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Breaking Barriers and Getting Girls Interested in Computing

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Abstract

The alarming decline in the number of women enrolled in college Computer Science degrees. The answer rests in keeping more of the women who are already registered, but new registration is more crucial. Many attribute the lack of interest to preconceived notions of computer science developed in high school, namely that it is a dry topic with no real-world relevance and is therefore only of interest to nerds. At the University of Waterloo, a week-long Computer Science Seminar was conducted for girls in grades 9 and 10, with the goals of attracting them to CS and determining whether or not early introduction to the fascinating range of CS and its uses might alleviate such views. Lectures, laboratories, and events were selected to show the diversity of CS and combat common misconceptions about the field. Results from questionnaires given before and after the lecture show a dramatic uptick in enthusiasm for computer science education at the secondary level.

Keywords; Diversity, Enrichment, High School, Women, and Gender Roles

Introduction

Women, as in many other scholarly fields, have historically been underrepresented in computer science. Women are increasingly enrolling in math, science, and engineering schools, but they are leaving computer science in droves. At the University of Waterloo, the percentage of female students majoring in computer science has dropped from 33 percent in the mid-1980s to less than 15 percent now [6]. The negative impacts of the alarming decline in female participation in computer science are well chronicled [7]. To combat this issue, we have made an effort to promote computer science amongst young ladies.

There are a variety of reasons why some women either never become involved in CS or later lose that desire [5, 7]. Two explanations, however, appear to rise above the rest. The first is that women are more engaged in using computers for practical purposes that help others than in computing itself [2]. The second is that most young women try to escape portrayals of "geeks with monitor tans" [5]. The

The purpose of the J.W. Graham Computer Science Seminar (henceforth the Seminar) is to encourage women to pursue careers in CS by challenging negative perceptions associated with the field. In order to make the lecture "cool" enough for the girls, we adapted a famous t-shirt phrase, originally reading "Canadian Girls Rock," and reworded it as "CS Girls Rock." The phrase served as inspiration for the seminar's overarching subject, which was devoted to challenging false beliefs.

Audience

In 2001, the University of Waterloo's Center for Education in Mathematics and Computing received a three-year, $200,000 Cdn grant to fund a Computer Science Seminar. When resources were secured, planning the program's framework came first. Students who make it to the semi-finals of Canada's national computing competition already get together once a year for a series of days of intense competition. Instead of repeating that workshop, we aimed to provide more CS-related extracurricular activities for high school kids. Finding a class with pupils who were all at a similar degree of computer expertise proved challenging. We also wanted to make sure that women were involved, as the last three years' worth of coding prize champions have all been men. Finding a class of pupils who have never used a computer before and teaching them the basics of computer science is a much superior strategy. We used our resources to host an all-female Seminar, with the goal of exposing young women to the realities of the computing field, giving them good role models, dispelling misconceptions, and inspiring them to study computer science [4].

Grade Level: The target age range of 14–16 years old was chosen for several reasons. First, it's crucial to reach your target audience as soon as you can after you decide to challenge the media's CS clichés. The results of our poll supported our hypotheses that the females had already begun to internalize these prejudices. It's probable, though, that prejudices become more ingrained in high school. Second, because some 30% of female pupils in their first year of college report that a

[5] It is important to pique students' interest in CS before they enter college by offering a computer education while they are still in high school. Last but not least, few pupils in ninth and tenth grades have had any exposure to computer code or technology. Because of this, we were able to presume that none of the females had any CS background and work from there.

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Scope and Size: The class attendees were selected to represent a wide range of states. Since the CEMC organizes nationwide high school math and computer competitions, we already had a network of contacts established. The girls' experience was enriched by the opportunity to network with peers from across the United States. To avoid having the classes and laboratories become overcrowded, we capped attendance at 40 people. The ideal group size would have allowed for substantial one-on-one time between pupils and speakers/organizers.

Selection Process

For only 40 open jobs, we got over 900 applications after mailing out fliers and application papers to the Head of Mathematics in every secondary school in Canada. With only a paper, a suggestion from a science or math instructor, and a personal statement to go on, two staff members chose the final candidates.

Having at least two pupils from each province or region participate was a major priority for the coordinators, as this would ensure a truly national presence of players. The population of each province and the quantity of replies from each province were used to establish the regional spread of the subjects.

The submissions received were of a very high standard. Extensive prior expertise in computing, attendance at a prestigious private school, and a poor maths GPA were all dealbreakers. Lack of growth options, strong motivation to attend the Seminar and learn CS, and exceptional conditions were all considered when deciding whether or not to keep a candidate. Given the limited availability of CS education opportunities in urban centers, there was a preference for remote regions.

