

Engaging Middle School Girls in Computing with a Project-based Summer Experience

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Abstract – Recruiting middle and high school girls is particularly critical to addressing the disparities of women in computing majors and careers. This idea has been explored in a three-pronged approach at Mississippi State University in the Computer Science and Engineering department with promising results. In addition to research experiences and internships for undergraduate women, the current program addresses the need to introduce computing to younger girls. In 2011 and 2012, week long residential camps were held for high school girls. The camps were designed to introduce the girls to computer science through information assurance activities. In 2013, a summer camp for middle school girls was held using a project-based approach to learning. An overview of the camp will be provided along with assessment results.

Keywords: STEM, summer experience, middle school outreach

BACKGROUND

The Computer Science and Engineering (CSE) department at Mississippi State University (MSU) has been working for several years to establish a pipeline of young women in computing. Summer camp offerings for high school girls in 2011 and 2012 were the first part of a larger, National Science Foundation-funded, three-pronged effort offered through MSU's Center for Computer Security Research. The second prong of MSU's effort includes a summer-long research experience for undergraduate women immediately after their freshman year at MSU. These students work in collaborative teams to produce original research. The third prong involves placing women with an interest in computer security in summer internships so they may see firsthand the opportunities that exist in cyber security and information assurance [1].

Analysis of the first high school girl camp in 2011 revealed that the participants were relatively well-informed about gender inequities in STEM fields. The girls were interested in the social relevance of computing skills, seeing the skills as "the means to greater ends, and not the end in itself." They were most interested in hands-on learning exercises and demonstrated a keen interest in the connections between specific skills and related jobs [2]. This data influenced the approach to introducing programming in subsequent camp offerings.

With research demonstrating that the later high school years may be too late to influence perceptions about career options [3], the decision was made to evaluate the impact that a computing immersion experience would have on the middle school age group by extending the 2012 offering to include a few girls in middle school. The qualitative data analysis for the high school aged subset of the second camp was similar to the first camp results. However, for the middle school girls included in the 2012 camp, it was evident that the camp's approach must be modified to effectively and positively influence their perceptions of computing. The younger girls responded most favorably to pure hands on activities, particularly the activity that involved programming a robot. The Finch robot [4] was used

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and the girls, working in pairs, programmed their robots to dance. The activity culminated in a dance competition. The younger girls were very invested in the outcome of the competition.

The high school girls expressed their dislike of the younger girls participating with them in camp activities. There is an obvious difference in maturity level between the two groups. Twenty-five percent of the 2012 camp participants had completed only sixth, seventh, or eighth grade. Based on these results, a camp for middle school ages only was offered in summer 2013 in an attempt to engage the girls earlier in their educational path.

Each of the summer camp projects sponsored by CSE at MSU have been structured to provide an affordable science and technology enrichment program to underrepresented groups in the surrounding area. Summer camp fees are often beyond the reach of families in the lower socioeconomic realm. The Mississippi counties adjacent to MSU include Oktibbeha, Lowndes, and Clay. Each of these counties reports a relatively high number of children living in poverty and a significant population of minority residents. The African American population is reported as 58.5% in Clay, 43.7% in Lowndes, and 36.4% in Oktibbeha. All three counties report over 30% of their residents less than eighteen years of age living below the poverty level [5]. The first two camps that were hosted at MSU were offered at no cost to participants; the middle school camp had a nominal fee of \$40. The percentage of African Americans in the first two camp offerings was 30%. In the camp held in 2013 for middle school girls, 75% of the participants were African American girls.

PROGRAM OVERVIEW

The 2013 camp offering was partially funded through a National Center for Women and Information Technology (NCWIT) pilot offering of the Aspire IT Middle School Outreach program. This program is designed to increase the pool of young women in the computing pipeline. Built upon the Aspirations in Computing program, AspireIT provides a platform for Aspirations in Computing winners to share their passion for computing and inspire middle school aged girls to identify and explore their aspirations in computing [6][7]. An Aspirations in Computing National Runner-Up and Mississippi Regional Winner, working with MSU, applied for and received an AspireIT grant. This entering freshman computer science major was the program leader for the camp.

