The Summer Academy for Advancing Deaf and Hard of Hearing in Computing

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ABSTRACT
Deaf and hard of hearing students are an underrepresented group in computing and face extra challenges in university-level computing courses. This paper describes a 9-week Summer Academy for Advancing Deaf and Hard of Hearing in Computing that jump-starts the academic careers of deaf and hard of hearing students and strengthens their interest in computing. Students take introductory computing and animation in a fun, supportive, accessible environment. We report on some of the problems students face and lessons we have learned about helping them overcome those problems. Through the academy, they meet other successful deaf and hard of hearing technology professionals, tour top computing companies, and display their own work to the local deaf and hard of hearing community. Students gain leadership, independent learning skills, and complete the program better prepared for a college major in computing.

Categories and Subject Descriptors
K.3.2 [**Computer and Information Science Education**];
K.4.2 [**Social Issues**] *Assistive technologies for persons with disabilities*

General Terms
Design, Human Factors.

Keywords
Deaf and hard of hearing students, CS 1, CS 0.5, Animation.

1. INTRODUCTION
Students with disabilities are currently under-represented in academic programs and careers in computing [6] even though the numbers of these students entering mainstream universities and colleges are increasing [3]. Unfortunately, the Taulbee Report, the standard demographic report for computer science, does not track the number of students or faculty with disabilities and exact numbers would be difficult to determine. However, the barriers that students with disabilities face in this field are preventing a type of diversity that would benefit both the disability population and the computing field.

Deaf and hard of hearing students face extra challenges compared to their hearing peers: some enter college with very different educational backgrounds, skilled sign language interpreters and captioners with advanced domain knowledge can be difficult to find, and collaboration inside and outside the classroom can be strained with language barriers [4]. Successful deaf and hard of hearing computing professionals demonstrate that opportunities do exist. But achieving success requires developing academic, technical, and self-determination skills despite potential barriers of inaccessible curricula and resources, inadequate support, lack of encouragement, and few role models [2].

The Summer Academy for Advancing Deaf and Hard of Hearing in Computing is a 9-week program that jump-starts the academic careers of deaf and hard of hearing students. It is designed to assist students in addressing these barriers in a challenging but supportive environment. By augmenting introductory computing and animation with support from tutors and mentors, we hope to provide better preparation for college level classes in computing and other sciences in which support may be less readily available. The students come to the University of Washington from all over the U.S. and they receive academic college credit, knowledge of university accommodation options, exposure to research, contacts at top computing companies, academic and self-advocacy skills, and experience working in a team on a large, technical project. We report here on the academy's first two years (2007 and 2008).

Transition programs for deaf and hard of hearing students at other universities have also seen success. Gallaudet, a liberal arts college for the deaf, hosted a 4-week summer program in 2006 to help potential computing majors transition from high school. TechGirlz is a weeklong camp for middle-school girls hosted at the National Technical Institute for the Deaf at Rochester Institute of Technology and focuses on several different sciences.

Our academy targets students in the transition from high school to college, a critical juncture during which students begin to decide their major field of study [1], and introduces students to actual for-credit university courses. We designed the academy to prepare students for college-level classes and promote computing as a future career. We accomplished this through mentoring and tutoring, choosing courses at appropriate levels for their abilities and interests, introducing them to successful people in computing careers who are both deaf and hearing, and organizing field trips to top computing companies that hire computer science graduates.

The overall goals of the Summer Academy are to:

- bridge the gap between a K-12 and a college environment,
- expose students to realistic, college-level computer science courses and topics within a supportive and fun environment,
- provide proper help and approachable tutors, but encourage independent learning and creative problem solving.

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Outcomes of and student reactions to the 2007 and 2008 Summer Academies included broad improvements in social and teamwork skills, better knowledge of computing as a whole, and improved study habits and time management skills.

2. CURRICULUM

For some students, the Summer Academy represents a first exposure to computer science courses; for some it is the first exposure to any college course. For this reason, we wanted to choose courses that would be fun and engaging, while also giving them skills that would prepare them for a major in computing.

The following criteria were used to select the courses for the academy and represent important aspects of an introduction to computing for a young, deaf and hard of hearing audience:

- The course must illustrate an exciting application of computer science to which the students can relate.
- The course must engage and develop the students' creativity and problem-solving skills in computing.
- Projects must be easily accessible to our students.

