Course Experiences of Computing Students with Disabilities: Four Case Studies

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ABSTRACT

Inclusive education is the practice of making sure that all students of all abilities have positive learning experiences. The study presented in this paper explores the current state of inclusive practices in computing education by presenting four case studies of students with disabilities taking their first computing courses. Their experiences share many common themes that reveal insights into their college experiences and connect with current theories as to how to achieve inclusive education. New technologies, such as podcasting, for promoting inclusion are also suggested.

Categories and Subject Descriptors

K.3.0 [**COMPUTERS AND EDUCATION**]: General

General Terms

Human Factors

Keywords

inclusion, disability, accessibility, case study, semi-structured interview, grounded theory, podcasting

1. INTRODUCTION

Since the early 1990s, disability legislation like the American with Disabilities Act (USA) and the Disability Discrimination Act in the early 1990s, students with disabilities have had increasing opportunities for accessing and receiving a postsecondary education [3]. Scott et al. notes that the percentage of U.S. college freshmen with disabilities increased from 2.3% in 1978 to 9.8% in 1998 [12] . Due to more and more students with disabilities having positive educational experiences in K-12, the number of disabled students enrolling in education will likely continue to increase. As universities and instructors are required to ensure that students with disabilities can enjoy the same educational opportunities as all students, several educational practices have been developed, including the policy of inclusion.

Inclusion or inclusive education is the practice of including all students of all abilities in all learning opportunities [2, 11]. Under inclusive education, educational practices are designed to proactively address disabilities. Instead of reacting to the presence of a disabled student by providing specific accommodations for that individual, various disability accommodations are instead proactively integrated into the curriculum, class management, and pedagogies [1]. Towards achieving this approach, inclusive education often emphasizes good pedagogical practices: collaborative learning, peer teaching, multimodal instructions, and reflective teaching [2]. Despite criticism and skepticism, inclusion has been implemented successfully multiple times.[1]

Although several studies [1, 12, 13] have looked at inclusive education at the postsecondary level, there has been little research on inclusive practices in computing education. One of the few examples is Egan's work on supporting students with Asperger's syndrome [5]. However, her work focuses on a single disability. Inclusion is about addressing all disabilities through a general approach [1, 11]. How successful computing educators are at including all students with disabilities is still an open question.

This paper is a continuation of previous work [4] investigating the current state of our inclusive practices. Four case studies of students with disabilities enrolled in computing courses are presented. The next section describes the research methodology and is followed by a description of the participants in Section 3. Section 4 presents the common themes found in the students' experiences, and the last section discusses the relationship of these findings to previous studies on inclusion as well as implications for computing education.

2. METHODOLOGY

As discussed by the author previously [4], certain challenges exist in studying the experiences of college students with disabilities. These challenges, which include sociocultural and population size issues, motivate the need to use a qualitative approach and careful recruitment of participants. This study's research methodologies are presented briefly below; the reader is referred to [4] for further details.

2.1 Illustrative Case Study

The qualitative approach used in this study is the illustrative case study. This form of case study involves studying a few instances of a phenomenon in depth with the intent of illustrating what is occurring [6]. For this study, the course experiences of students with disabilities were gathered to

[1]For further reading on inclusive education, the author recommends Clough and Corbett's review of the subject [2].

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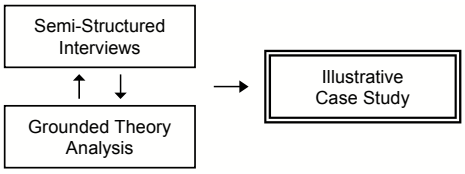

Figure 1: Process for illustrative case studies. Note the data collection and analysis occur in parallel.

investigate current inclusive practices in computing education. Most importantly, the goal of any illustrative case study is NOT to make generalizable claims but to provide insights into the many nuances of what is being studied. The rich, descriptive data collected here is to be used to stimulate thought and conversation about inclusive practices in computing education as well as for comparing with existing knowledge and theories about inclusion and students with disabilities.

