A General Education Course on Universal Access, Disability, Technology and Society

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ABSTRACT
This paper reports on a General Education course called "Universal Access: Disability, Technology and Society" that enables students from all majors to learn more about disability and the issues that surround it, as well as how Assistive Technology facilitates effective participation of those with disabilities in society. Guest lectures, meant to give the students different perspectives on disability, are integral part of the course. Guest lecturers include experts in disability studies, professionals working with people with disabilities, and persons with disability. To gain practical knowledge, the students carry out group projects or volunteering activities that involves people with disabilities. Since its first introduction in 2006, the course had always filled to capacity. A survey with 75 students conducted in Winter 2010 revealed that students felt that their knowledge about universal access and disabilities had improved significantly, and that they had become aware of accessibility in everyday life.

Categories and Subject Descriptors
K.3.2 [Computer and Information Science Education]: Computer Science Education, Curriculum, Self-Assessment.

General Terms
Documentation, Human Factors.

Keywords
Universal Access, General Education, Undergraduate education, disability awareness

1. INTRODUCTION
Spearheaded by the Computer Engineering Department and supported by the University of California Santa Cruz' (UCSC) higher administration, Assistive and Rehabilitative Technology (ART) has become a strategic educational and research trust at UCSC. The campus has recently established a new undergraduate Bioengineering major, which includes an ART-focused concentration, and a flexible program in Biomedical Science and Engineering at the doctoral level. Within the past 3 years, two faculty members working in ART joined the Computer Engineering faculty, a clear sign of the institutional commitment on ART.

Significant efforts were made to embed new courses in ART into the existing undergraduate and graduate curricula in Engineering. In addition, one General Education course was designed so as to enable students from all majors to learn more about disability and the issues that surround it, and how Assistive Technology facilitates active participation of those with disabilities in the society. (General Education courses, usually abbreviated as GenEd or GE, are courses that are not program–specific. They introduce students to a variety of disciplines to promote lifelong learning, and prepare them to handle the complex and unexpected problems of the future with wisdom and resourcefulness). This course is called CMPE 80A: Universal Access, Disability, Technology and Society. Since its first introduction in 2006, the course has always filled to capacity, which ranges from 118 to 207 students.

This paper reports on the course structure and curriculum. Our hope is that our experience may inspire other educators to include disability and universal access as part of Engineering curricula.

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2. RELATED WORK
While most universities with a Disabilities Studies, Special Education or Biomedical Engineering program/department/ major are likely to offer one or more courses that discuss disability and ART, very few Engineering schools offer Assistive Technology courses and fewer yet offer a GenEd course focusing on Assistive Technology. Exceptions include the courses offered by CMU and University of Pittsburgh (separately or in combination) such as "Assistive Robotic Technology in Nursing and Health Care" and "Assistive Technology" in 2005; a capstone design course series at SUNY (the University at Buffalo) in which in 2002 and 2003 included socially relevant projects, more specifically an AAC device for stroke survivors and children with cerebral palsy [1]; "Perspectives in Assistive Technology", an Engineering course regularly offered at Stanford University; and "Enabling Technology", offered by the Computer Science Department at University of North Carolina. This scarcity of courses in ART in Engineering schools is alarming as there are strong arguments for including Inclusive Design, Accessibility and Assistive Technology within HCI curriculum [2] or within computing courses in general [6], especially in light of the world's aging population and of the increasing involvement of people with disabilities in society.

3. COURSE STRUCTURE
A substantial portion of this course is devoted to studying physical, psychological and psychosocial aspects of disability and old age, as well as demographic, legislative, accessibility and acceptance issues. The course schedule consists of 3.5 hours per week of lectures consisting of presentation on various topics, complemented with relevant movies YouTube videos to support the topic presented. Movies shown in class include "Sound and Fury", focusing on Deaf Culture, and "Freedom Machines", a movie produced by PBS that looks at disability

through the lens of Assistive Technology. Examples of YouTube videos used in the class include a TED[1] talk on brain researcher Jill Bolte Taylor, who describes her own experience as a brain stroke survivor, and has become a powerful voice for brain recovery after stroke (http://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight.html), as well as various videos released by the Disability Rights Commission in the UK to increase public awareness of various disabilities. An example of the latter is a video describing a blind customer service representative woman as she guides a customer choosing an adventure package over the phone. From the conversation, one learns that this blind woman enjoyed skydiving, parasailing and bungee jumping, all activities that the sighted customer was afraid to try. This video was chosen as it breaks sterotypes about blind persons and how they live their lives (http://www.youtube.com/watch?v=0fvKp7voPkg).

