BUILDING BRIDGES: THE 2006 SUMMER INSTITUTE *

Lori Scarlatos
Stony Brook University
Stony Brook, NY 11794-3760
Lori.Scarlatos@stonybrook.edu.

Susan Lowes
Teachers College, Columbia University
525 W. 120 St.
New York, NY 10027

Elizabeth Sklar, Samir Chopra, Simon Parsons, Ira Rudowsky, Heidi Holder
Brooklyn College
2900 Bedford Ave.
Brooklyn, NY 11210

ABSTRACT

In an effort to broaden participation in computing, the authors have initiated a series of interventions focusing on the recruitment, preparation, and retention of under-represented students in computer science. Their approach is to emphasize the practical side of computing through a series of tracks: business, law, medicine, graphics and multimedia, and robotics and simulation. This paper describes one of those interventions: a summer institute, conducted in 2006, that gives local high school students a taste of what computing is all about.

INTRODUCTION

After years of unprecedented growth, computer science departments across the nation have recently experienced a precipitous drop in their enrollments, with the number of newly declared computer science majors falling 50% from 2000 to 2005 [4, 5]. At the same time, the percentage of women and minorities in the IT workforce has dropped even further [2]. As noted by Freeman and Cuny, this "under-participation" of certain groups represents "a loss of opportunity for individuals, a loss of talent in the workforce, and a loss of creativity in shaping the future of technology" [3].

The Broadening Participation in Computing project at Brooklyn College addresses this problem by helping under-represented minority and female students to initially make the transition into computer science, and ultimately work within their urban communities as role models. It achieves this with a series of interventions that demonstrate the importance of computer science in a larger context, and provide peer mentors and role models at varying levels. This paper reports on one of these interventions: a summer institute for high-school students, held in July 2006.

The purpose of the summer institute was to give high-school students a chance to explore context-based computing concepts in a relaxed and friendly learning environment, surrounded by computer science researchers and students. Inspired by other successful summer programs [1], we aspired to give the students a taste of what they will be able to do after four years of training in computer science, while emphasizing the need for adequate preparation. While giving low-income students a rare opportunity to work with computers in a meaningful way, aided by computer science undergraduates that are just like them, we hoped to convince them that they, too, can succeed in computer science. Finally, we wanted to show guidance counselors that CS can be a good career option for their students.

PARTICIPANTS

Five computer science professors participated in this intervention. Their goal was to convey the excitement and importance of computing in five tracks: demonstrating new technologies in graphics and multimedia, robotics and simulations, and practical applications of computing to the medical, legal and business fields. Each professor worked with two student ambassadors to help plan and present these topics, and to create a true bridge between the faculty and the high-school students. These student ambassadors were a diverse group: half were women, half were Black, and only three were White. An outside evaluator also worked with us to plan, design surveys, and analyze the results. The high school students were actively recruited by our high school liaison, who has a close working relationship with the local schools. We wanted to focus on Black and Hispanic females who had high enough math and science grades to support a CS major but were not planning to major in CS.

Student Demographics

A total of 63 applications were received from eight local high schools for the summer institute. Of these, 31 students attended at least one week of the two-week institute; an additional 4 students (who did not submit an application) also attended. The applicants and attendees represented exactly the population that we intended to reach, with many of the students coming from newly immigrated families. All reported that they planned to go on to college, with the primary anticipated barrier being their finances. All but 16 of the 55 who answered the question reported they knew adults who worked with computers. What the students said they would like to do with computers ranged from constructing computer systems to modeling the human genome, but the emphasis was on graphic design. The reasons they gave for wanting to attend the summer institute was not a good predictor of who would attend.

