Girl Scouts Compute!

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ABSTRACT
In this paper, we describe our attempt to attract more girls to computing by working with the Girl Scouts. We describe the types of outreach we have done with the Girl Scouts and the results of our efforts. We have found that even four hour workshops can change girl's attitudes towards computing in positive ways. In the last three years we have dramatically increased the number of workshops we offer and the number of girls that we reach. We hope that others will follow our example and start computing outreach programs with the Girl Scouts.

Categories and Subject Descriptors
K.3.2 [**Computers and Education**]: Computer and Information Science Education – *computer science education, information systems education, curriculum*

General Terms
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Keywords
Computer Science Education, Gender Issues, Outreach

1. INTRODUCTION
Computing is one of the few fields where the percentage of women in the field has decreased in the last 25 years. In 2007 women earned only 19% of all CS degrees. Back in 1984, women earned 37% of CS degrees [1].

Part of the problem is a lack of women in the pipeline starting in high school. We have been offering Advanced Placement (AP) Computer Science (CS) workshops since 2004, and when we ask teachers how many females they have in their classes the typical answer is zero, one, or two. Only teachers that have made an effort to recruit girls get higher numbers than this.

This is not only a problem in Georgia. The percentage of females that took the AP CS A Exam in 2007 was 18.34% [2]. The percentage of females who took the AP CS AB Exam in 2007 was 12.15%. It is striking that in that same year 48.66% of AP Calculus A examinees were female, and 41.08% of AP Calculus AB examinees were female. While some have argued that women don't like computer science because it is math-based, these statistics show that many women are not afraid of math.

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Research on why females avoid computer science shows that women often lack experience in computing and are discouraged by the negative stereotypes [3]. Many young people think that computing is boring, anti-social and not creative. Our outreach efforts show girls that computing can be fun, social, and creative. By increasing experience with computing, providing role models in computing, and changing attitudes towards computing we hope to attract more women to computing in high school computing courses and eventually to careers in computing.

2. BACKGROUND
The Institute for Computing Education (ICE) was created in the spring of 2004. ICE is a partnership between the Georgia Department of Education and the College of Computing at Georgia Tech. The goals for this partnership are to increase the number and quality of computer science teachers and increase the number, quality, and diversity of computer science students[4][5].

To increase the number and diversity of computer science students we offered two weeks of summer camps for high school students in the summer of 2004. While the results from the summer camps were positive, we wanted to do more to attract females to computing.

3. OUTREACH WITH THE GIRL SCOUTS
We started working with our local Girl Scout council in the fall of 2005.

3.1 Getting Started
Ericson had been considering using the LEGO robots to run computing workshops for students, but was concerned about research that showed that in mixed-gender groups the boys tended to take over. Based on a conversation at a poster session at SIGCSE 2005, she decided to try the robots in a setting with only girls.

She contacted the local Girl Scout council and found that they had LEGO RCX robots and laptops but didn't know what to do with them. Ericson proposed that ICE work with the Girl Scouts to offer computing workshops and provide female undergraduate and graduate computing students that could assist the girls and also serve as role models. In the beginning, the female computing students volunteered to help work with the Girl Scouts, but after

we received a National Science Foundation (NSF) Broadening Participation in Computing (BPC) grant in the fall of 2006, we started paying the undergraduate and graduate students for their work with the Girl Scouts. This enabled us to staff all the workshops instead of just the ones the volunteers could make.

3.2 The First Year (2005-2006)

In the fall of 2005 we spent three weekends at a Girl Scout camp introducing girls to computing through one-hour sessions in which they programmed pre-built LEGO RCX robots to go through courses outlined in painter's tape on the floor. On these weekends the girls were camping with their Dads, and the girls worked with their Dads to program the robots (Figure 1).

Figure 1. Girl Scout and Dad with LEGO robot

We also offered two four-hour basic robot workshops where the girls could both build and program the robots. In total we introduced about 190 girls to computing using LEGO robots during the 2005-2006 school year.

In the spring we trained Girl Scout camp counselors how to build and program the LEGO robots, and they offered robots as one of the camp activities at one Girl Scout camp that summer. We introduced about 138 girls to computing using LEGO robots in the summer of 2006 at the Girl Scout camp.

3.3 The Second Year (2006-2007)

In the fall of 2006 we spent three weekends again working with girls and their Dads to program pre-built LEGO RCX robots to go through courses in one-hour sessions.