The Bulldog Bytes Aspire IT camp was held June 23-27, 2013, on the campus of MSU. Sixteen middle school girls moved into the dorm on Sunday afternoon and were welcomed by the program leader. In addition, a female information technology (IT) employee from FedEx Corporation, drawing from her experiences in a computing career, offered words of inspiration to the girls as they embarked on their four day enrichment experience. Camp counselors were introduced. These near-peer mentors, all female, included a high school sophomore who had attended one of the previous computing camps, five CSE undergraduate students, a business information systems undergraduate, and two computer science graduate students.

Following breakfast in the dorm on Monday morning, the girls were introduced to the risks of identity theft to teenagers by a CSE faculty member. Techniques for protecting personal information online were discussed. The girls were tasked with using the programming skills they would learn and their creativity to develop a mechanism for educating their peers about identity theft. The program leader led the introduction of Scratch programming to the group. The girls spent the afternoon creating programs with Scratch and wrapped up the afternoon with a team-building field trip to a movie.

Tuesday morning opened with an introduction to Finch robots. The Finch offers a very hands-on approach to programming instruction, and students receive instant visual feedback [3]. While the Finch supports multiple programming languages, *Snap!*, a visual, drag and drop language, was used to program the Finch robots [8].

The educational discussion on identity theft risks was continued on Tuesday afternoon. The afternoon culminated with a visit from a female small business owner and an MSU graduate. She shared her experiences starting and running a technology business. Later, the girls enjoyed a QR code scavenger hunt. The activity took them across campus and offered small prizes for the first and second place winners.

Wednesday began early with an offsite activity intended to build upon the bonds that were forming among participants. The girls enjoyed a trail ride which for most was their first time to ride a horse. The rest of the day the girls worked on their projects in small groups.

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Thursday brought the last day of camp and time for project work in the morning. After lunch, the girls were joined by family and friends for a closing ceremony. Following a motivational message from a female IT management employee at Hewlett Packard, the girls presented their project deliverables. Each team demonstrated their tool which used either Scratch or Snap! coding and the Finch robots to create an animation about identity theft. Some of them used the robot in a video, demonstrating the Finch sneaking in the dark and stopping when lights were turned on, analogous to a perpetrator stealing identity information when the object of the theft is unaware. Many of them used Scratch to build short animations with animal characters discussing identity theft risks.

ASSESSMENT

Participants were asked to fill out a brief, open-ended survey on the first day of the camp. Surveys were designed to measure what the girls hoped to learn at the camp, their background in math and science courses in high school, the level of encouragement they had received from adults to pursue math and science, and their existing levels of expertise with computing. The second wave of data collection occurred on the last day of camp, when girls completed another written survey. Results were limited on many questions with many responses left blank. The conclusion drawn from the lack of response is that interviews should be conducted before and after camp rather than written surveys for this age group. By having individual interviews with each girl, the opportunity will be available for the participant to ask for clarification of questions.

The open ended questions on the final survey provide the most enlightening results. The two questions that provided particularly interesting results were:

- A. If the program you just attended **INCREASED** your confidence in any of these areas, tell us about that.
 - o Areas: design computer games, use new computer software, solve computer software problems, program computers, think of new technology inventions, create new technology inventions
- B. If the program you just attended **CHANGED** your ideas about your future, tell us about that.

Responses to those questions are reflected in Table 1.

Table 1. Survey Question Responses.