To develop the case studies, the research process shown in Figure 1 is used. Data is collected using semi-structured interviews and then analyzed using a grounded theory approach. As in other phenomenological studies [3, 14], data collection and analysis were conducted in parallel.

2.2 Semi-Structured Interviews

A semi-structured interview [14] is a form of one-on-one interviews in which the set of questions acts as a guide for the researcher. The questions are mostly used only to promote dialogue at the beginning and low points in the interview. Primarily, the subject drives the interview by talking about whatever he or she views as important. The researcher can always interject for clarification or to probe an idea further, but the participant's own perspective is the focus.

Appendix A lists the interview questions used in this study. Each participant was interviewed on two separate occasions. The first interview focuses more on the participant's background than on current course experiences. While some questions inquire about the student's background and prior programming experience, many of the questions focus on the student's disability and usage (or not) of accommodations. The second interview focus on the student's current experiences with their disability in the course. Many of the questions do not specifically mention disability, however. Instead, the questions ask the student to talk about how the course is managed, interactions with teaching staff, coursework, software, etc. If their disability significantly impacts any of these items, the student is likely to mention it.

An interview is intended to take 45 to 60 minutes. In practice, the interviews have ranged in duration from 24.5 minutes to 65 minutes. On average, interviews have taken 44.5 minutes to complete.

2.3 Grounded Theory Analysis

Grounded theory is one approach for analyzing qualitative data [14]. In grounded theory, one inductively develops theories and themes from the data instead of attempting to test the validity of an a priori hypothesis. For identifying these themes, a standard coding approach [14] was used to tag the interview transcripts with category descriptors to highlight possible themes. Because this analysis occurred soon after an interview was completed, the interview questions were added to or adapted to further explore and challenge identified themes. The questions marked with an asterisk in Appendix A were added during the course of the study to explore themes that emerged during the earlier interviews.

3. PARTICIPANTS

Two iterations of this study were conducted at a large, public university. Both iterations took place during the regular (non-summer) academic year. A total of four participants (two per iteration) were interviewed.

3.1 Recruitment

For the study, a participant was defined as a student with a disability enrolled in his or her first or second university computing course, typically a CS1 or CS2 course. Calls for participation were posted to the courses' mailing lists and message boards (see [4] for more specific information on the recruitment process).

The choice for focusing on early courses was motivated by two reasons. First, these courses are traditionally large, averaging 400 and 200 students, respectively, at the start of the term. Moreover, these courses are taken by students both interested in majoring in computer science as well as students interested in other fields. These reasons not only increase the chances of students with disabilities taking the course but also increase the diversity of backgrounds and interests of the participants.

3.2 Biographies

Seth[2] is an 18 year old Caucasian male in his first year of college and was enrolled in CS1 with the intent on majoring in computer engineering. He also plays the saxophone in a jazz band. Seth is severely hard of hearing in his left ear and subsequently has difficulty filtering out background noise. Although he used a hearing aid when younger, he chooses to no longer use one due to the limited improvement the technology provides him. He primarily self-accommodates by positioning his good ear towards whoever is speaking. Seth is not registered with disability services, as both he and the disability services office view his hearing as not being sufficiently impaired to warrant the need for accommodations.

Pam is a 19 year old Caucasian female currently enrolled in a CS2 course. A first-year student, she is truly passionate about math and has found programming enjoyable. She is currently deciding between majoring in computer science or electrical engineering. About a year ago, Pam started having panic attacks. She was subsequently diagnosed with general anxiety disorder and began medication and counseling. In situations where attention is focused on her (e.g., giving a solo presentation in class), deadlines, or other stressful situations, Pam begins to feel anxiety, nausea, and a want to get away from the situation. Aside from close friends and family, she tends to not disclose about her anxiety to others. Pam is aware that her anxiety is strongly related to her strong work ethic of making sure that tasks are completed and done well. Prior to this study, Pam had never considered her anxiety as a disability and as such is not registered with disability services.