Several members of the school's parent, faculty, and administration community voiced concerns about transportation. We were asked to arrange lodging for parents who wished to accompany their daughters on their trip as chaperones. When feasible, we helped other parents get their girls on the same flight as one another. Organizing transportation for 40 females, aged 14 to 16, from different parts of Canada presented the greatest logistical task.

1 Approach

We organized the Seminar with a number of goals:

1. To spark interest in CS.
2. To show how CS can be applied to many differentfields.
3. To present positive role models.
4. To debunk negative stereotypes.

We decided early on that we wanted the Seminar week to feature faculty-led talks, interactive workshops, and scheduled social gatherings, so we set about planning for all of these elements. A five-person program group comprised School of Computer Science professors, a CS graduate student, and the head of the Women in Mathematics committee decided on the program's details.

The daily schedule consisted of four classes, each lasting 90 minutes. The program's backbone was daily lessons in either code or digital electronics. We invited inspiring professors or graduate students to talk at the remaining Seminar sections on topics we felt young women would find interesting. The availability of an engaging and motivating speaker on a given subject was a major factor in selecting presentations. All of the presenters were primarily focused on winning over adolescent females, a demographic they knew little about.

Infrastructure

Having these young women have the opportunity to live on a university campus and make use of the living halls and school resources is a nice perk, but the location is not the most essential factor in an undertaking of this nature. All of the events took place in on-campus laboratories and lecture halls. Each student was given a unique university account that could be used during lab meetings as well as outside of class time to conduct research or explore other interests. They got a taste of what it's like to be a college student in many respects. What did you take away from the seminar?A student reflected, "I got a kind of feel for university life too, and am almost looking forward to it."

Students will have the chance to meet and engage with role models in a variety of settings thanks to the Seminar. Both the professor and the PhD student who were primarily responsible for organizing the Seminar also gave presentations at different times throughout the week. About half of the workshop speakers were female post-secondary educators. Male role models in computer science who are dynamic and fascinating and who reject the 'nerd' image are just as crucial. When one of the female students said, "We were in the RIM (Research In Motion) lab and there was a really good-looking guy, and I thought: 'You're in computer sciences?'" during a field excursion, the message was driven home.""

Josée Lajoie, a computer science (CS) master's student with a bachelor degree in computer engineering and twelve years of professional experience at IBM, was our first lecturer. She decided to get her master's degree in computer science alongside her fine arts degree so that she could focus on computer animation. In addition, the females had female "houseparents" who were Computer Science and Mathematics majors in their college years. The houseparents ate and slept with the females and participated in all extracurricular activities. These college kids grew close to the ladies over the course of the week. As is the case in many mentorship relationships, the teachers benefited just as much as the mentees. The houseparents were compensated for their time, but they all reported feeling fortunate and pleased to have participated in the Seminar.

Curriculum

6.1 Core Courses

Throughout the program, we had two concurrent main classes. Two courses were offered, each serving as an introduction to a different aspect of digital technology: code and hardware. So that a student could study electronics one day and code the next without falling behind, the courses were developed to be self-contained and flexible.

For many reasons, tcl/tk was chosen as the beginning programming language of choice. To begin, it doesn't cost anything and can be used on a wide variety of devices. It's a straightforward writing language that supports all the fundamental coding elements (variables, loops, selection lines, etc.).

processes), and as such is a great resource for introducing students to new ideas. Students can rapidly and easily create graphical user interfaces (GUIs) for the screen using Tcl/tk. As a result, students are more engaged in the computing process and receive instant, positive feedback on their code. The students' weeklong assignment was a sketching program to which they added features targeted toward a youthful, feminine audience. "I liked the tcl/tk because I got to make something that I can take home and I found it hard, yet satisfying," noted one pupil.

The goal of the "digital hardware" workshop was to provide pupils with a hands-on introduction to computer hardware creation and operation. Binary digits and Boolean reasoning were covered in the first meeting. After that, they moved on to more advanced topics in circuits, such as voltage, current, resistance, and controllers. Modular exercises were conducted throughout the remainder of the week to introduce Boolean logic gates, demonstrate how inputs can be modified through circuitry to display anticipated output, and help the girls gain a better understanding of the computer's components. Because "you had to figure out everything that was wrong and try working with someone to fix it," this class was one student's favorite.