To achieve these goals, we chose one of two introductory programming courses and an animation course designed to showcase an exciting application of computer science. Although we could have designed a customized curriculum, we felt it was important for students to participate and succeed in typical computer science courses offered by the university.

2.1 Introductory Programming

During the 2007 academy, all of the students took a CS 1 Java programming course. In 2008, the students took one of two different introductory programming courses. Students who would continue on in high school the following fall took an online web programming course in HTML and Javascript at the CS 0.5 level. Students who would begin or continue on in college the following fall took the CS 1 Java programming course. All of these courses were mainstream courses taught to both hearing and deaf students and students earned academic college credit for the courses.

The CS 0.5 course topics covered HTML, variables, expressions, data types, functions, parameters, return values, decisions and conditionals, logical control flow, loops, arrays, objects, and algorithms such as sorting. The CS 1 course covered all of the above as well as file processing, defining objects, and inheritance.

CS 0.5 was a gentler introduction to programming, but was not excessively easy or watered-down. Students learned nearly all the concepts taught in CS 1 except for objects and inheritance. Plus, the "coolness" factor of building web pages with Javascript added modern relevance that motivated the students and gave them concrete examples of how they could apply the course content to future projects. Like many students, some of the Academy students in CS 1 struggled with the fast-paced nature of the class and abstract concepts such as objects and inheritance.

2.2 Animation

We also created an animation course specifically for the Summer Academy. The course included 3D modeling, design, lighting, animation, and video editing using Maya 3D, Adobe Photoshop, AfterEffects, and Premiere (see Figure 1).

Students worked in groups to develop animated shorts (1- to 2-minute films) for the final project. They first created paper storyboards outlining characters, storylines, and scenes. A local deaf actor, whose credentials include several years traveling with the National Theater of the Deaf, helped the students develop intriguing yet short, manage-able stories. During the last 3 weeks of the course, students hosted critiques of their shorts to get feedback from outsiders at each design stage: initial storyboards, rough outline models and animations, and nearly final shorts.

Figure 1: A Student works on her group's animated short with the help of the instructor and an interpreter.

The teams consisted of a production lead (one student that organized the shots and scenes), a modeler (responsible for modeling the characters and shapes), an animator, a cameraman, and an editor. At the end of the quarter, the shorts were displayed at a Community Premiere attended by several members of the Seattle deaf and hard of hearing community and students received a Certificate in Computer Animation.

Team work required to finish the animated short turned out to be one of the most valuable aspects of the Summer Academy. Many deaf and hard of hearing students are the only (or one of only a few) deaf students at their school and may have never had the opportunity to work on a team. And very few of the students in our academy had worked on a team with other deaf students.

3. DESIGN OF THE ACADEMY

The best way to excite and engage students in computing fields is to expose them to innovative, personally relevant aspects to give them a better idea of ways they may contribute to the field in the future [7]. The Summer Academy did this through invited guest speakers and mentors, field trips to local companies, contact with people in the field, and opportunities to showcase their work to members of their own community.

3.1 Guest Speakers and Mentors

Guest speakers from both academia and industry gave talks each week to inspire the students and broaden their view of computing. We chose speakers who are themselves deaf or hard of hearing, speakers whose work relates to the deaf community, and speakers who work on interesting, exciting, or socially relevant projects. Examples included deaf technology developers at CSDVRS (a national Video Relay Service where operators facilitate phone calls between deaf people and hearing people by signing what is spoken and voicing what is signed), a hard of hearing employee at Cray, a deaf programmer at IBM, a hearing researcher working on classroom technology for deaf and hard of hearing, and a deaf professor in Computer Science and Deaf Studies at the National Technical Institute for the Deaf at Rochester Institute of Technology. The speakers were diverse in a number of ways: communication styles (some using sign language, others speech),

gender (3 women, 6 men), and a diversity of ethnic backgrounds. After the talks, students signed up to meet with guest speakers to encourage networking skills for the future now.

3.2 Visits to Computing Companies

Students visited some of the top computing companies in and around the Seattle area including Adobe, Boeing, Google, Intel, Microsoft, and smaller game design companies such as Gas Powered Games and Valve. Students toured the facilities, met with deaf and hard of hearing developers at many of the companies, and saw new projects under development.