A number of guest speakers are regularly invited to the class. These include faculty members from the Department of Psychology, personnel from the UCSC Disability Resource Center, professionals from local organizations involved with the disabled community (such as the Vista Center for the Blind and the Visually Impaired, and the Palo Alto Veteran Health Care System), and persons with disabilities. Past guest lecturers included:

1. Ms. Alida Lindsey from Whirlwind Wheelchair International, a non-profit social enterprise dedicated to improving the lives of people with disabilities in the developing world while promoting sustainable local economic development in the process.
2. Mr. Foster Anderson, a person with quadriplegia who founded and manages Shared Adventures, a successful non-profit organization in Santa Cruz devoted to providing recreational activities to persons with disabilities.
3. Dr. Sybil Kline, a Psychologist who developed the Kline Attention Screener for Adult Learners (KASAL), which has been used to screen for adult ADHD.

Two faculty members teach the course in alternating terms. The following topics are covered (some more extensively than others):

1. *The disabled community*. Diversity and integration: history, social perception, role models. Sociological and cultural models of disability.
2. *Disability-related U.S. legislation*. This includes the Rehabilitation Act of 1973, the Americans with Disability Act (ADA) of 1990, the Individuals with Disability Education Act (IDEA), the Telecommunications Act of 1996, the Fair Housing Act of 1988, the Air Carrier Access Act, the Technology Act of 1998, Medicaid and Medicare.
4. *Physiology and psychology of disability*. The most common causes of disabilities (visual, hearing, mobility, cognitive and learning) and their effect on the activities of daily living are considered from a medical model perspective.
5. *The two extremes of human life*. This topic covers a child's developmental phases along with possible developmental disabilities. It also describes the aging process and aging-related impairments.
6. *Principles of Universal Design*. Home and urban environments for all types of abilities, smart homes for independent living, and the ten Principles of Universal Design.
7. *Assistive Technology for independent living*. This topic covers technology that helps people with disabilities to live independently, and that provides access to the workplace and school. This includes technology for wayfinding, safe mobility and access to written information for persons who are blind; strollers, scooters and wheelchairs for persons with mobility impairments; adaptive interfaces and Augmentative and Alternative Communication (AAC) .
8. *Rehabilitation, assessment and therapy programs*. This covers typical tests and protocols administered by therapists, such as the Mini Mental State Exams to detect dementia and Conners' Rating Scales to detect ADHD.
9. *Doing research on disability*. This topic covers the role of the Independent Review Board (IRB), the importance of human subject approval, and specific considerations when recruiting persons with disabilities for research studies.
10. *Worldwide disability initiatives*. This topic covers initiatives around the world regarding disability, ranging from the UN International Convention on the Rights of Persons with Disabilities to the World Bank/World Health Organization joint "World Report on Disability, Rehabilitation, and Inclusion", and the International Telecommunication Unit's Dynamic Coalition on Accessibility and Disability.

Students are assessed through formal coursework (homework and class quizzes). Homework questions are often formulated so as to inspire students to search for more information on the Internet. Other homework assignments aim to increase the students' awareness via simple personal experiences. For example, students may be asked to wear earplugs for two hours and then write an essay about what it feels to be "deaf". As another example, students may be asked to observe whether their residence is accessible for a person using a wheelchair.

Students also carry out group projects or volunteering activities that involves people with disabilities. This is meant to provide students with some direct and practical experience about the material covered in class. For example, in one class offering, the group projects were designed under the theme "Helping persons with special need one at a time." For this project, the students were tasked with finding a person (the "partner") with special needs. This could be a person with disability, a person 55 years old or older, a very young child, a person who does not speak English (and is required to access information in English, or use products with only English labels), a person with low or no literacy, etc. The first task in the project was an interview, in which students in a team tried to find whether there was some technology that their partner was prevented from using due to his or her disability. Each team was tasked with assisting their partner throughout the quarter, helping him or her to learn to use the inaccessible technology from the simplest to the most complex task. The final deliverable was in the form of a written group report and poster presentation.