Alan, a junior and a commuter student, is a 26 year old Caucasian male majoring in visual arts. He is enrolled in an interdisciplinary course on computer animation. Having heard about the study, Alan contacted the author expressing interest in participating. Prior to the animation course, he

[2]All names have been changed to protect student privacy.

had taken one web programming course five years ago. Alan has a developmental disability that impacts his short-term memory and reading and writing speeds. He is currently registered with disability services and uses books-on-tape and note-takers as accommodations. He makes a strong effort to contact his instructors before each term to discuss his accommodation needs. Alan is also active in disability advocacy and participates in mentoring programs to help disabled students transition from K-12 to college.

Dave is a 19 year old Caucasian male interested in majoring in neurology and psychology major with the intention of becoming a surgeon. A first year student, he enrolled in CS1 out of intellectual curiosity about programming. Upon moving away from home to attend college, Dave decided to see a mental health therapist to address issues he had been dealing with in his life. Previously, his family's disbelief of mental illness prevented him from doing so. In the past year, he has been diagnosed with and started counseling and medication for generalized anxiety disorder, obsessive-compulsive disorder (OCD), and dysthmia (low-level, chronic depression). While the dysthmia affects his energy levels, the OCD impacts Dave's learning process in that if he attempts to solve a problem incorrectly, he typically obsesses about why it does not work before moving on to attempting another solution. This can lead to him falling behind in a course, and the pressure to meet deadlines triggers anxiety. At the time of the interview, he was also experiencing emotional stress due to a parent being called up for deployment to Iraq. Like Pam, Dave did not view his psychological conditions as a disability and was thus not registered with disability services. However, because of the multiple stressors and their negative impact on his productivity, he did begin conversations with his instructor for advice. Due to scheduling issues, Dave was unable to complete the second interview.

4. FINDINGS

In the analysis of the seven interview transcripts, many themes emerged: role of family support, personal definitions of disability, frustration with collaboration policies, etc. Due to space limitations, only four of the themes relevant to computing education are presented.

4.1 Self-Advocacy

One clear aspect of all the participants is their strong sense of self-advocacy regarding their disabilities. For better of for worse, each of them takes direct responsibility for managing the impact of their disabilities on their lives. Dave's initiative to seek out a mental health therapist is one example. Pam, however, hesitates to seek out help. When asked if there are any situations that would make her ask an instructor or TA for help regarding her anxiety, Pam states:

> Because of the person I am, I probably would not tell them and try to deal with the problem myself... I'd just think I'd be kind of embarrassed and feel like I was just complaining...

She does go on to say that in a particularly stressful situation, she might seek out help, but she prefers to tackle it on her own. Pam is willing, however, to seek out friends or family for help when really anxious, but that is her choice.

For some, the sense of self-advocacy was instilled by the parents. As previously mentioned, Seth chooses seating positions that favor his good ear. He has been doing this for himself since the sixth grade. Before then, his parents would contact his teachers and ask for appropriate seating but then shifted the responsibility to him. Now, he feels comfortable talking to teachers if the need arises.

Alan's parents were active in advocating for their son throughout K-12, and they made certain to include Alan in the meetings with school officials. As such, he is very aware of what he needs and how to work with the system. Since attending college, he has interacted with disability services on his own. In the animation course, Alan's request to have the textbook on tape, however, fell through due to a last minute change in texts by the instructor. This led to him falling severely behind and snowballed into further problems. As Alan says, his parents had to intervene:

> Generally, I try to keep my parents out of my business being that I'm a junior in college, but at this point my mom did get involved because she saw how frustrated and angry I was.

Although he had successfully negotiated accommodations for several years at the university on his own, his parents had to step in to help. While it is fortunate that he had their support, the embarrassment Alan feels in failing at his own self-advocacy is very evident.