A comparison of those who applied with those who attended suggests that the group that attended self-selected for gender, perceived competence with computers, and having math as a favorite subject. Among the applicants, the largest proportion believed that they were "okay" with computers; yet among the attendees, those who thought they were "pretty good" made up a larger proportion. More male than female applicants thought that they were "pretty good." This could be particularly important because the female attendees self-selected at a higher rate than the males for perceived computer expertise. About 40% of the applicants listed math as top among their favorite subjects. Students whose favorite subject was Science, English, or History did not attend in numbers proportionate to their applications. This was particularly true for females. This suggests that future outreach efforts need to emphasize that computer skills are not a prerequisite. It also suggests a need to reach out to non-math students, which may involve more work with guidance counselors who tend to associate computers with math and, as a result, recruit math students.

As would be expected, these students all used computers for school work, at a job, or just for fun. Although the students were more familiar with cell phones than email and least familiar with digital and video cameras, 87% reported using the Internet for research at least several times a week. 64% of the applicants and 61% of the attendees included playing games in their list of what they do for fun. Among these, boys were more likely than girls to play games, and only the girls listed card games or solitaire among the games they like to play. The applicants were most likely to use computers at home or at a relative's house than at school. This confirms what is known about students' access to computers at the large New York City high schools, where the computer labs are often locked and/or reserved by specific teachers, and do not have open access hours for students.

SUMMER INSTITUTE ACTIVITIES

The summer institute was scheduled over two weeks in July, soon after the start of the high school students' summer break. In planning this intervention, the professors struggled to achieve a balance between academic and informal, theory and practice, fun and work. We decided to schedule working sessions from 9:30-11:30 AM and 1:30-3:30 PM, with a two-hour lunch period for watching movies (created by and about computers), touring the campus, socializing, and just relaxing. Working sessions were held either in a classroom with laptops or in labs using both Macs and PCs.

In the first two and a half days of the institute, small groups of students rotated through five two-hour workshops corresponding to the five tracks. At the end of the third day, students were asked to select a track for the second week. Although students were all given one of their top three preferences, assigned on a load-balancing basis, some of the students expressed severe dissatisfaction with their assignments. Wanting to make this a positive summer experience, the students were polled again and given their first choices without being concerned about load balancing. Interestingly, many students chose something different the second time around; we suspect that, more than anything, the students wanted to be with their friends. For the remaining five days, the professors and student ambassadors worked with their student groups, with everyone gathering together during the lunch periods. At the end of the summer institute, students put on an evening

showcase event to show off their projects to each other, as well as parents, siblings, and friends. It was clear the students were very proud of their work, and many insisted on providing detailed descriptions of their work.

The five participating professors made the following personal observations about the summer institute activities in their five tracks.

Business Applications: "E-Biz"

I had a few topics I thought I'd cover but once I started with HTML that's all they were really interested in. The instant feedback and ability to express themselves in text, images, music and color opened up new avenues of expression they were all eager to use. A few in the cohort had previously used mySpace.com to put up web pages but they just used the tools provided and really didn't know what they were doing. I began the second week by encouraging the students to come up with their own ideas for web sites. I explained the importance of working as a team in the business world. The teams spent part of the morning discussing and designing their website and in the afternoon began working on the actual content. Each morning and afternoon session began with a short lesson in some features of HTML; the students took to it immediately and incorporated it into their web pages. I also showed them the website youngmoney.com and tried to start a competition in stock investing. Initially, there was some interest but that waned as the week progressed. The students set the pace of development and the ambassadors and I stepped in when they had technical questions or difficulties. By Wednesday, the teams began sharing ideas and comments about each other's websites.

It's important to minimize lectures and have a lot of student directed, hands-on work to engage them. By telling the students to create a web site and giving them the choice of what to include and how to design it, not one student bailed out. At the Showcase, they were all very proud of their work and couldn't wait to show it off to family, friends and other students in the program. The program also allowed me to get to know some of the ambassadors. These intense, eight days gave me a better appreciation of what they can do. I hope the reverse was true and the students got to see the professors in a different light.