In class offerings, the students proposed a project where they could explore a topic of interest involving people with disabilities. These proposals ranged from writing a research papers to shooting a short documentary about a friend with a disability. Selected projects were presented to the class in the form of a slide show or a movie.

Student choosing volunteering activities worked with organizations that help people with disabilities live fully and

[1] TED is a nonprofit organization devoted to the ideas of free talks by inspiring speakers in technology, entertainment, and design. It started out in 1984 as a conference, and now the talks are released online in various media including YouTube.

integrate seamlessly into society (such as Shared Adventures, mentioned earlier).

4. SAMPLE HOMEWORK

In general, the homework was perceived positively by students (although some students complained about the short deadline). The homework often elicits innovative ideas. For example, Figures 1 and 2 homework submissions examples on the topic of "Halls-of-shame" and "Halls-of-fame" products advertised in the media for older adults. One product in the "Hall of fame" was Taizo, a robot designed to help older adults stay in shape. It can perform and demonstrate 30 different exercise moves. The technology is still very new; the Japanese government plans to start selling and renting these robots next year. One student stated: "*I can think of a lot of people, both elderly and non-elderly who would like this robot. I would use it if it could go through a yoga work-out with me.*"

Figure 1. Hall of fame: Taizo, the humanoid exercise companion for older adults.

As for the "Hall of shame", one student provided an example of a social networking web site (shown in Figure 2) aimed at baby boomers that was designed with a very complex and crowded layout, and with low color contrast (e.g., the pull-down menu turns into purple menu when hoveredover, a color very close to the blue surrounding).

Figure 2. Hall of shame: eons, a social networking site for baby boomers.

One homework aimed to challenge a stereotype about people with disabilities. In this homework, students were asked to find an example of a scene that people with color blindness would find it easier to see or enjoy than those without color blindness. Students were asked to use Vischeck, an online color blindness tool that can simulate the three most common forms of color blindness, given an image or URL as input (http://www.vischeck.com/vischeck/). Of course, this homework also aimed at encouraging students to experiment with tools, such as Vischeck, that can help them better understand the issues surrounding disability. Figure 3 shows an image of a street in San Francisco's Chinatown that was input to Vischeck. One student argued that it may be less tiring for people with color blindness to walk around without seeing all of those sharp contrasting shop signs seen in Figure 3a.

In general, the homework submissions showed evidence of initiative and hard work. Most went above and beyond what was asked (especially considering that each homework was only worth 4% of their total grade).

a. b.

Figure 3. a. **An image of San Francisco's Chinatown**. b. The same scene seen by a person with Protanope (as simulated by Vischeck).

5. SAMPLE PROJECTS

The following are sample projects carried out by students in the class.

5.1 Finding the Best Mobility Aide for an Active Older Woman

For this project, two students performed a detailed analysis of various mobility aides (scooters, wheelchairs, and walkers), in order to identify the model that would best serve a "partner" with a specific mobility impairment. They developed a set of criteria based on their partner's needs and daily activities, including cost, usability and mobility. Then, the students tested different mobility aids, ranking them according to these criteria. When the team presented the project to the class, they brought along two scooters manufactured by Pride (the Go-Go Scooter and the Go Chair, shown in Figure 4), so that other students could try them out and experiment in first persons their different characteristics (such as the turning radius).

5.1.1 (a) 5.1.2 (b)

Figure 4. Mobility tools demonstrated in class. a.: Go-Go Scooter. b.: Go Chair.

5.2 Teaching a Blind Student how to Use a Laundry Machine Independently

In this project, the students in a team attempted to teach a blind friend how to use the washing and drying machines located in the student dormitory inside the UCSC campus. This blind student could not do her laundry independently and always desired not to have to rely on her friends for operating the machines. Figure 5 shows the series of events that occurred during the project. Figure 5a shows the blind participant. Figure 5b captures the complexity of using these particular washing machines without sight, including the fact that there are many instructions and that the machines have a digital interface. Figure 5c shows the card reader, which is rather complex to use and has step-by-step instruction printed next to it, unfortunately without any Braille or audio version. Figure 5d-e shows the learning process. Figures 5f-5h, taken toward the end of the quarter, show the participant performing the tasks independently.