4.2 Attention to Different Learning Styles

Another theme that emerged from the data is the participants' awareness to different learning styles and instructors that attend to different styles. As an artist, Alan views himself as primarily a visual learner. In the animation course, in-class or video tutorials are particularly helpful when learning the animation software. His reading disability makes text-based tutorials less helpful, especially if they skip over too many steps. However, he recognizes their usefulness to others. Seth expresses a similar preference for when instructors both wrote and said aloud what they were doing as that attenuates any potential hearing difficulties he might have.

Dave displays an interesting twist in regard to active learning. He states that he finds it very productive when instructors have the students work on a small problem during lecture. Since he is struggling in the course and can obsess over understanding why a wrong answer is incorrect, in-class problems can become a major distraction in lecture. As a solution, Dave brings his laptop and displays two copies of the lecture slides (which are available before class) and shows both the current and the next slide. During these in-class exercises, he works on understanding the solution. This self-accommodation prevents his disability from hindering his learning during lecture.

4.3 Access to Course Artifacts and Materials

Dave is able to perform that act of self-accommodation due to another common theme in the interviews: access to course materials and artifacts. In the CS1 and CS2 courses, many course materials are available from the course web sites: lecture slides, code produced in class, example exams, etc. Seth, Dave, and Pam all cite these as being very useful. These provide a fallback for Seth if he mishears something in class. They also reduce anxiety for Pam and Dave in that they can refer to the archived materials if they get lost or miss a lecture. For the animation course, Alan states similar benefits for the various materials resources available anytime from the course web site.

However, two breakdowns in access are noted in the interviews of Pam and Alan. When Pam took CS1, she found the textbook helpful. Working through exercises and example problems increased her confidence with the material and less anxious about exams. In the CS2 course, the textbook is online and password protected. Unfortunately, Pam's TA never distributed the password to his students. Pam relates that she is thus unable to work through exercises and example problems as before. Although she states that this is not a huge loss, the lack of access to the course text did remove one of her support systems.

Alan's breakdown relates to the software tutorials in the animations course. Although he prefers their visual nature, taking notes is difficult due to his memory and writing issues. He mentions having looked into getting the tutorials videotaped, but this was not possible due to lack of time and resources. Interestingly, he also mentions a set of DVD tutorials available to the students. However, they are only available for use in the computer lab when a teaching assistant is present. Although they are quite helpful, their limited availability clearly causes frustration for Alan.

Clearly, the breakdowns experienced by Pam and Alan are easily rectified. The point, however, is that these simple oversights did negatively impact these two students as access would have provided helpful accommodations.

4.4 Podcasting

Evolving out of the previous theme, several of the interviews highlighted the benefits of an emerging educational technology: podcasting. In the past year, the University of Washington implemented and began studying academic podcasting [9]. Several classrooms have been outfitted to automatically audio record lectures and post them to a website. Students in the course can then download the lectures and listen to them on computers or mp3 players.

None of the computing courses the students were recorded for podcasts. However, Seth and Alan had both taken or were taking courses that were podcasted. Both found the technology helpful. For Seth with his hearing issues, the podcasts in his psychology course provide a safety net "...if I want to go back and be like 'I didn't quite catch that.'" Podcasts are similarly useful for Alan. Because his learning disability affects his ability to take effective notes, Alan can fall behind in a class even if disability services provides a notetaker. With a podcast, he can listen again to the lecture as if it were another book-on-tape. When asked if his animation course is podcasted, Alan replies:

> No and I wish it was. I actually recently purchased an iPod for podcasts, and I've taken lectures with podcasting before and have done really well when it has been podcasted because I have been able to keep up and I can listen to it anywhere—on the bus...

Note that Alan sees added utility in the podcasts beyond just helping him keep up with course lectures.