Legal Applications: Cryptography

More people signed up than I expected, and it turned out to be an all-girl group. Initially, the tutorial seemed a bit wordy to them, but once the ciphers started showing up, they became more interested. I had to explain modular arithmetic when we got to multiplication ciphers but most seemed to get the hang of it quickly. There was a big "eureka" moment when I pointed out that computers and mathematics entered the picture at this point because we turned letters into numbers and then operated on them. A very interesting social interaction occurred at the end of the day, when students from another group walked into lab. Some of the boys who knew girls in my group seemed intimidated, saying, "Man, that's some crazy s**t, you going to work on that?" For a moment, I had a glimpse into the amount of disparagement girls must put up with for being interested in material like that.

When we got to public keys, we talked about how it could help us to solve the problems of secure communications, protecting against tampering, digital signatures and non-repudiable documents. They loved the "niftyness" of it all, especially when I showed how digital signature verification plus encrypted email was close to our locked box example. Towards the end of the day I gave them an elementary introduction to the RSA cipher. My student ambassador, found an example of a large prime number like the ones used in RSA; everyone was suitably impressed, and reasonably convinced factoring it would take forever! One amusing moment: there was a girl in my class who I had overheard complaining about math in high school. When I introduced the RSA cipher, I mentioned relative primes and asked the class if they knew what that was. Up went her hand: "Isn't that when they don't have any common factors?" I wonder if her math-dislike was a put on?

The showcase went off well. The students enjoyed showing off their use of PGP and explaining it to everyone. All in all, it was very gratifying in more ways than one.

Medical Applications: Biologically-inspired Simulations

This section focused on the intersection between computing and the medical field, emphasizing biologically inspired models and simulations. The sessions were built around the use of NetLogo, a package for doing simple agent-based simulations. When we planned the summer institute, my intention was to engage the students by showing them how they could use NetLogo to create colorful, animated simulations that were fun to program and use. It was also to tie the use of simulation back to science, showing how, for example, one might use simulation to perform experiments that would be impractical “in vivo”. This approach was reflected in the “taster” session which introduced simulation through the use of flocking models and the way that such models could be used to create animated crowd behavior as in the wildebeest stampede in “The Lion King”. We watched footage of the stampede sequence, compared it to flocking simulations, and discussed how changing the parameters of the simulation changed its behavior.

Only a handful of students chose the simulation part for the second week, and those that did worked steadily through the NetLogo tutorial to construct a first, simple, simulation based around hill-climbing. With this completed, I encouraged the students to think big and create their own simulation from scratch, drawing ideas from the library of models that is supplied with NetLogo. While all created models that were some kind of ecological model, the results were very credible, and the students had great fun explaining them to their parents at the showcase event.

New Technologies in Graphics and Multimedia

In the first week, I talked with the students about the pervasiveness of computer graphics and multimedia in our lives, and showed short Pixar animations to demonstrate that good stories don't need narrations or dialogs. I also had a broad spectrum of applications that they could play with: educational games that came from my research projects, 2D games and 3D interactive models created by my undergraduate students, and games and visualization tools developed by others. I also had some sample "worlds" created with Alice (CMU's teaching tool) as an example of what the students might do

in the second week. Yet I discovered that the students quickly tired of playing someone else's games; they wanted to make their own. Each day in the second week of the institute, I gave a brief overview of some computer science topic by showing how it applied in Alice. I covered program design (scenarios and storyboarding), objects (classes, properties, and methods), events (mouse and keyboard) and other programming concepts (conditionals, loops, variables, functions and parameters). I told them that they could create anything ... as long as it was something that they would not be ashamed to show their grandmothers.

I noticed that the boys generally liked to sit near one another and look over one another's shoulders. One of the male student ambassadors quickly made friends with the boys and would often sit and chat with them about their movies. This camaraderie was a great motivating factor: these boys came to the sessions early, and were reluctant to leave at the end of the day. The one girl, however, initially sat alone and wandered in later than the others. Yet after I asked my very shy female student ambassador to go sit and talk to her, the girl looked much happier and put more effort into her project. It was clear to me that the student ambassadors were key to our success, primarily because they did show high school students that computer scientists can have fun and be friendly ... and they "look just like me". In the end, each of the students produced a very unique animated story using Alice, which they were happy to show off at the Showcase.