We also offered two four-hour basic robot sessions where the girls built and programmed LEGO robots. In addition, we offered one four-hour advanced robotics session and one session using Alice to introduce computing (Figure 2). In total we introduced about 372 girls to computing during the 2006-2007 school year.

Alice is a free environment from Carnegie Mellon University that allows students to use drag-and-drop programming to build 3D animations and games. There is also a version of Alice called Storytelling Alice that was designed explicitly for middle school girls. However, this version was not available when we held this workshop. For more information on Alice see http://www.alice.org.

Figure 2. Girls working with Alice

In the summer we had one of our undergraduate students help run the robot activities at a Girl Scout camp. About 144 girls did a robot activity at the Girl Scout camp in the summer of 2007. Thanks to a donation from Microsoft we were also able use PicoCricket kits at another Girl Scout camp. About 305 girls did PicoCricket activities at a Girl Scout camp in the summer of 2007.

PicoCrickets are similar to LEGO robots but the activities that they come with are much more arts and crafts focused. For example, you can make a fake birthday cake that plays a tune when you blow on the "candles" (straws) which activate a sound sensor. You can use a resistance sensor to make a musical pickle. You can also make a kinetic sculpture that changes direction when you clap your hands. Girls learn from these activities and then make their own creations (Figure 3). See http://picocricket.com/ for more information on PicoCrickets.

Figure 3. PicoCricket Creation

3.4 The Third Year (2007-2008)

There was tremendous growth in our Girl Scout program in 2007-2008. The NSF BPC grant allowed us to hire more students to work with the Girl Scouts. We also received a grant from the Atlanta Women's Foundation that allowed us to buy the new LEGO NXT robots and more PicoCricket kits. The Girl Scouts also received a grant from AT&T which allowed them to buy LEGO robot kits and newer laptops. We were able to serve as many as 65 girls at a time in LEGO robot workshops or PicoCricket workshops as we usually pair girls up for these workshops. For Scratch and Alice workshops we usually have the

girls work individually, so we limit these workshops to about 45 to 55 girls at a time.

In the fall of 2007 we spent four weeks working with girls and their Dads to program pre-built LEGO NXT robots to go through courses in one-hour sessions. In addition we also spent three weekends working with girls and their Moms to do PicoCricket activities in one-hour sessions (Figure 4).

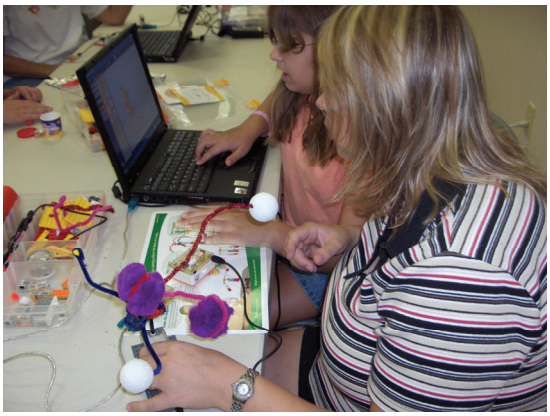

Figure 4. Girl Scout and Mom programming a PicoCricket

We offered a total of ten four-hour workshops. We did two robot basics, one advanced robots, four PicoCricket workshops, two Alice workshops, and one Scratch workshop (Figure 5).

Scratch is a free environment from the Massachusetts Institute of Technology (MIT) that allows students to use drag-and-drop programming to build 2D animations and games. We have found that middle school students find Scratch easy to use and fun. See http:///scratch.mit.edu for more information on Scratch.

Figure 5. Girl Scouts working with Scratch

We also went to a school with a large Hispanic population and worked with the Girl Scouts two hours each week for three weeks using PicoCrickets and LEGO robots (Figure 6).

Thanks to a grant from the Anita Borg foundation we were also able to bus Hispanic Girl Scouts to Georgia Tech for one of the PicoCricket four-hour workshops. In total we introduced about 900 girls to computing during the 2007-2008 school year.

We did train Girl Scout counselors to use the PicoCrickets and LEGO NXT robots at the Girl Scout camps for the summer of 2008. We don't yet know the total number of girls who did these activities for the summer of 2008.

Figure 6. Hispanic Girl Scouts working with PicoCrickets

3.5 Plans for this Year (2008-2009)

We are scheduled to spend four weeks working with girls and their Dads to program pre-built LEGO NXT robots to go through courses in one-hour sessions. In addition we will spend three weekends working with girls and their Moms to do PicoCricket activities in one-hour sessions.