Figure 2: Field trip to Google Seattle, 2008.

Field trips to companies allow students to have a first-hand look at what computing professionals do on the job and gave them a sense of the breadth of careers in computing fields (see Figure 2).

3.3 Community Premiere

At the end of the 9-weeks, students displayed their own animated shorts at our Community Premiere (see Figure 5 and Figure 6). People from the Seattle deaf community attended the formal evening showing. The premiere was a nice way to encourage community involvement in the project, motivate the students to produce showcasing work, and inspire the community as a whole about the accomplishments of the students.

4. ACCOMMODATION & PREPARATION

Students were taught in a variety of environments. The CS 1 course is very popular at this university and even summer quarter attracts upwards of 100 students. The instructors and the majority of students are hearing. The animation course was designed specifically for the Summer Academy, the instructor was hearing and was accustomed to teaching hearing students. The CS 0.5 course was an online, distance-learning course. The online nature of the course added some accessibility benefits as all of the notes, lectures, homework, and discussion forums were text-based.

Each class session, lab session, and study group was augmented with interpreters, a real-time captioner, and (in 2007) a cued speech interpreter. Student preferences dictated accommodations we provided. Whenever possible, we chose interpreters and captioners with some knowledge of programming or who had taken a CS 1 level course before. It was also crucial to schedule the same interpreters and captioners throughout the quarter as knowledge of material and signs for technical terms develop.

Some students had not used captions before and told us that even though they preferred sign language, the captions were helpful, especially for technical terms and new vocabulary. Others had not used an interpreter before and, conversely, some told us they enjoyed the alternate information modality. Reading captions can be similar to reading a textbook, so an alternate, sometimes more interesting, mode of information was helpful.

To increase access to courses, we employed two deaf students from the 2007 Academy to come back and tutor for the 2008 Academy. Both students had first-hand experience with Summer Academy courses and mentoring deaf students, so they were ideal candidates to help improve the accessibility of our program.

Before the summer courses began, we held an orientation for teachers, tutors, staff, and other interested parties on how to teach and work with deaf and hard of hearing students. The session was led by the third author, who is himself deaf, and guest speakers including representatives from the Disability Resource Services office and the deaf and hard of hearing accommodation coordinator for university events and courses. Tips and suggestions for the session were drawn from personal experience, local expertise, and accessible teaching materials [2, 5].

5. BENEFITS OF THE ACADEMY

For many students, the Summer Academy strengthened their interested in computing and helped them to realize that a career in this field is a realistic goal. Because of diverse student backgrounds, benefits of the Academy were equally diverse.

5.1 Diverse Student Backgrounds

Deaf and hard of hearing students experience a huge range of educational backgrounds due in part to a recent trend toward mainstreaming in the U.S. In 1970, Public Law 94-142, now Individuals with Disabilities Education ACT (IDEA), mandated that all children with disabilities be assured a free appropriate public education. With this law came a push away from centralized, residential schools specifically for deaf children toward deaf programs and accommodations to mainstream public education. Now, most deaf children (~85%) are educated in mainstream schools [8].

Because many students are mainstreamed, they are often isolated, they lack mentors, and they face barriers caused by difficulties of the K-12 system to meet a wide range of student needs. Some students do well in mainstreamed programs with appropriate accommodations, other have needs that are not met. Educational approaches also vary. For some students, speech training and lip reading is emphasized and, because of the inherent difficulties, they miss out on other valuable content. Other programs emphasize signing and using interpreters in class and the students' education depends greatly on quality of available interpreting. Even signing programs vary from American Sign Language (ASL), to Signed Exact English (SEE) where students are taught a sign system using English language structure, to "Simultaneous Communication" (using both sign language and speech at the same time), and other mixtures specific to the student's school or home. Furthermore, K-12 teachers sometimes (intentionally or un-intentionally) lower their expectations and dilute the curriculum for deaf students, thereby disempowering them as successful learners in both high school and college.

Regardless of educational philosophy, it is not uncommon for a deaf person to struggle with spoken and written language.