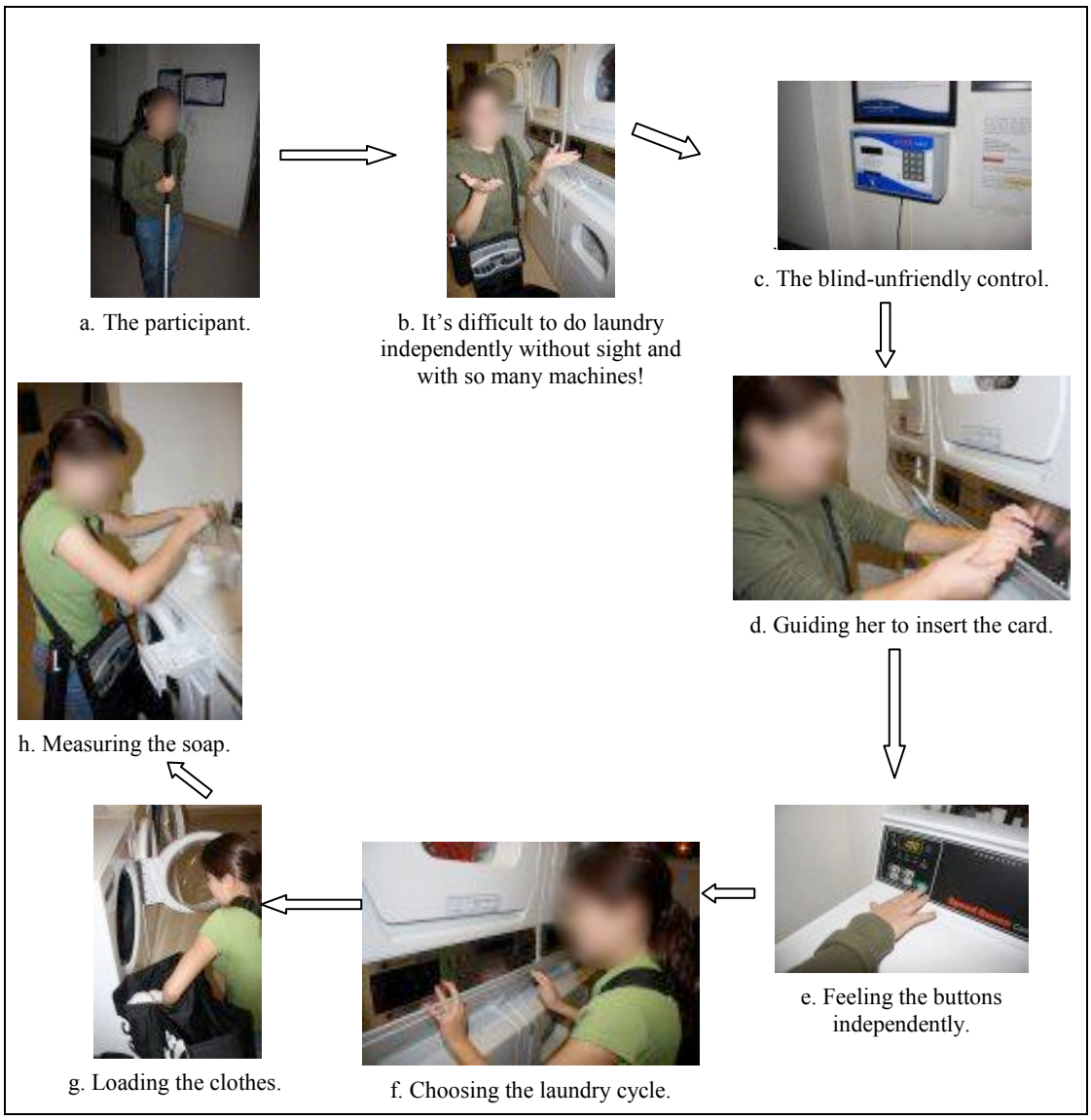

Figure 5. A class project: helping a blind student to use a washing and drying machine independently (pictures taken and included with permission from the participant).