6.2 Curriculum Enhancements

The extra workshops had a critical role to play in showcasing the scope of CS and its relevance to real-world uses. These considerations guided the selection of courses on biology, AI, and computer graphics. The 'History of Computer Science' lesson provided students with background knowledge and set the stage for the subsequent topics. To offer a more accurate picture of what studying computer science entailed, we also included talks on topics like program design and finite state machines.

The pupils were actively involved in a variety of hands-on exercises. The ladies disassembled a computer, learned to identify its parts, then put it back together and turned it on. Student: "I enjoyed the PC Disassembly the best because I could use my expertise to piece something together. As a result of the wide variety of classes available, I felt a surge of contentment as soon as it kicked on.

Our goal was to inform pupils about the wide variety of possible careers in computer science. To this purpose, we convened a group of successful women in the field of Computer Science. After the group discussion, we hosted a supper for the female students who attended. The ladies appreciated the opportunity to network with current and former female college students. We also planned a trip to a nearby tech firm where women were overrepresented to learn about their experiences in the field. The excursion included a meal with the staff, a tour of the factory, and a video presentation about the business and some of the women who work there.

6.3 Supplemental Readings

A CD-ROM with all of the presentations, including the programming and digital hardware course modules, was distributed to all of the attendees after the session concluded. The Artificial Intelligence lesson included computer-generated music files and graphics from the Graphics lab, both of which were included on the CD. Pictures from the week were also included.

Social Activities

The social events of the conference were just as important to us as the formal lectures. The girls needed to see that other young women exist who share their academic and computing interests and abilities, but who also have vibrant social lives. As a result, we planned a number of activities for the ladies to participate in together.

The pupils and coordinators of the conference had an opportunity to mingle and get to know one another at a casual barbeque on the first night of the event. Each lady received a plastic sign and a set of markers at the event, and they were instructed to create a signpost that would identify the city or village they came from and the distance they had driven before arriving in Waterloo. The banners were mounted on signposts and exhibited all week long and at the closing dinner. This graphically demonstrated the widespread nature of the Seminar's reach. Seminar gifts, including a "cool" tote bag, a cloth notepad, a water container, and other things, were distributed to students at the barbeque. They also received fashionable training blouses. The phrase "CS Girls Rock" appeared boldly on both the purse and the blouse.

Two of the week's most exciting excursions involved going rock climbing at a nearby sports facility and watching a performance by Shakespeare at the Stratford Festival. Many of the females were having their first encounters with such things. The event included faculty and postgraduates to offer students more exposure to successful people in their fields. Students were able to see that their peers and the adults they looked up to in the field of computer science shared their interest in other areas, such as sports and the arts, through these events. On our last night together, we all gathered for a dinner to say our goodbyes. Many parents and other family members joined their girls at the dinner, which we encouraged them to attend. All the professors and doctoral students who delivered talks were also invited. We showed a photo slideshow of the Seminar pupils at the dinner. Last but not least, students received their closure gifts, which included a badge of completion and a class picture.

2 Analysis

8.1 Survey Results

Initial Survey: At the beginning of the seminar, the students completed a survey on their preconceptions about CS. We also wanted to know about their computing experience. The survey confirmed many of our ideas about why women are stayingaway from CS. Many of the girls felt that CS was „geeky". Whenasked: "What does a typical computer scientist looks like?" one girl wrote "not athletic (sitting in front of a computer all day does that to you)." Remarkably, a few girls told us that they were aware of, but did not accept, the stereotypes. We also asked the girls who they approached for help with computer problems. Typical responses were "my teacher", "my dad", "the guys in my class", or some other male. Conversely, when we asked them to describe circumstances in which they helped someone with the computer, many of the girls answered that they helped their mom. In most cases, the girls had predominately male „computer expert" role models, and it appeared they were more proficient with computers than manyof their female role models.

In terms of computing experience, we were surprised and impressed by the computing experience of the young women and particularly by the diverse ways in which they use computers. Thirty-five girls said that they used computers almost every day. Thirty-six of the forty students had at leastone computer at home, and all but two of the participants had access to computers at school. Almost all of the girls used computers for email and word processing, and many of the girls used computers for web surfing, online chatting and research. Some of the girls used the computers for making web pages and presentations. As expected, none indicated that they hadprevious programming experience.

Final Survey: Results from the final survey indicate that we were largely successful in achieving the goals outlined earlier.

1. **To spark interest in CS:** This was our main goal, and with many of the girls, it appears that we were successful. When asked how their perception of CS had changed, students wrote: "It is way, way, way more interesting. There is a lot more to it than just programming", "I know what it is now exactly! I am much more interested in computers than I was before, and havea desire to keep learning about it" and "I find computer science much more interesting and purposeful now that I understand it inmuch more depth."

