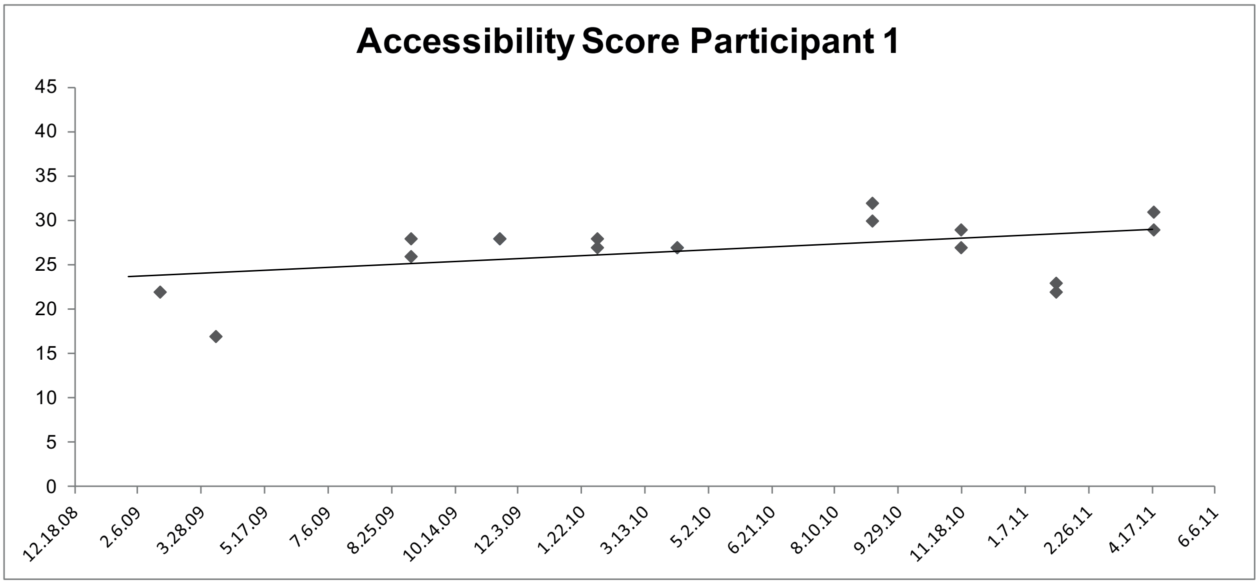
Gradual Improvement over Time: First, our research found that overall improvements in classroom accessibility occurred incrementally over a period of several years. This gradual process of moving toward more accessible and inclusive learning environments suggests that a "longitudinal" mindset is required for success.

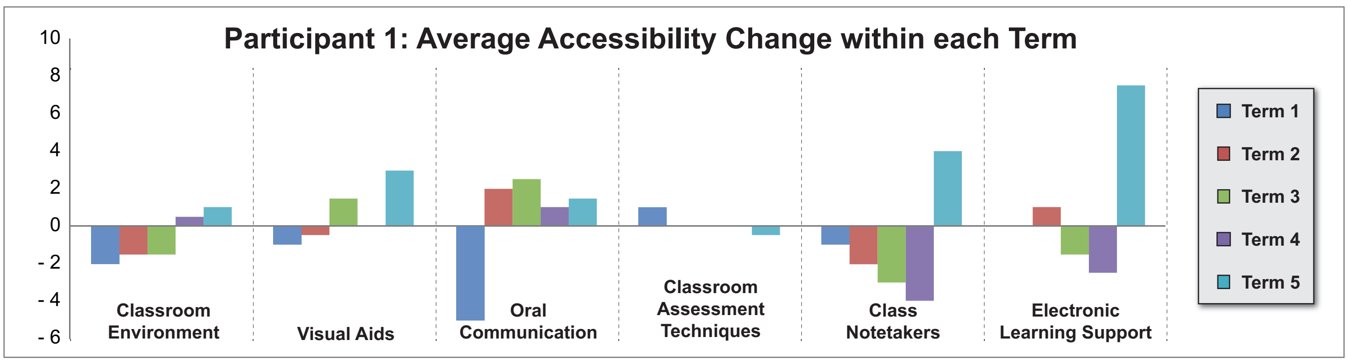
Building upon Existing Strengths and Capabilities: Our findings indicate that the greatest initial gains in accessibility occurred in the use of oral communication and visual aids. This suggests that initial improvements typically occur in those areas identified as most fundamental to teaching. In order to effect immediate improvements, as well as to create a pattern of success upon which to build, it may be best to begin with core competencies or strengths associated with processes with which instructors are already familiar due to their lecture-style teaching, such as speaking ability and PowerPoint® skills. The transformation of teaching styles which include more interactive approaches to accessibility and inclusivity take more time to accomplish and/or require significant amounts of peer coaching or mentoring.