New Technologies in Robotics and Simulation

The aim of the Robotics section was to show students how robots are currently being used in various everyday settings. During the half-day teaser in the first week I brought a Roomba robot vacuum cleaner into the classroom and showed them how it works. We talked about how a robot is a canonical agent—it has a controller (i.e., brain) that produces output (e.g., moves) in response to input (e.g., sensing dirt on the floor). Then I had them build a robot using the LEGO Mindstorms. I had a test program, written in RoboLab, ready for them to download and tryout their robot once it was built, which made the robot go forward for 5 seconds and then stop. Once they had all built their robots, they raced them in the hallway to see whose robot went the furthest. We discussed our observations of the race: most robots did not go straight and some went faster than others. We talked about calibration, how to use software and/or hardware to compensate (e.g., to make a robot drive straight) and about gear ratios. They modified their robots and ran the race again.

The students were enthusiastic about the robots, though some thought that LEGO was “just a toy”, and did not make the connection with real-world robots like the Roomba. I told them that if they stuck with robotics for the following week, they would learn an icon-based graphical programming language, RoboLab. One student stuck with Robotics in the second week and did some very good work. Using multiple robots wandering around the classroom, he figured out how to make one over-write the program of another. This was demonstrated at the Showcase.

EVALUATION

Out of 35 students attending Week 1, 31 students also attended Week 2. In general, the girls were more satisfied than the boys: 79% of females reported that they enjoyed it "very much" compared to 57% of males, although about 70% of both groups felt they had "learned new things". The students rated all of the academic aspects —faculty, graduate students, university ambience — highly but were less enthusiastic about the movies and the food. Although less than one-quarter felt that the institute was "definitely" what they had expected it to be, many indicated that the institute was better than their expectations, not worse.

The students overwhelmingly liked Week 2 better than Week 1. Those who liked Week 1 best liked the variety. Those who liked Week 2 best liked being able to focus on one topic of their choice. Their reasons for choosing a particular workshop in Week 2 showed how important the first week was in making that choice. When asked about what they had liked about the Week 2 workshop, their excitement about learning something new comes through. Asked if they had any suggestions for making the institute better, most wanted more activities (meaning both more things to do in general, and more workshops in particular) and a faster pace. Several wanted more than two weeks. The students were also asked if there was anything that should not be changed. Most listed the professors, and many also included the student ambassadors and the location. Several said specifically that they wanted to keep the schedule.

CONCLUSIONS

Overall, the institute should be considered a great success. Student complaints about peripheral and logistical issues do not seem to have affected their overall enjoyment of the actual workshops. The format—one week of overview and one week of work in a single area—seems to have worked well. The main issue is the matter of expectations: the fact that this was a better experience than many had expected suggests that they were expecting a traditional summer school format rather than a computer camp. In addition, the students seem to want to focus on areas that they believe have real-life applications (E-Biz, Graphics, Cryptography), suggesting that they need to understand the ultimate purpose—in terms of computer science or employment—of each workshop subject.

ACKNOWLEDGEMENTS

This work is supported by the National Science Foundation, award no. 0540549.

REFERENCES

[1] Das, M. (1997) Novel summer camp for underrepresented minority high school students, *Proceedings of the ASEE Conference*, Washington D.C.

[2] ITAA (2003) Information Technology Association of America, Report of the ITAA Blue Ribbon Panel on IT Diversity.

[3] Freeman, P.A. and Cuny, J (2005) Common Ground: A Diverse CS Community Benefits All of Us, *Computing Research News*, Vol. 17/No. 1.

[4] National Science Foundation, Division of Science Resources Statistics (2006) S&E Degrees, by Race/Ethnicity of Recipients: 1995-2004, NSF 07-308. S.T. Hill and M.M. Green, project officers, Arlington, VA.

[5] Vesgo, J. (2006) Drop in CS Bachelor's Degree Production, *Computing Research News*, Vol. 18/No. 2.