

CHANGING GIRLS' ATTITUDES TOWARDS COMPUTER SCIENCE

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ABSTRACT

This paper describes the initial results of running a Computer Science camp for middle school girls. The goal of the camp is to change the way that girls from all ethnic and class backgrounds experience the field of Computer Science. The camp focuses on women Computer Scientists as leaders and features original curriculum that utilizes active learning and computational thinking, a mentoring program, a multi-media approach and interactive web site, as well as a ten-year study of the aspirations and career choices of the students involved.

1. INTRODUCTION

The number of females in Computer Science has been in consistent decline since 1985, and there has been much research in recent years on the importance of increasing girls' participation in the field through innovative curriculum and after-school programs [1, 4].

This paper describes a four-week long Computer Science camp for middle school girls called "Girls Gather for Computer Science" or G²CS. The overall goal of the camp is to change the way that girls experience the field of Computer Science by removing them from their usual surroundings and preoccupations and exposing them to many female Computer Scientists. Parents and middle school teachers are also involved with the camp since parental support and engaged teachers have emerged as key elements of successful intervention [2, 5, 6]. This, and the fact that all of the staff, instructors, teachers, and field trip presenters are female, make this camp unique. The project includes a 10-year study during which all campers will be contacted annually to fill out a survey on their aspirations and attitude towards Computer Science.

2. OVERVIEW OF THE CAMP

2.1 Camp Format

The camp is a 4-week long day camp for girls who have just completed 7th or 8th grade. The camp accommodates 30 girls and is held on the campus of Pacific University in Forest Grove, Oregon. The first camp ran in the summer of 2011 and 21.2% of the girls indicated that they were Hispanic, 12.1% were Asian, 6.1% were American Indian, 6.1% were Native Hawaiian, 51.5% were white, and the remainder preferred not to report.

The day starts at 9:30am and ends at 3:30pm. The girls get approximately four hours of instruction a day with the remainder of the time taken up by lunch and snack breaks. The girls also get an hour of physical activity time after lunch. The last 30 minutes of the day

is dedicated to writing a summary of what they have learned on blogs located on a private social networking site [3].

Each week of the camp focuses on a different topic. The topics in 2011 were:

1. Introduction to Computer Science: the first week was used to settle the girls into the camp. Campers and instructors defined the camp code of conduct, and campers developed web pages, and participated in activities from CS Unplugged [8].
2. Robotics using Lego Mindstorms© Robotics Kits: the girls built a basic rover robot, and then worked in pairs to program it to follow a line. During the last two days, the girls worked in teams on designing and building their own robots. Girls built a crawling robot, and a shooter bot that shot colored balls while also calling out the colors. The girls commented in their blogs that this week encouraged them to be persistent and that patience is key. Their favorite part of the week was programming the robots.
3. Programming with Alice [7]: campers learned the basics of using Alice, then worked in pairs to develop a movie around the theme of “Independence”. This theme was chosen because the week fell around the 4th of July. The tutorial that we used was a modified version of the Princess & Dragon tutorial by Susan Rodger and Alice Team at Duke University [11]. In our version, the princess saves the prince rather than the other way around. One of the campers commented on this stating, “I loved how the girls is saving the guy this time”.
4. Hardware: campers took apart computers and learned about memory, motherboards, hard drives, and other computer components. The girls also learned about the BIOS and beep codes and what they mean. Another activity for this week was taking apart broken electronic gadgets including a hard drive, a CD ROM drive, an iPod, a keyboard, a mouse, and a printer, then researching the components and putting together a web page describing the device and how it worked. The goal of this activity was to teach the girls not to be afraid to take things apart and to learn how to search online to find out how different components functioned.

2.2 Camp Staff

The camp has an all-female staff consisting of:

1. Two camp directors who are university faculty members.
2. One administrative assistant and one student assistant.
3. Two curriculum assistants. In 2011 these were undergraduate students who had just completed degrees in Computer Science. Their job was to assist the directors in preparing the daily educational activities and to assist in the lab with helping the campers complete the activities. The assistants also led some activities.
4. Two undergraduate students. These are in charge of the physical activity in the middle of the day, the snack breaks, walking the girls to and from the bus stop, and helping with the daily preparation and clean-up.

5. Four middle school teachers. The teachers are essential in making the camp successful as they are experienced in managing and guiding the learning of middle school girls. The teachers are there as both educators and learners, and do not have any experience with Computer Science prior to attending the camp. Part of the teachers' contract is to present what they have learned about computer science and the lack of females in the field to their peers.

6. Four CS professional instructors. In 2011, three of the instructors are Professors of Computer Science, and the other one is a retired high school Computer Science teacher.

All staff members attend the field trips, overnight trip, and opening, closing, and reunion events.

2.3 Field Trips

The campers went on three field trips to local technology companies in 2011. The companies were Intel, Vernier [9], and Galois [10]. The goal of the field trips was to expose the girls to a variety of inspiring female role models, as well as for them to see Computer Science in action.

2.4 Overnight Trip

The camp includes one overnight trip. In 2011, the overnight trip was to the Oregon coast. The girls stayed in cabins, with six girls and two adults per cabin. The girls were responsible for cooking dinner, and loading and unloading the buses.