We currently have 15 four-hour Girl Scout workshops scheduled. We will be offering six PicoCricket workshops, three basic robot workshops, two advanced robot workshops, two Scratch workshops, and two Alice workshops.

As part of our NSF BPC grant we provide seed funds and training to help other colleges and universities in Georgia start summer computing camps. We started three camps in the summer of 2007 and four camps in the summer of 2008. We encourage these colleges and universities to also offer Girl Scout workshops.

4. EVALUATION METHOD

We don't do any evaluation in the one hour sessions as we feel that they are too short. We use these short workshops to get the girls interested in the four-hour sessions. We also hope that the one-hour sessions help to change the parent's attitudes about computing. Some of the research about women in computing suggests that parental support is crucial [6]. We hand out career brochures from the Computer Science Teachers Association (CSTA) and ACM to the parents to help dispel the myths they often have about the field (e.g. there are no jobs, computer scientists don't interact with other people, etc.) [7]. This year we plan to hand out the Talking Points brochure from the National Center for Women in Information Technology (NCWIT) [8].

At each four-hour or longer Girl Scout workshop, the participants are asked to complete pre and post workshop questionnaires. The questionnaire items ask the participants to rate their perceptions of various constructs along a 5-point Likert scale where the midpoint is "neutral." Thirteen items measure participants' confidence toward computing, gender perceptions about computing, intent to persist in computing, knowledge of computing careers, and attitude toward computing. . Some items are negatively worded, so the scale for those items is reversed during analysis.

The "pre" version of the questionnaire is administered at the beginning of each event and collected once each participant completes the questionnaire. The "post" version of the questionnaire is administered at the end of the event and also

collected once the participants complete them. Both pre and post surveys are analyzed using Mann Whitney's U test for significance which is appropriate for independent, ordinal data and relatively small sample sizes (~20). The null hypothesis is that the participants' perceptions will not change from one observation to the next.

The pre/post instruments have changed as we have learned more about the specific constructs we were and were not measuring. Therefore, not every workshop group received the most current version containing 13 Likert scale items. Originally, the questionnaires contained only 5 items. The questionnaire was modified before the 2007 summer workshop series and again prior to the 2008 summer series. Overall, there are 113 pre/post comparisons. Of those, 11 comparisons are statistically significant at $p < .05$, and four are statistically significant at $p < .01$. Further, by extending the p-value to .10, an additional 6 combinations would be considered significant (see Table 1).

5. EVALUATION RESULTS

Looking across all 13 four-hour or longer events for Girl Scouts offered since the beginning of BPC funding, six of those contained at least one statistically significant ($p<.05$) pre/post response. The number of attendees at each event ranges from 24 to 67.

Table 1 shows the questionnaire items that are statistically significant from pre to post administration. The lightly shaded cells are significant at the $p < .05$ level, and the darker cells are significant at the $p < .01$ level. Blank cells indicate that the item was not administered to the participants. The primary reason for this is that we added and edited items on the questionnaire. For example, the statement "Computing is hard" was changed to "Programming is hard" because participants expressed multiple, inconsistent views of computing.

The events are intentionally grouped down the table: One Alice event is followed by six PicoCrickets events followed by five robotics events and ending with one Scratch event. Interestingly, most occurrences of statistical significance occur with PicoCricket events while none occur with the robotics events. There are more PicoCricket events, but still, PicoCrickets demonstrates significance eight of 31 times while the robotics events generate no significance across 27 opportunities to do so.

Further, some questionnaire items show significance across two events such as "Computers are fun;" "Computing/Programming is hard;" "Computer jobs are boring;" and "I know more than my friends about computing."

Our hypothesis is that the girls who come to the robot workshops already have a positive view of computing, so we aren't changing their attitudes much. Also the PicoCrickets are very easy to use and the most similar to other Girl Scout arts and crafts activities and thus resonate with the Girl Scouts. Alice takes longer to learn, so the girls don't get the full understanding of what they can do with Alice in a four-hour workshop. During the Scratch workshop 14 girls showed up late without registering which meant that we had to double up girls on computers. So the fact that we have any change in attitude in a positive direction from the Scratch workshop is amazing.

