

# CS Girls Rock: Sparking Interest in Computer Science and Debunking the Stereotypes

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## Abstract

Declining female enrollment in undergraduate Computer Science programs is a serious problem. Part of the solution lies in retaining more of the female students currently enrolled; even more important, however, is increasing initial enrollment. Many believe lack of interest to be rooted in stereotypes of computer science formed early in high school: that it is a boring subject, devoid of interesting applications and stimulating only to 'geeks'. To attract high school females to CS, and to determine whether early exposure to the interesting breadth of CS and its applications might ameliorate such attitudes, a week-long Computer Science Seminar for Grade 9 and 10 girls was held at the University of Waterloo. The seminar consisted of lectures, labs and activities chosen to demonstrate the breadth of CS and to dispel the negative stereotypes. Pre- and post-seminar surveys indicate a substantial increase in interest, translating directly into increased desire to take high school CS courses.

## Categories & Subject Descriptors

K.3 [Computers & Education]: Computer & Information Science Education – *Computer Science Education*.

## General Terms

Human Factors.

## Keywords

Gender, Women, High School, Enrollment, Stereotypes, Diversity, Enrichment Program

## 1 Introduction

There has always been an under-representation of women in CS, as well as in many other scientific disciplines. However, while female enrollment numbers in math, science and engineering programs are slowly rising, female enrollment in CS is steadily decreasing. Female enrollment in the undergraduate CS program at the University of Waterloo has fallen from 33% in the mid-1980s to under 15% currently [6]. Decreasing female enrollment in CS is a serious and disturbing phenomenon, and the adverse effects are well documented [7]. We have attempted to address this problem by trying to attract young women to computer

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science before the stereotypes set in. The inaugural J.W.Graham Computer Science Seminar was held at the University of Waterloo in June 2002. Forty Grade 9 and 10 girls from across Canada were invited to a week-long seminar of activities, lectures and labs.

There are a number of factors that contribute to women never becoming interested in CS or to women losing interest in CS [5][7]. However, two reasons seem to stand out above all of the others. The first is that women want to use computers in real-world applications that will benefit people; they are not interested in computing for the sake of computing [2]. The second is that the 'geek with a monitor tan' stereotype is prolific and is an image that most young women want to avoid [5]. The J.W. Graham Computer Science Seminar (hereafter the Seminar) was designed to promote Computer Science (CS) and confront the stereotypes that are discouraging women from participating in this discipline. To ensure the seminar was 'cool' enough for the girls, we borrowed a t-shirt slogan from current popular culture and switched it from 'Canadian Girls Rock' to 'CS Girls Rock'. This slogan created a theme for the seminar aimed at debunking the negative stereotypes.

## 2 Audience

In 2001, the Center for Education in Mathematics and Computing at the University of Waterloo was awarded \$80,000 Cdn per year for three years to run a Computer Science Seminar. Once the funding was in place, the first priority was to determine a program structure. There is already an annual multi-day session that involves students who have advanced to the second stage in the Canadian Computing Competition. We did not want to duplicate that session, but rather to expand the CS enrichment opportunities available to high school students. However, finding a group of students with a relatively homogenous level of computing experience was difficult. In addition, we wanted to ensure female participation, and the pool of computing contest winners has been completely male for the last three years. A better approach was to find a group of students with little or no computing experience and introduce them to CS. Thus, we used our funding to create an all-female Seminar to show young women the real-world side of CS, to provide them with positive role models, to dispel the negative stereotypes and to encourage female students to enter CS [4].

**Grade Level:** There were several reasons to focus on the 14-16 years age group. First, when challenging the media stereotypes of CS, it is important to get to the audience as early as possible. As we expected and as was confirmed by our survey, the girls had already embraced some of those stereotypes. However, it seems likely that the stereotypes would be more firmly entrenched at the higher grade levels. Second, because approximately 30% of female undergraduate students state that a

high school programming course is the deciding factor in their decision to major in CS [5] it is necessary to spark interest in CS before the students get to university. Finally, most students in Grades 9 and 10 have not taken any programming or hardware courses. This allowed us to assume that none of the girls had any CS experience and plan accordingly.

**Scope and Size:** We chose a national scope of participants for the seminar. Because the CEMC runs national math and computing contests, we already had connections and contact information for high schools across the country. The chance to meet other students from all over the country added to the girls' experience. We restricted the number of participants to forty so we did not overload the labs or classrooms. It was crucial that the group size allow for ample personal interaction between the students and presenters and organizers.