Hearing people learn spoken language naturally without actually being taught, much as deaf people born to deaf parents learn signed language naturally. However, over 90% of deaf children have hearing parents who do not know any signed language and many are not exposed to language in a natural way during early critical years of language acquisition. This may be a reason some deaf people have difficulty with written language [3].

The transition from high school to college is a critical time for deaf and hard of hearing students because college-level classes may require different accommodations than high school, students must now self-advocate for accommodations, and courses may be faster-paced and less accommodating. Transition programs, such as summer college preparation programs, mentoring, and internships are positively correlated with better academic and employment outcomes of program participants. For many students with disabilities, transition programs are essential for successful transition to and success in college and careers [1].

At our Academy, students are treated as adults who can manage their own time to complete academic work, and have fun as time allows. Most students respond well to this freedom, but as with all young adults not used to this much personal responsibility, there can be problems. We are proactive in talking frankly with the students about personal responsibility, relationships, and personal problem solving. We help the students mature by having high expectations and by reinforcing their good choices. We have access to professional counseling if needed.

The Summer Academy tries to create a supportive environment with appropriate help and approachable tutors, but we also encourage the students to work independently, solve problems creatively, and check their own work. Not all are accustomed to this style of learning, but for some, the independent learning skills developed at the Academy will carry through and help them throughout their academic career.

5.2 Diverse Student Benefits

To date, 20 students have attended the Summer Academy; 4 young women and 16 young men. After the initial weeks of the program, it became clear that 2 students were not adequately prepared for the Academy. These students did not complete the program. Of the 18 who did, 5 were continuing on in high school the next fall, 9 were transitioning into college the next fall, and 4 would continue on as a sophomore or junior in college.

Performance has varied in the CS 0.5 and CS 1 courses: 9 of 18 succeeded at a level that they could go on to the next computing course, 6 students received above average scores. All 18 students who completed our program also completed the CS courses (CS 0.5 typically sees a 30% dropout rate and CS 1 typically sees about a 10% dropout rate). And all 3 students who took the CS 0.5 course passed, with 2 of the 3 receiving above average scores.

All of the students, except for one deaf-blind student in 2007, successfully completed the animation class earning a Certificate in Computer Animation. The deaf-blind student studied discrete mathematics instead of computer animation because his vision was not sufficient enough to work with the animation software.

During the summer of 2008, we asked the students to fill out pre- and post-questionnaires regarding their current skill level in introductory programming and animation. The students rated themselves on a scale from 1 to 5 (1 being "What's that?" and 5 being "Way above average") on 30 statements, for example, "Understanding iterations (for/while)," "Using parameters and return values appropriately," "Creating advanced computer animations," and "Using editing tools such as Adobe AfterEffects and Adobe Premiere."

Figures 5 and 6 show the responses to questionnaires as an average by topic area and separated by each student. Some students benefitted from the program more than others, but overall the program had a positive effect on the students' knowledge of computing concepts and animation techniques.

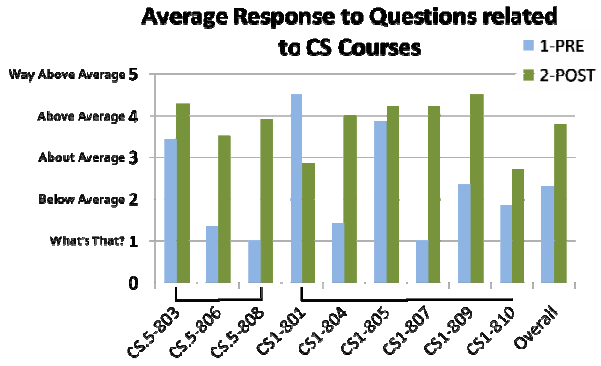

Figure 3: Pre- and post-test responses to Computer Science questions. The three on the far left took the CS 0.5 course.

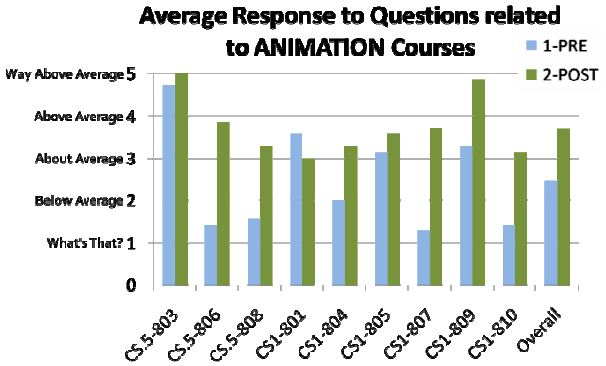

Figure 4: Pre- and post-test responses to Animation questions. All students were enrolled in the same course.