Table 1. Questionnaire items for Girl Scout Workshops with Mann-Whitney U Significance Levels

Event	Computers are fun.	Computing is hard.	Programming is hard.	Girls can do computing.	Computer jobs are boring.	I am good at computing	I know more than my friends about computers.
Alice 3/8/08	.503		.601	.118	.043	.678	.397
Crickets 3/1/08	.040		.001	.050	.065	.104	.042
Crickets 3/30/08	.464	.421		.444	.890	.473	.356
Crickets Summer 07	.001	.040			.151		
Hispanic Crickets 4/16/08	.074		.060	.435	.045	.217	.952
Hispanic Crickets 11/6/07	.580	.757		.508	.205		
Crickets 10/27/07	.079	.312		.208	.914	.012	.002
Robot Extreme 4/12/08	1.00		.878	.776	.959	.220	.916
RobotBasics 1/26/08	.473		.155	.516	.167	.132	.944
RobotBasics 3/10/08	.628	.882			.891		
Robot at Tech	.910	.312		.394	.479	.813	.425
Robots Misty Mtn	.281	.579		.620	.177	.693	.441
Scratch 2/9/08	.383		.253	.036	.404	.722	.523

5.1 Limitations

Survey research that is self-reported and that uses pre/post Likert scale items generally suffers from various forms of bias. Central tendency bias means that respondents are less likely to use extreme response categories like "Strongly Disagree" or "Strongly Agree;" instead, they may prefer to use the lesser version of each: "Disagree" and "Agree." We believe that this wasn't a problem given that the girls filling out the questionnaires used the extreme categories frequently. Also, since their names are not associated with the forms, they are more likely provide a genuine response. Social desirability bias means that respondents will respond to a questionnaire as they perceive the researchers or course leaders would like them to respond [9]. Naturally, this measure is difficult to gauge, and we admit that some social desirability may have occurred. Here again, however, this may be limited in that names were not associated with questionnaire

responses. Finally, acquiescence bias means that respondents will simply agree with the statements as they are presented [9]. We have corrected for this bias through by intentionally phrasing positive and negative statements.

We must also remember that the questionnaires are self-report data completed by middle and high school students who may not always take the questionnaire seriously.

6. CONCLUSIONS

Nearly all of our Girl Scout four-hour or more computing workshops show positive changes in attitudes towards computing even if only 6 of them had statistically significant changes. We did have one workshop, the Scratch workshop, that had some negative changes in attitudes towards computing, but we think that this was due to 14 girls showing up late without registering. This meant that we had to double up girls as we didn't have enough computers.

The PicoCricket workshops generated the most statistically significant changes in attitudes about computing followed by Alice and Scratch workshops. Only our LEGO robot workshops didn't show any statistically significant changes in attitudes. We think this may be because the girls who sign up for LEGO robots already have positive attitudes towards computing.

The huge growth in our Girl Scout computing workshops is evidence that girls are interested in learning more about computing. These workshops now regularly fill and have waiting lists even though we have greatly increased the number of workshops and increased the number of girls that we can handle at each workshop. About 25-30% of the attendees have been to at least one other computing event with us.

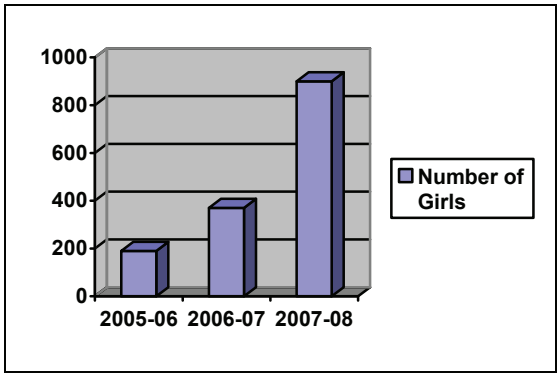

Figure 7. Growth in our School Year Workshop Attendance

The Girl Scout Council of Greater Atlanta has about 40,000 girls in it. About half of these are younger than our target group of middle to high school females so there are 20,000 girls in our target group in the council. While we did have about 900 girls do some computing workshop with us in 2007-2008, there are still plenty of girls that haven't yet had the opportunity to learn about computing in a way that gets them excited about the field. We hope that others will follow our example and also offer computing workshops for Girl Scouts.

It is our hope that by providing engaging introductory computing experiences, increasing parental support, and providing female role models we will increase the number of girls who take computing classes in high school. In turn this may increase the number of women who major in computing at the college or university level and the number who continue on to graduate school in computing.

7. ACKNOWLEDGMENTS

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