5.3 Sample Documentary Video Projects

One project in this category documented the recovery and rehabilitation process of a female fellow classmate after a spinal cord injury, occurred a few years earlier. The team created a video narrating this student's story, which also included a tour of the facilities where the recovery took place. Pictures of the student before and after the surgery were also shown. The video helped the class to realize that disabilities can affect anyone, including one of their peers. As the video was shown to the class, with personal memories of the incident rolling on the screen, gasps and "aw's" could be heard from the audience. It became evident that the class became emotionally involved with the story of their classmate.

Another group presented a video about the disability transportation service on campus. This included footage of the dispatch center, a ride on the disability van to all stops on campus, and an interview with key players of this service (see Figure 6a-b). The video also highlighted the various

modifications on the disability van to improve accessibility, such as the one shown in Figure 6a.

a.

b.

Figure 6. Frame snapshots from the documentary project about the disability van service on campus. a.: The wheelchair ramp. b.: Riding on the van.

6. SAMPLE VOLUNTEERING ACTIVITIES

The volunteering activities involved volunteering for local organizations and facilities, such as Shared Adventures and KidsQuest. Students volunteered from 1 to 36 hours each (n = 63; Mean= 15.28 hours; Std. = 8.32). Each student had to record their volunteer hours and get a signature from their supervisor to verify their volunteer work.

6.1 Shared Adventures Volunteer Activities

As mentioned earlier, Shared Adventures is a local organization dedicated to providing outdoor recreational and social activities for people with disabilities. Some students chose to volunteer with Shared Adventures, and helped supervise children at the "Young Artists' studio", an inclusive after-school art program. Students also took the children to a local yogurt shop, where they were participated in an outdoor drawing activity. Other activities organized by Shared Adventures to which student volunteers participated included the Valentine's Day Party and a trip to the Año Nuevo state reserve to see the elephant seals. During these activities, the student volunteers had a chance to work directly and socialize with persons with different disabilities.

6.2 KidsQuest Volunteer Activities

KidsQuest is an organization dedicated to providing activities to help children with special needs develop social skills and confidence to interact with all children at school. Students who volunteered with this organization played with the children, helped with the gardening project, helped to prepare food, and assisted with arts and crafts activities. One student described a volunteering moment as follows:

"*On our walk to the park he kept on stopping me holding my hand and asking me about the telephone and electricity wires and as I explained his face was full of excitement and amazement as I told them what the wires did. That made me feel good inside, helping a child who needs attention and wants for people to listen to him.*"

The same student described their whole volunteering experience as, *"[...] a good opportunity for me to learn more about them and how hard it could be at times when people don't understand them."*

7. CLASS EVALUATION SURVEY

After a few years of offering the course, we decided to investigate whether the course had some impact on the students' awareness of disability and of related issues. In the Winter quarter of 2010, we conducted a paper-based, take-home, non-mandatory survey. The survey contained 5 questions with ordinal ratings. For each question, the students were invited to provide comments. The five questions were:

Q1: Before taking this course my knowledge about universal access and disabilities was:
(1= very bad, 2 = bad, 3 = not good nor bad, 4 = good, 5 = very good).

Q2: As a result of this course my knowledge about universal access and disabilities is:
(1= very bad, 2 = bad, 3 = not good nor bad, 4 = good, 5 = very good).

Q3: I believe I am more open to pursuing a career in the area of accessibility / assistive technology / people with disabilities / universal access because of this course:
(1 = strongly disagree, 2 = disagree, 3 = not agree nor disagree, 4 = agree, 5 = strongly agree)

Q4. After taking this course I feel more comfortable interacting/working with people with disabilities:
(1 = strongly disagree, 2 = disagree, 3 = not agree nor disagree, 4 = agree, 5 = strongly agree)

Q5. I believe I am more aware of accessibility in everyday life:
(1 = strongly disagree, 2 = disagree, 3 = not agree nor disagree, 4 = agree, 5 = strongly agree)

Seventy five students (out of a class of 118) participated to the survey. There were 42 females and 33 males. Twenty one were freshmen, 32 were sophomores, 14 were juniors, and 8 were seniors. Eleven students had not declared their major yet at the time they took the survey. The remaining students came from all five divisions at UCSC (Humanities, Arts, Engineering, Social Sciences and Physical and Biological Sciences).