The 2008 post-test also asked "Overall how much did you benefit from participating in the Summer Academy" on a 5-point scale. Eight of nine students marked "5 very much," one marked "4".

In both years, many of the students were undecided about the major they would choose in college before they entered the Summer Academy, but most knew a computing-, technology-, or math-related field would suit them. After the Academy, 13 of the 18 indicated an interest in a computing-related major or minor such as Computer Science, Information Technology, Software Engineering, Electrical Engineering, or Game Design. Other students told us they plan to pursue Applied Math, Pathology, and Civil Engineering. Many changed their plans and modified their expectations of themselves: for example switching from web design to computer programming and deciding against "working on hardware" to instead "working on software".

Likely because of the team-oriented animation projects (see Figures 3 and 4), leaders emerged. Each group had a "project

lead" for animated shorts, giving students the ability to take a leadership role. Some students also became informal mentors to other students as they understood and completed the homework and could provide explanation and help to those still struggling.

One unforeseen benefit was improvements in sign language skills. Some of the students came to the academy with little or no sign language ability; others had life-long sign language skills. Both years, we witnessed increases in sign language use. This was not something we explicitly taught, but just naturally developed as students came to know each other and worked together on homework and projects. We also saw improvements in general communication, experience working with interpreters, and communicating with people with different communication styles and abilities. Not unrelated, students gained confidence, pride, and self-identity as being deaf or hard of hearing through interactions with students to whom they could relate.

Figure 5: Screen shot from the animated short created by Group 1 entitled "Love at Last Sight."

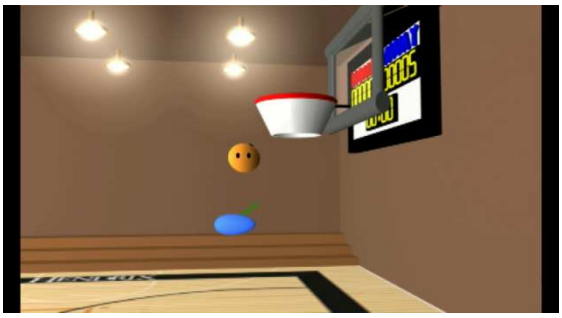

Figure 6: Screen shot from the animated short created by Group 2 entitled "Papa Ball's Little Bouncer."

After one year, we asked the 2007 students how the academy benefited them most. One student responded "Most thing that it affected me is that it made me to realize that there are many opportunities of different jobs out there for me, it doesn't matter how hard the courses are, or just because I'm deaf. I can really do anything so I'm going to do whatever I want to be in the future." Another said, "I am slightly less shy now, I may get a job soon."

We also asked the 2008 students how the Academy benefited them most and one said, "the education and everything including conflicts with other students helped me to find another way to solve [problems] which also helped my leadership skills."

6. LESSONS LEARNED

The Summer Academy has taught us many lessons about deaf and hard of hearing students in university level classes.

Diversity is the norm. Deaf and hard of hearing students have a diversity of accommodation needs (sign language, cued speech interpreters, and real time captioners). Diversity also exists within sign language preferences: for example ASL, SEE, and SimComm. The students worked with interpreters to develop signs for computer programming vocabulary. The students were also diverse in their abilities, with some student having multiple disabilities (Usher's Syndrome (deaf-blindness), Tourette Syndrome, Cerebral Palsy, and learning disabilities).

Recruit tutors and mentors from the disability population. Tutors who are themselves deaf or hard of hearing can better relate to the students, better understand their specific challenges, and serve as mentors.

Take time to teach the teachers. Teachers in our program were hearing and accustomed to teaching hearing students. Students benefit when instructors understand student needs and are able to modify their techniques slightly to better accommodate the audience. Examples include, pausing to account for interpreter delay and making sure materials such as slides and code are displayed long enough for students who are splitting their visual attention to have time to both look at the materials and watch the interpreter or captions. For more guidelines see [2] and [5].

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