### 3 Selection Process

After sending out flyers and application forms addressed to the Head of Mathematics in all the high schools in Canada, we received over 900 applications for 40 available positions. Two faculty members selected the final participants using very little information: a transcript, a recommendation from a science or math teacher, and a personal statement.

National representation by the participants was extremely important to the organizers; the goal was to have at least two students attend from each province and territory. The geographic distribution of the participants was determined based on two factors: the population of the province and the number of responses from that province.

The quality of the applications was excellent. Factors for eliminating an applicant included having considerable programming experience, attending a large private school, or having a relatively low mathematics grade. Factors for retaining an applicant included lack of enrichment opportunities, overt interest in attending the Seminar and learning about CS, and unique circumstances. There was a bias towards rural areas, given the relative lack of opportunity for CS enrichment in small towns.

Issues concerning travel were raised by several parents, teachers, and school administrators. Some parents wanted us to provide accommodation for chaperones traveling with the girls. Other parents contacted us to make arrangements for their daughters to fly with other participants where possible. Without question, the single largest administrative challenge was facilitating travel for 40 girls, aged 14 to 16, from all over Canada.

### 4 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 different fields.
3. To present positive role models.
4. To debunk negative stereotypes.

During initial brainstorming sessions for the Seminar program, we determined that we wanted the week to include lectures by faculty members, hands-on activities, and organized social events. The specifics of the program were determined by a five-member program committee that included faculty members from the School of Computer Science, a CS graduate student, and the chair of the Women in Mathematics committee.

Each day had four sessions; each lasting 90 minutes. Daily sessions in either programming or digital hardware formed the backbone of the program. For the remaining sessions at the Seminar, invitations to speak were made to dynamic faculty or graduate students in areas we thought would be of interest to young women. In many cases, topics were chosen because an expert was available who could deliver an interesting and inspiring session on that topic. In all cases, the speakers were most concerned with appealing to teenaged girls – an audience with whom they were relatively unfamiliar.

## 5 Infrastructure

**University Life:** Although the venue is not the most important consideration for a project such as this, giving these young women a chance to stay in residence and use the facilities of a university campus is a bonus. All of the sessions were in labs or classrooms on campus. Each student was assigned a university account for use in the lab sessions, but it also allowed the students to access the network or use the lab during their free time. In many ways they experienced life as a university student. When asked “What did you learn at the seminar?” one student wrote: “I learned a lot about how women fit into CS...I kind of got a feel for university life too, and am almost looking forward to it.”

**Role Models:** The Seminar naturally provides an opportunity for the students to meet and interact with role models in several scenarios. The two main coordinators of the Seminar, one lecturer and one PhD student, also presented several of the sessions during the week. Approximately half of the session presenters were female graduate students, lecturers, or professors. Dynamic and interesting male computer scientists who defy the ‘geek’ stereotype are equally important role models. This point was clearly illustrated during a field trip when one of the girls commented: “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?’” [1]

Our opening speaker was Josée Lajoie, a female CS graduate student who has an undergraduate degree in computer engineering and had worked for 12 years at IBM. She had returned to school to do a combined Masters degree in CS and Fine Arts, specializing in computer animation. In addition, the girls were chaperoned by female, undergraduate “houseparents” from Mathematics and CS. The houseparents ate with the girls, stayed overnight, and attended the social functions. Over the course of the week, these university students developed a strong bond with the girls. As with many mentoring situations, the mentors gained as much from the experience as those being mentored. Although the houseparents were paid, each one said that they felt lucky and proud to have been a part of the Seminar.

## 6 Curriculum

### 6.1 Core Courses

We had two core courses that ran in parallel during the seminar. One course was an introduction to programming and the other was an introduction to digital hardware. The programs were designed to be independent and modular, so that a student could go to hardware one day and switch to programming the next day and not be left behind.

**Programming:** The tcl/tk scripting language was used to teach introductory programming for a number of reasons. First of all, it is free and available for many platforms. It is a relatively simple scripting language that has all of the basic programming constructs (variables, loops, selection statements and

procedures), and thus it is an excellent tool for teaching introductory concepts. Tcl/tk also allows the students to produce GUIs on screen very quickly and with very little code. This gives immediate, gratifying feedback to the coding efforts of the student and makes programming fun and interesting. In order to appeal to the young, female audience, the project that the students worked on throughout the week was a drawing program to which they added various features. One student wrote “I liked the tcl/tk, because I got to make something that I can take home and I found it hard, yet satisfying.”