Table 1 shows the means and standard deviations of the quantitative results for all questions. Please note that one student did not answer Q5, but the student's data for Q1 to Q4 is still included in the statistical analysis.

Table 1: Descriptive Statistics for Q1-Q5.

Question	N	Mean	Std. Deviation	Median
Q1	75	2.40	1.053	2
Q2	75	4.33	.553	4
Q3	75	3.01	.951	3
Q4	74	3.84	.844	4
Q5	74	4.20	.641	4

7.1 QUALITATIVE ANALYSIS

In order to get a better insight, we analyzed the comments from the students using content analysis technique, more specifically conceptual analysis [3]. The transcripts were coded using the constant comparative method of analysis, a technique out of grounded theory methodology [4].

7.1.1 Knowledge Prior to Taking the Course

As shown by the quantitative ratings, the mean of the answers to Q1 falls between 2 = bad and 3 = not good nor bad (the median is actually at 2 = bad).

Sixteen students commented that they had no knowledge nor interest in learning about disabilities prior to taking the course. The three most commonly stated reasons for this were: 1) lack of readily accessible material, 2) the material is often boring, and 3) too far remote from their own condition or situation (as in "*I didn't care to think about it because it never seemed to affect me or a family member.*")

Nineteen students remarked that they had some previous knowledge about a certain disability, usually because a person they knew had this particular disability, but little or no knowledge of other types of disabilities or available assistive technology, as exemplified by the following comment:

"I knew a lot already about existing disabilities and their effects on people + community (my brother has Down syndrome), but I knew little on any assistive technology."

Some students also commented that they were not aware of the existence of such a wide range of disabilities prior to taking the course, as this comment suggests:

"*I was not aware of any modern technologies that provide any assistance for people w/multiple disabilities. I also defined the disabled-body as limited to those on wheelchairs.*"

Some of the students' comments were very touching, as it was apparent that the course had opened their eyes to various aspects of disabilities, as the following comment indicates:

"*I didn't know there were that many aspects about universal access & disabilities. I didn't know many disabled people were unhappy with the technology introduced today and that they were discriminated so much against.*"

7.1.2 Knowledge After Taking the Course

The mean of the answers to Q2 (relating to the student's perception of his/her knowledge about universal access and disabilities after taking the course) was of 4.33, significantly better than the perceived knowledge before taking the course (as tested with Wilcoxson's signed rank test). Some interesting themes emerged from the comments:

a. *Change in perception regarding persons with disabilities*: Some students stated that taking the course had changed their perceptions of persons with disabilities, as exemplified from this statement:

   "I now understand many different types of disabilities and ways in which people have tried to help and pass laws to help them. I now understand that it is hard to be them and want to also try to contribute my input to benefit their lives." or

   "I think American society really shies away from the disabled & doesn't recognize them as normal, feeling individuals. The course made me recognize how isolated & misunderstood they feel."

b. *Change in general attitude*: Some students felt that taking the course made them see life in a new light as in:

   "*I learned to appreciate everyone, and take to account everything that's around us.*" or

   "*Now that I have been expose[d] to these topics/issues [I] am really conscious, and it's really interesting. I feel like I have opened my eyes, and started seeing the world from a different perspective.*"

7.1.3 Pursuing Career in Disability Field

The mean and median of the answers to Q3 indicate that the students do not agree nor disagree with the statement that they are more open to pursuing a career in the area of accessibility / assistive technology / people with disabilities / universal access as a result of taking this course. Analysis of the students' comments revealed several themes related to this topic:

a. *Too early to decide*: Some students (especially freshmen) felt that it was too early for them to start thinking about their career in general, as the following statement indicates:

   "As a freshman I am still too indecisive to feel a desire in this career, but it did personally attract me to the idea of equality, and the questioning of it."

b. *Interested but will not commit to a career*: Some students are interested to be more involved with people with disabilities but not as a career, as exemplified from this statement:

   "I am not interested in working with the disabled as a career, however I do enjoy volunteering and would like to volunteer more as a result of this class."

c. *Already interested in pursuing a career in the disability field*: Some students were already interested in a career in the disability field before taking the course, and felt that the course made them more confident that they made the right choice, as this statement suggests:

   "I've been interested in social work involving helping people w/disabilities for quite some time. This course made me become more passionate about the subject."

d. *Planning to change major to work in the disability field*: Some students stated that they planned to change the direction of their study to work in the disability field as a result of taking the course:

   "My BioE major concentration is molecular, but now I'm more interested in rehabilitation. I never considered it before, but now I recognize it as something very fulfilling."

7.1.4 Interacting/working with people with disabilities

Question 4 asked the students whether they agreed that after taking this course they felt more comfortable interacting/ working with people with disabilities. The median of the answers shows that the students agree with this statement.

From the qualitative data, it was apparent that the projects, which require the students to become involved with disability in

some form, contributed to a certain degree to making them feel comfortable working and interacting with people with disabilities. Some of the statements indicate the following themes:

a. *Seeing a person with disabilities as a "normal" person*: Some students stated that taking the course changed their perception about persons with disabilities, and that they began considering persons with disabilities as "normal" persons as exemplified in this statement:

"The project we did for this class really helped me to see that people with disabilities can interact and have normal conversation."

b. *More considerate toward those with disabilities*: Some students stated that taking the course made them more considerate and patient as exemplified from this statement:

"I really feel more considerate when it comes to disabled people. I now have more patience and more tolerance for them."

c. *Empathy toward those with disabilities*: Some students stated that after seeing the struggles that people with disabilities experience in their daily lives, they felt more sympathetic toward those with disabilities as exemplified from this statement:

"I see their struggles in everyday life and the obstacles they have to face and I have sympathy toward them. I am now able to interact in a better form."

d. *Still uncomfortable*: Not everybody felt comfortable around persons with disabilities even by the end of the class:

"I am still a bit nervous because I would not know what to do since I always feel that a doctor should be nearby. Also, I really do not understand how to deal with a visually/physically impaired person."

"Although I have more knowledge of disabilities, I still don't know how to approach people with disabilities and interact with them."

7.1.5 Awareness of accessibility in everyday life

When asked whether they agreed that they became more aware of accessibility in everyday life, most students agreed with this statement, as shown by the median of the answers (equal to 4).

Qualitative data reveals that students have been made aware mostly of:

a. *Their own condition*: Interestingly, some comments suggest that knowing more about various disabilities made them more aware of their own condition, as in the following comment:

"People usually take everyday normal activities for granted. This helps me appreciate life more."

b. *Barriers to accessibility:* Some comments suggest that this course made students more aware of inaccessible infrastructure or environment, as this comment suggests:

"I've started seeing some problems in campus. Example: my dorm house only has stairs, how would a person in a wheel chair get around?"

c. *Accessible design:* In conjunction with the awareness of barriers to accessibility above, some comments suggest that students became more aware of and understand good designs in terms of accessibility, as this comment suggests:

"I would now understand why the[y] make fridge handles from top to bottom. I would think deeper of products made and how it could be accessible to everyone."

d. *People with disabilities*: Some comments were related to the fact that students are now more aware of people with disabilities around them, as exemplified by this comment:

"Now I always see disabled people around campus"

7.2 What Did Not Work Too Well

While in general the various initiatives within the course seemed to have worked well, a number of issues were raised by the students and will need to be addressed in future offerings of the course, including:

a. *Emotional impact of the material*: Some of the movies shown in class could also be emotionally draining. For example, in a movie about autism, there was a scene with a mother stating that at one point she contemplated suicide because of the burden of caring for a child with ASD (autism spectrum disorder). One student complained that this was emotionally disturbing (another student stated that he could not believe the scene was real).

b. *Personal interests*: Some students seemed to have taken the course out of personal interest. One student, for example, stated that she wanted to take the course because her mother had schizophrenia, and she had hoped that more time was allocated to this topic. While it is difficult to cover all possible disabilities, we plan to poll the students at the beginning of the class to find out whether there may be some special interest in some particular disabilities or related topics that could be discussed more in depth.

c. *Too much to cover in a quarter*. Some students felt overwhelmed by the amount of material covered in this course. While we have not considered splitting the course into two quarters at this time, we might consider offering two separate courses (one on Disability and one on Assistive Technology).