Addressing Technology Concerns: While more conventional skills associated with teaching improved significantly in a short period of time, accessibility and inclusion issues related to instructional technology, such as course management software and personal response systems (i.e. "clickers," used as a classroom assessment technique) proved to be more difficult. Process Education professionals should be mindful about the accessibility and inclusion challenges associated with technology. Given that technology choices may be an institutional decision and not left up to individual instructors, creative "workarounds" may be required. Or, if possible, instructors may need to become more active in institutional decision-making processes.

Maintaining the Classroom Environment: While accessibility scores pertaining to facilitation-related elements of the classroom environment sometimes decreased (markedly in some cases), this was not necessarily an indicator of a less accessible or inclusive learning environment. Rather, certain aspects of classroom facilitation, such as professor-student rapport or a need for reminders about etiquette or appropriate technology use, frequently become embedded as the term progresses. As a result, our end-of-term observations may not have discerned these indicators. While it is possible that these facilitation-related elements of the classroom environment may be implied, it is important to periodically reinforce them—in the form of formal greetings, or during opening announcements, or by praising appropriate team or individual behaviors such as appropriate use of computers, etc.—as the term progresses.

Finally, we recommend for future endeavors that these insights be built into the methodology for faculty development generally, and into the methodology for facilitation in Process Education settings where accessibility is an important concern. Further, insights from this work related to UDL should be incorporated into Process Education methodologies for activity, course, and program design. The value of these insights will also be strengthened for process educators if they connect to the appropriate literature supporting each insight as part of the details within these methodologies.