We asked the girls if they had planned to take CS courses beforethey came to the Seminar and if those plans changed as a result of the Seminar, see Table 1 below. Many students indicated that CS was not offered at their schools. However, since the seminar we have received an email from one such student who determined that CS is indeed offered. She has now signed up for the course. It is possible that she was not the only girl mistaken about the availability of CS courses at her school. Of the 27 students who do have CS courses available, 81% are planning to take CS courses and another 7% are considering taking CS courses. Thus, we definitely sparked their interest in CS.

Pre-Seminar	Post-Seminar
12 plan to take CS	22 plan to take CS
2 may take CS	2 may take CS
14 CS not offered	13 CS not offered
12 do not plan to take CS	3 do not plan to take CS

Table 1: CS Course Plans of 40 girls

2. **To show how CS can be applied to many differentfields:** A few of the responses to the question "What did you learn at the Seminar?" show that we had some success with this goal. One of the girls wrote: "I mostly learned that there are many fields, careers and aspects of daily life related to computers (bioinformatics, AI). Before, I saw them as boring and having no significant purpose in the further development of humanity." Another girl said she learned "that the field is more open and that it can be applied to almost anything."

3. **To present positive role models:** We felt it was very important to provide positive role models to the girls, and the role models did not have to be female. In fact, one of the students found various people to admire, including a male presenter. In response to the question "What was your favourite session?" she replied "Bioinformatics – it kept me 100% attentive. I was really interested in everything that he talked about…Career panel – Great insight from women." When asked if her perception of computer scientists had changed, one girl responded "Yes, especially the girls [and] women. They areawesome and they are very intelligent and outgoing."

4. **To debunk the negative stereotypes:** Although the organizers of the conference never made explicit statements trying to debunk stereotypes, many of the girls specifically referred to the „geek" stereotype when we asked them how their perception of computer scientists had changed. The most telling statement, "We aren"t geeks!" was remarkable because the student used the inclusive „we". Some of the other responses were: "Their jobs seem a lot more interesting … CS scientistsare ordinary people, not geeks", and "I realize now that many computer scientists work with people in teams and in social situations, rather than only alone with a machine."

8.2 Areas for Improvement

Our experience in this (first year) has prompted us to make two explicit changes in response to student abilities and needs. We will change the lecture length from ninety minutes to one hour. Many of the girls commented that the lectures were interesting but too long. We will also be more proactive in priming the presenters for an audience of high school aged students. For example, one session was run by two professors who had little experience teaching in a lab environment. Too many peoplewere left waiting while the instructors dealt with the inevitable problems that arise when students use an unfamiliar operating system and software. The session would have been much more effective if it had been designed to allow students to progress at their own pace.

3 Future Work

We would like to expand the Seminar in future years because of the strong need and interest. Since part of the success of the Seminar depends on the participants getting a chance to know each other and interact with available role models, we do not want to increase the number of students invited for a particular week or lose the national representation of participants at the Seminar. Ideally, we would like to increase the number of seminars we can offer during the summer. We are currently considering a second seminar with a duplicate program but anew group of girls. We would like to further increase the number of participants by having seminars at various universities throughout Canada. In both cases, registration would be centralized, and core program material shared. We believe that the Seminar can be easily replicated by institutions outside of Canada as well. Details of the program structure and specific session topics can be molded according to local needs and resources. This type of seminar is a rewarding opportunity for the university community to directly influence high school students.

This seminar was designed to address the issue of attracting female students to CS; there is a related issue of retaining femalestudents in CS, both at the high school and the university levels. This is an area of interest to the authors, and it is an issue we may investigate further.

4 Conclusions

Given the overwhelming number of applications to the first J.W. Graham Computer Science Seminar, we know that an audience of interested females is available. We simply need to provide more opportunities. This type of seminar is equally as rewardingfor the people organizing it as for those who attend. One of the presenters stated that, "the talk for the high school girls was the most important thing I did

all summer" [3].

The students embraced the university experience. They enjoyed a chance to explore CS, and learn from university professors and graduate students. The interaction between the girls and the role models was critical to the success of the Seminar. The mixture of lectures, hands-on activities and social events was well received. Although it is impossible to please everyone all the time, survey results show that the girls found most sessions engaging, and at least one of the sessions especially exciting.The efficacy of this project will not be truly known for three years, when the girls make their post-secondary career choices. However, there are strong indications that we have changed the image of CS for these girls and we hope that they will pass on that new-found knowledge and enthusiasm to their peers.

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