8. DISCUSSION AND CONCLUSIONS

Our experience with several offerings of the course, along the survey data, seem to indicate that the structure, course material, and coursework do improved the students' perception about themselves, disabilities, assistive technologies, and universal access. Most students also felt they have become more comfortable working and interacting with people with disabilities.

Our experience also shows that projects and volunteering activities involving either direct interaction with a person with disabilities or exposure to various disability issues made the students feel more comfortable around persons with disabilities. Some students who were already interested in this area became more passionate after this course, while others even considered undertaking a career in a disability-related field, or at least volunteering with support organizations.

Most students stated that they became more aware of accessibility in their environment. They mentioned that they notice accessible and non-accessible areas around campus, and that they learned to identify accessibility problems. Improved awareness of accessibility in campus buildings contributes to the students' increased awareness of social and environmental obstacles faced by people with disabilities. This has prompted some students to believe that a career in a disability-related area would be fulfilling, with some stating that they would definitely include disabilities in their political/legislative activism.

Although most students felt that they were more comfortable with and interested in disabilities after taking this course, this was not always the case. Some students still felt they needed more experience with people with disabilities to learn how to engage socially with them and to improve their comfort level around them. Some more attention should be paid to this issue in future course offerings. For example, we might include a class discussion about how to interact with a person with a certain type of disability. This was also brought up in the students' comments: for example, some students wanted to know more about to help persons with different disabilities (how to help a blind person to cross an intersection, how to help a person with a wheelchair in front of a steep ramp, how to speak to a deaf person who lip reads, etc.).

More guest lectures with persons with disabilities can also improve the students' comfort level and "break the barrier", especially when the lecturers talk about details of their daily lives. We have noticed that, when persons with disabilities are invited to talk to the class, students often ask them questions about their social interactions and day-to-day activities. For example, one student asked a blind lecturer if he could dream, and what his dreams looked like. Direct interaction with persons with disabilities within the context of a class meeting proved a great opportunity for students to have their questions and concerns addressed, to validate and possibly modify their prior perception of disability, and to better understand the differences and similarities between their lifestyle and that of a person with a disability. In the future, we will consider assessing the change in students' attitude toward disabilities through a formal metric, such as the Attitudes Towards Disabled Persons Scale (ATDP [5]).

We have described a General Education undergraduate course on Universal Access, Disability, Technology, and Society. We have shown that this course has generally improved the students' subject matter knowledge, comfort level, and interest in volunteering activities and even in disability-related careers. We believe that our experience may inspire other educators and academic institutions to include similar courses in their curricula. Here are the main characteristics of our course:

- The course material is supplemented with guest lecturers (who are either persons with special needs or those working in disability fields) and relevant videos to improve the learning experience. Many illustrative and helpful videos are freely available on YouTube. One advantage of using YouTube in addition to being free is related to Google's new and free initiative to automatically caption YouTube movies using their speech recognition application[2] (albeit with some errors due to the nature of automatic speech recognition). This will make it easier if captioning needs to be performed for deaf students, for example.
- Students are required to undertake projects or volunteer work involving people with disabilities. This provides them with direct experience and helps to improve their perceptions about disabilities.
- Course material that builds the students' general knowledge base about disabilities is provided online. In the course feedback, some students indicated that they appreciated the fact that online material was available online. It allows them to immediately click on resource links without having to manually type them.

Finally, we would like to emphasize that our students normally have little knowledge about disabilities before taking this class, as emerged from the class survey. Some students even stated that they never thought about disabilities prior to taking this course. This is rather alarming, as it shows little general awareness of this topic in the student population. The outcome of this course, as measured by the survey, is promising in relation to changing this trend. For the most part, after taking this course, students feel that they have a better understanding of life with a disability, are more comfortable interacting with persons with disabilities, have an increased awareness of accessibility issues, and are more open to undertaking disability-related volunteering activities or even career paths.

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