Dave had also taken courses where podcasts were available. His opinion of them was very clear: "They *are so* helpful!" (italics added to show vocal emphasis). However, when asked if he had ever listened to podcasts of his other classes, Dave states:

> I've never done that because I've never had this much trouble with a class before but I definitely would with computer science if that were an option... It would be so much nicer to have a podcast. I work out. It would be an awesome opportunity for me to listen to the podcast while working out.

Dave's comments are very similar to Alan's. Both see podcasts as a convenient way to keep up with a course. However, Dave sees this value despite never having used the podcasts. As with Seth, podcasts can provide a safety net.

Dave and Alan also pointed out some potential drawbacks to podcasts for their courses. Because the CS1 instructor is often referring to code and slides, Dave suspects it might be difficult to follow only by listening. Alan suggests the same about the software tutorials in the animation course but adds that the dialogue itself might be enough to refresh one's memory of being in class. He also points out the possibility of video podcasts.

5. DISCUSSION

As case studies focus on only a few instances of a phenomenon in depth to illustrate what is occurring, one cannot and should not attempt to generalize the findings. No attempts were made to guarantee that the participants were a representative sample of students with disabilities or to control for factors such as race or gender. The themes identified are only applicable to the four participants in the study. However, these themes can be considered and discussed in context of other studies of students with disabilities.

One aspect of note is that the disabilities of the four participants are not readily apparent to an observer. Although our concept of disability is often associated with visible signs like white canes and wheelchairs, many disabilities (learning disabilities, anxiety, hard of hearing, depression, etc.) are in fact invisible. At the university level, the number of students with invisible disabilities is difficult to ascertain as many students with such disabilities tend to avoid disclosing about their disability due to concerns of social stigma, unawareness that support systems exist, and other reasons [3, 4]. Seth, Pam, and Dave not being registered with disability services fits with this pattern.

Still, among students who do register with disability services at public, 4-year institutions in the United States, 51% have learning disabilities like Alan's, 5% have hearing difficulties like Seth, and 7% have psychological conditions like Pam and Dave [10]. As these numbers include only the students who disclosed about having a disability, the actual statistics are likely much higher given the tendency of these disability types to not disclose [3]. This highlights a critical benefit of the inclusive approach. By adopting inclusive practices and being aware of disability issues in education, the instructor can provide a positive learning experience to disabled students like Seth, Pam, Dave, and others without even being aware that they have disabilities. In other words, inclusive education can invisibly benefit those with invisible disabilities.

An example of this is seen with the students' views on podcasting as a means of accommodating their disabilities. The motivations for incorporating podcasting into university courses were about embracing newer technologies to support studying and the mobility options inherent to the technology [9]. Potential benefits for disabled students were not considered. However, the case studies show that podcasts can be a useful, helpful tool for these students. Dave's emphatic statement that while he has never used podcasts in other courses, podcasts would have greatly aided him in the com-

puting course is a striking example of this potential. Further research on the potential benefits of podcasting for students with disabilities is warranted and should also be one factor instructors consider when deciding whether or not to adopt podcasting course technologies.

Ultimately, the themes found in the interviews are not specific to computing. Instead, the interviews show that good pedagogy is a key aspect of these students' learning experiences. When instructors attend to different learning styles and provide access to course artifacts for later review, the students noted their benefits. These benefits were not confined only to Pam, Dave, Alan, and Seth, however. Attention and awareness of different learning styles has been repeatedly shown to benefit the learning process for all students [7]. The positive outcomes of access to course materials are also documented [8]. What makes inclusion truly realizable is that it focuses on and embraces well-established, successful teaching practices that benefit all students regardless of their abilities [11]. For all educators, computing or not, a direct step towards achieving inclusive classrooms is simply to consistently engage in good teaching practices.

6. REFERENCES

[1] S. Burgstahler. *Universal Design of Instruction*. University of Washington, DO-IT, 2001.

[2] P. Clough and J. Corbett, editors. *Theories of Inclusive Education: A Student's Guide*. Paul Chapman Publishing, London, 2000.