**Digital Hardware:** The digital hardware session was designed to give students a hands-on look at the principals of computer hardware. The first session was an introduction to the binary number system and Boolean logic. From there, students learned about some basic electronics concepts such as power, ground, resistors and voltage regulators. Throughout the rest of the week, the girls did modular experiments designed to introduce Boolean logic gates, to show how inputs can be manipulated through circuits to display expected output, and to demystify the hardware side of a computer to some extent. For one student, this session was her favourite “because it was very hands on and you had to figure out everything that was wrong and try working with someone to fix it.”

## 6.2 Supplementary Curriculum

It was very important that the supplementary sessions reveal the breadth of CS, and its relation to real-world applications. The lectures on bioinformatics, artificial intelligence and computer graphics were chosen for these reasons. The ‘History of Computer Science’ lecture demonstrated the importance of women in the history of computing and gave students a context for the rest of the curriculum. It was also important for us to give a somewhat realistic idea of what the study of CS involved, so we included sessions such as algorithm design and finite state machines.

A number of hands-on activities kept the students engaged. In one popular session, the girls removed and identified various components of a personal computer, reassembled the computer, and rebooted. When asked about her favourite session, one student responded: “I liked the PC Disassembly the best because I could use my knowledge to put something together. I had a great feeling of satisfaction when it turned on.” Such a diverse selection of sessions meant that there was something to please everyone.

We wanted students to learn about career opportunities in the CS field. To this end, we organized an all female Computer Science career panel. We invited female undergraduate and graduate students to attend and to stay for a dinner following the panel. This allowed the girls to interact with female university students and alumni. We also organized a visit to a local high tech company to meet women at work in the industry. The field trip included a slide show about the company and some female employees, a tour through their manufacturing facility and a lunch with employees.

## 6.3 Follow-up Material

After the seminar, the participants were mailed a CD-ROM containing all of the presentation materials from the conference, including the programming and digital hardware curriculum units. The CD contained animations from the Graphics lab and computer generated sound tracks from the Artificial Intelligence lecture. We also included photos taken throughout the week.

This material is posted on the University of Waterloo liaison website: [http://www.cs.uwaterloo.ca/High\\_School\\_Liaison/](http://www.cs.uwaterloo.ca/High_School_Liaison/)

## 7 Social Activities

We considered the social aspects of the seminar to be of equal importance to the academic sessions. It was crucial that the girls discover that there are other young women with similar mathematical and computer aptitudes, but with interesting hobbies and active social lives. Thus, we tried to incorporate a variety of events to allow the girls to socialize.

An informal barbecue was held on the opening evening of the seminar to give the students a chance to get acquainted and to meet the organizers. At this event, the girls were given plastic signs and markers to use in making a sign post that named the city or town they had come from and the distance they had traveled to reach Waterloo. All of the signs were nailed to signposts to be displayed throughout the week and at the final banquet. This was a visual reminder of the national scope of the Seminar. At the barbecue, students were also given their seminar packages, which consisted of a ‘cool’ satchel bag, a canvas notebook, a water bottle and other items. They were also given stylish seminar shirts. Both the bag and the shirt had the ‘CS Girls Rock’ slogan prominently displayed.

The two major field trips of the week were a rock-climbing session at a local sports complex and a trip to see a Shakespeare play at the Stratford Festival. For many of the girls, these were new experiences. Faculty and graduate students were invited to participate, to give the students another opportunity to mingle with role models. These activities allowed the students to see that people who are interested in computers, both their fellow participants and the role models, are well-rounded people who also enjoy athletic and artistic endeavors.

Our final social activity was a banquet on the last night. We invited parents to join their daughters at the banquet, and a number of parents or other family members attended. We also invited all of the faculty members and graduate students who gave presentations. At the banquet, we ran a pictorial slide show of the students participating in the Seminar. Finally, students were given their closing packages: a certificate of achievement and a group photo.

## 8 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 staying away from CS. Many of the girls felt that CS was ‘geeky’. When asked: “What does a typical computer scientist look 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 many of 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 least one 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 had previous 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 have a desire to keep learning about it" and "I find computer science much more interesting and purposeful now that I understand it in much more depth."

We asked the girls if they had planned to take CS courses before they 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 different fields:** 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 are awesome 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 scientists are 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 people were 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.

## 9 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 a new 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 female students 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.

## 10 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 rewarding for 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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