While at the coast, the group visited and got tours of the Hatfield Marine Science Center and the Newport Aquarium, where they learned how technology is used to monitor the oceans and marine life.

The overnight trip in 2012 will be to Seattle, and the girls will visit Amazon, Microsoft, and the University of Washington's Computer Science department.

2.5 Opening and Closing Receptions, and Reunion

It is important that the parents are involved with the camp and educated on the opportunities available in the field of Computer Science. The day before the camp starts, an opening banquet is held on campus and the girls, their parents, siblings, and all the staff and instructors attend. The directors give an overview of the camp and provide the parents with any information needed on the logistics of the camp.

The focus of the closing reception is on what the girls have achieved during the four weeks of camp. The girls present posters and demonstrations of their work to their parents, friends, and camp staff.

The reunion is held six months after the end of camp and is an opportunity for the girls to reconnect with each other and with the staff of the camp, and is another way that we try to foster a learning community.

3. CAMP ASSESSMENT METHODS AND RESULTS

In this section we describe the assessment methods that we use. The results are what we found after running the camp for one year. We have funding to run the camp the camp for another two years.

3.1 Daily Two-Minute Evaluations

At the end of each day of camp, students were asked to write a very brief evaluation of the day's activities.

The most commonly mentioned activities to keep for next year were Alice and the Lego Robots. Using the social networking site to post blogs was also very popular. The campers clearly loved the camp and the entire staff! There were numerous comments each day along the lines of: "This has been the best camp ever!", "I'm sad that we're approaching the last day."

In terms of what they learned that will be most helpful in their future, there were two prevalent themes: they learned the power of working together as a team, and they learned the value of persistence – not giving up when the project doesn't work right away.

3.2 Student Pre- and Post-Camp Surveys

The campers completed surveys before the start of camp and after the end of camp.

3.2.1 Attitudes Toward Computers

In this section, five items resulted in statistically significant changes in means from pre- to post-survey; these two items had increased means (more agreement):

To get a computer job, you have to work really hard.
I would like a job working with computers or technology.
Most computer scientists are men.

These two items, which were worded in the negative, resulted in statistically significant decreases in means from pre- to post-survey (more disagreement):

People who have "computer jobs" sit in front of a computer screen all day.
Working with computers means working on your own.

3.2.2 Career Goals

In this section, there was only one item that resulted in statistically significant changes from pre- to post-survey (more agreement):

People who work with computers make really good money.

3.3 Qualitative Analysis of Attitudes Toward Computers

Students were asked to "Describe what you think a typical computer scientist does at work each day". This was a free-response format that allowed for a variety of answers.

These have been summarized in the table below, indicating the number of responses in each category by pre- and post-survey.

Table 1: Attitudes Toward Computers

Categories	Pre-Survey Results	Post-Survey Results
Write computer programs/software/code	17	10
Study/design/build computers; hardware	9	12
Improve efficiency of computers/chips	9	9
Problem-solving	9	13
Fix computers	3	0
Improve lives and productivity	4	5
Graphics and presentation software	2	2
Research and gathering information	2	3
Websites and web pages (design/build)	2	3
Robotics	1	4
Teach	0	5

Discussion:

There were major differences between the responses from the student pre- and post-surveys. In the post-survey, students tended to be more descriptive of computer scientist’s work, suggested multiple roles (rather than naming just one), and provided more examples of responsibilities. Several mentioned that computer scientists rarely work in isolation but are more likely to work with colleagues or part of a team; none in the pre-survey said anything about working alone *or* with others. Several in the post-survey noted that there really is no such thing as a ‘typical’ computer scientist because they have such a broad range of skills and tasks.

4. SUMMARY OF THE RESULTS

The camp instilled in the participants an understanding and appreciation of women as leaders in science. The strongest evidence for this comes in the post-camp surveys.

The camp activities and curriculum have increased the students’ confidence and skills in using the computer but beyond that as well. Some of the typical post-camp quotes were “It has made me much more comfortable using a computer and trouble-shooting” and “Now I don’t give up if I don’t find what I am looking for” and “Computers and technology are not scary any more. “ Over time, we will be able to learn whether there has been a long-term effect past six months.

On the post-camp survey, students demonstrated an increased interest in math and Computer Science as career opportunities. Essentially all of them indicated an interest in STEM fields and/or Computer Science along with the recognition that no matter what career they choose, effective use of computers will be an essential part of their career.

The girls responded very favorably to the camp curriculum, to the instructors’ methods, and to the instructors themselves. They appreciated having all-female leaders/organizers

and demonstrated an increased interest in math and Computer Science as career opportunities. They reported an increased awareness of the value of collaborating within a team in order to problem-solve effectively, and an increase in persistence in order to complete a difficult task. These collaborative efforts should be viewed as components of the broader learning community. In addition, they valued the social networking opportunity, but at this point, it is unknown whether the latter contributed to the overall effectiveness of the project.

5. FUTURE WORK

As part of this study, we are planning to follow the girls for ten years. The girls will be contacted each year and asked to fill out an attitude survey. We will also track the relevant courses they take in high school, their major in college, and their chosen career.

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