[3] R. C. Cory. *Identity, Support And Disclosure: Issues Facing University Students With Invisible Disabilities*. PhD thesis, Syracuse University, NY, USA, 2005.

[4] K. Deibel. Studying our inclusive practices: Course experiences of students with disabilities. In *Proceedings of the 12th annual ITiCSE Conference*, pages 266–270, New York, 2007. ACM Press.

[5] M. A. L. Egan. Students with Asperger's syndrome in the CS classroom. In *Proceedings of the 36th SIGCSE Technical Symposium*, pages 27–30, New York, 2005. ACM Press.

[6] General Accounting Office. Case study evaluations. GAO Programme Evaluation and Methodology Division, Washington, DC, 1990.

[7] P. B. Guild and S. Garger. *Marching to different drummers*. Association for Supervision and Curriculum Development, Alexandria, VA, USA, 2nd edition, 1998.

[8] J. Heines, K. Börner, M. Y. Ivory, and E. F. Gehringer. Panel on the development, maintenance, and use of course web sites. In *Proceedings of the 34th SIGCSE technical symposium*, pages 94–95, New York, 2003. ACM Press.

[9] C. Lane. Podcasting: Evaluation of year one. Technical report, Catalyst Learning and Scholarly Technologies, University of Washington, October 2006.

[10] L. Lewis, E. Farris, and B. Greene. An institutional perspective on students with disabilities in postsecondary education. Statistical Analysis Report NCES 1999-046, U.S. Department of Education, Washington, DC, August 1999.

[11] T. Loreman, J. Deppeler, and D. Harvey. *Inclusive Education: A Practical Guide to Supporting Diversity in the Classroom*. Allen & Unwin Pty., London, 2005.

[12] S. S. Scott, J. M. McGuire, and S. F. Shaw. Universal design for instruction: a new paradigm for adult instruction in postsecondary education. *Remedial and Special Education*, 24(6):369–379, 2003.

[13] C. Strange. Creating environments of ability. *New Directions for Student Services*, 91:19–30, Fall 2000.

[14] S. J. Taylor and R. Bogdan. *Introduction to Qualitative Research Methods*. John Wiley & Sons, New York, 3rd edition, 1998.

APPENDIX

A. INTERVIEW QUESTIONS

Initial Interview:

- Gender? Age? Full-time or part-time student? Major?
- What disability(ies) do you identify as having? Describe what it means [to you] to have this disability.
- When and how were you diagnosed?
- How does your disability affect your education?
- Have you ever been embarrassed due to your disability?
- Are you registered with Disability Resources for Students? Why or why not?
- What accommodations have you used / currently use / plan to use for your disability?
- How has your family responded to your disability? *
- Have you or are you planning to inform the instructor and/or your TA about your disability? Why?
- Assuming that your instructor(s) knew about your disability, how would you want them to respond to you as a student?
- What are your reasons for taking this course?
- Do you have prior programming experience? Describe.
- How do you think you will do in this course?
- How do you think your disability will affect you in this course?

Follow-up Interviews:

- How is the course going for you? What do you liking/not like?
- Have you considered changing the level of disclosure about your disability? Why?
- Have you told more people [instructors, students, etc.] about your disability? Why?
- Have you changed or thought of changing any accommodations you use for the course? Describe.
- Describe how the instructor runs class. What do you like? What would like the instructor to do differently?
- Describe how the TA runs section. What do you like? What would like the TA to do differently?
- Do you attend office/lab hours? Describe.
- Describe your experiences using any course resources [textbook, e-mail, course web, etc.].
- Have you ever used course podcasting? *
- Describe your experiences with the assignments.
- Have you had difficulties using the suggested software for the course? Explain.
- Do you regularly talk or meet with students from class?
- Have you disclosed about your disability to them? Why?
- Compare your experiences in this course with other courses. Are there things that you wish were present in this course? Describe. *

* Question added during the course of the study.