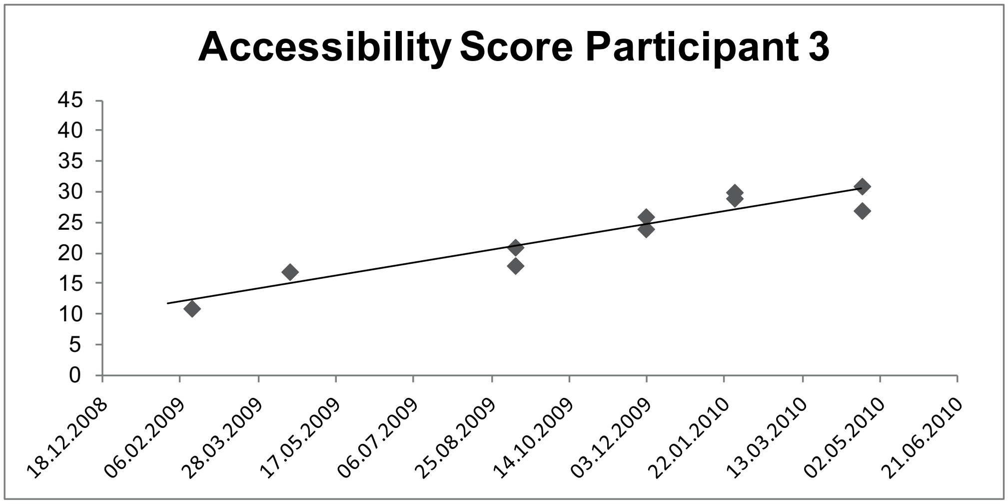


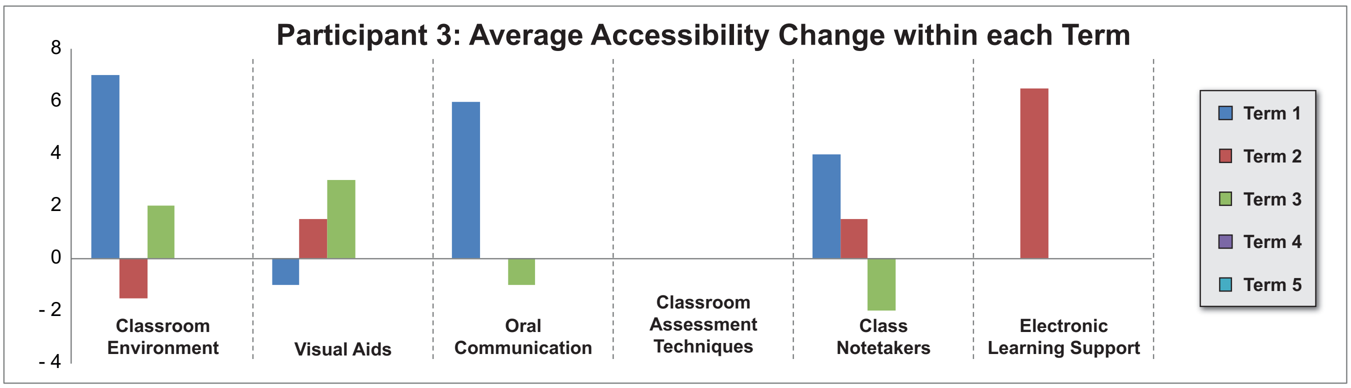
No. of Observations:	18		**Average Attendance:**	145
Class Observed:	Health Concepts and Strategies		**Subject:**	Health

Qualitative Observation Findings:

Participant 1 teaches an introductory freshman-level course entitled Health Performance Sciences, which is designed to educate several hundred students about personal health issues such as nutrition, exercise, and disease prevention. This course has generally been taught as a large, lecture-oriented survey. Beginning within that context, this instructor made a clear effort to know students individually, and to offer content relevant to students' everyday lives. To maximize the usefulness of the lecture portions of class, the instructor paid particular attention to the improvement of visual aids through the use of multiple formats, such as text, charts, photographs, cartoons, and video clips. PowerPoint® materials were easy to read, having large text fonts and a high degree of contrast that showed incremental improvement in accessibility scores throughout the observation period. For more complex material, such as graphs and charts, the instructor frequently took the time to use perception checks and to capitalize on student questions when explaining their significance.

In order to compensate for the large number of students, the professor also utilized group notetaking, with the intent of creating a group-based study guide that could be used by the entire class for exams (classmates voted on the most useful guides). In order to ensure their effectiveness, the instructor developed measures to hold students accountable to their peers within the groups and frequently reminded the class of the importance of working together as a group. Group activities assigned through the course management software were also commonplace. In order to ensure that students got individual attention, the instructor reiterated his/her accessibility via e-mail.

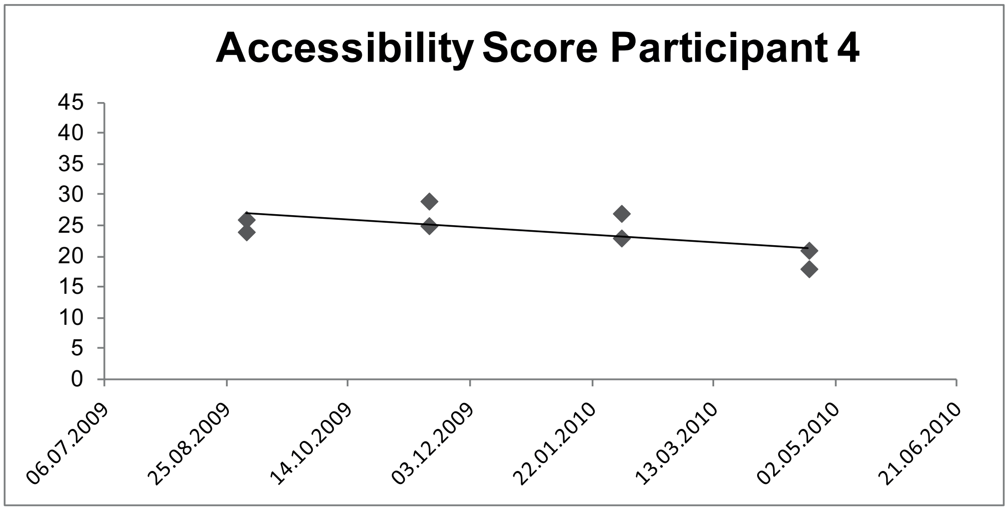


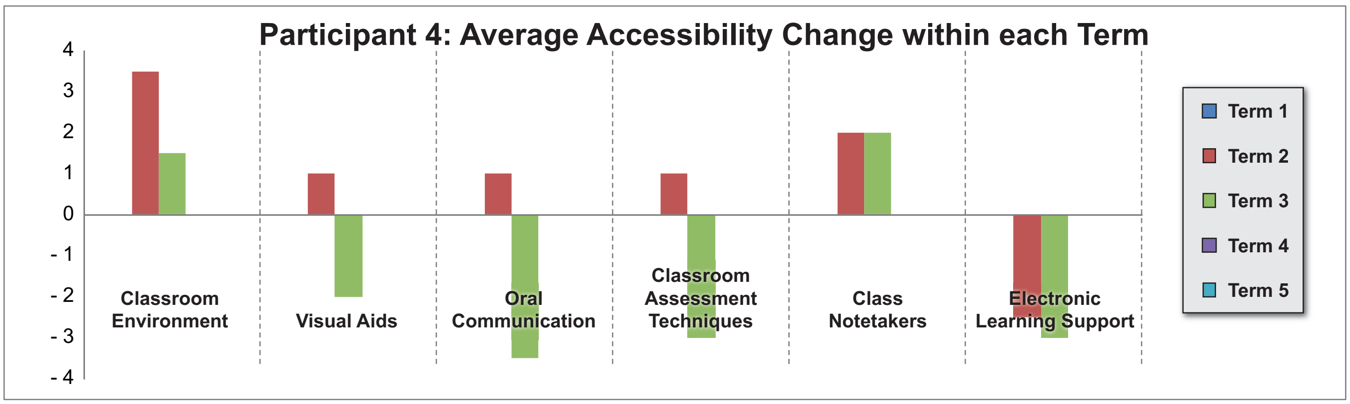


No. of Observations:	10	**Average Attendance:**	145
Class Observed:	3 Different Chemistry Classes	**Subject:**	Chemistry

Qualitative Observation Findings:

Participant 3 persistently worked to improve visual aid techniques after struggling early in his/her involvement, and continued improvement is noted within each term. Classroom assessment techniques were used but they had been used in the same manner for both observations each term, so there was no change in score within terms. The electronic learning support strategies were incorporated in Term 2, but the participant did not maintain them. This participant has made significant gains in accessibile teaching overall, and particularly by revising the instructional design approach for his/her courses between terms such that additional UDL approaches could be incorporated. Activity design utilizing student involvement in small groups to address key conceptual issues was one major area of effort that spanned several categories of the observation instrument (visual aids, oral communication, assessment techniques, and electronic learning support were involved in some activities). For example, in one activity related to molecular bonding, students worked with reading and video materials before class, participated in “clicker” questions to assess their level of preparedness during class, were exposed to a variety of visual aids to assist their understanding of the concept during a brief presentation mode, and worked in groups to address several conceptual questions and present answers to the class.





No. of Observations:	8	**Average Attendance:**	43
Class Observed:	3 Different Math Classes	**Subject:**	Mathematics

Qualitative Observation Findings:

Participant 4 taught several mathematics courses, as well as courses in probability and statistics. Despite declining accessibility scores, this instructor was found to be an effective teacher who demonstrated the utmost concern for student success. Examples such as game theory and bank loans were used to make the material at hand more relevant for students. Connections between previous days' material and the current day's lesson were common.

Despite strong oral communication, however, the instructor faced repeated issues with visual aids. PowerPoint® presentations were occasionally used, but the whiteboard was the most common means for showing examples. Owing to the large size of the classroom, text was frequently difficult to read due to small text size and a lack of contrast (i.e. inadequately dark dry-erase markers). Management of the whiteboards was also an issue, as the instructor often ran out of space and had to erase material, sometimes too early. The biggest issue, however, was the use of electronic course software that was not ideally configured for mathematics courses (i.e. inability to write equations using the software). There was also a notable amount of friction between this instructor and the workshop's developer over the implementation of group learning activities, which resulted in some initial efforts being dropped, thus reducing scores.

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