<i>If the program you just attended INCREASED your confidence in any of these areas, tell us about that.</i>	<i>If the program you just attended CHANGED your ideas about your future, tell us about that.</i>
My social skills	Made me get a better grasp on what I want to major in
I never knew how easy it was to create animations	I thought I would never learn about computers
Controlling the robots.	I did not really look at computers as an occupation or even major of mine. Now I may not get a computer job, but I at least might get a degree.
I feel like this is a fun area to learn in. I feel more confident about this area because the program gave me more information.	I reconsidered doing something that would be computer science related.
The program helped me increase my knowledge in how computers work.	I might become more open minded with the major in technology now.
It helped me because I learned so much more about technology/computers.	I feel more confident in technology.
It increased my confidence on trying new things.	Maybe I could design games it seems fun.

One participant's comment about the program increasing her confidence in 'social skills' warrants attention. Social skill was not one of the areas denoted in this question. There were additional comments on other parts of the survey where girls noted their enjoyment of residing in the dorm with other girls and making new friends. Adolescents are heavily influenced by "social schemas", with social support among peers important in realizing a feeling of acceptance [9]. Non-technical activities during the camp provided an environment where the girls could interact socially in a safe girls-only environment. The girl-led and girls-only academic environments provided an opportunity for non-threatening social interaction in the context of learning technical subject matter. The social implications of camp activities and the impact on girls attitudes about computing provides an interesting point for further study in subsequent camp offerings.

FUTURE PLANS

MSU plans to host two residential summer camps for middle school girls in 2014 designed to create an awareness of and excitement about computing. Undergraduate and graduate female students will serve as near-peer camp counselors and reside with participants in the dormitories. Most importantly, this program will enable low or no-cost camp experiences for girls, particularly underrepresented minorities, in surrounding counties of Mississippi.

The camp curriculum will be modified with a cross-disciplinary approach. Leadership will be provided by female faculty from the Art, Computer Science and Engineering, and English Departments at MSU. Bulldog Bytes: Digital Divas will be designed to engage young women in design and writing in addition to computer programming. Similar ideas have been successfully implemented at other institutions. The Art2STEM project emphasizes design and creativity to introduce middle school girls to opportunities in science, technology, engineering, and math [10]. In the Digital Mirror project, digital design, rhetoric, and writing are employed to enhance girls' aptitude and interest in technology [11]. In Carnegie Mellon's Arts & Bots craft-based robotics program, activities focus on expression and creativity in the application of technology. One Arts & Bots project tasked students with researching and writing a biography of an historical figure, then building a robotic model of that figure. The robotic model was programmed to act out the biography the student had written [12].

During their 5-night stay, girls participating in Bulldog Bytes: Digital Divas will be introduced to a number of "digital diva" role models on MSU's campus and from industry. In addition to learning to program with the Finch robot, Hummingbird Robot Kits will provide participants, working in teams, the opportunity to design "robots, kinetic sculptures, and animatronics built out of a combination of kit parts and crafting materials" [13]. To facilitate relationship building, the girls will participate in some non-academic activities that encourage long-lasting bonds.

Each girl will leave the camp with a digital portfolio that showcases the work that she has accomplished over the course of the week. Each participant will also take home the Finch robot that she has learned to program, enabling her to expand on her programming skills beyond the camp and share her knowledge with others. In addition to establishing a female-focused collaborative network, girls will leave the camp with the tools and savvy to use, create, and critique computing technologies.

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Dr. Sarah B. Lee

Dr. Sarah B. Lee is the Director of Undergraduate Studies in the Department of Computer Science & Engineering at Mississippi State University. She received her BS from the Mississippi University for Women, a Master’s degree in Computer Science at Mississippi State University, and her PhD in Computer Science at the University of Memphis. Dr. Lee has considerable software development and project management experience, having worked in industry for twenty years prior to returning to academia in 2011. Her research interests include knowledge management in software engineering, and recruitment and retention of women and underrepresented minorities in computing.

Ms. Rian Walker

Rian Walker is a freshman computer science major at Mississippi State University. As a high school senior, she was an NCWIT Aspirations in Computing Regional Winner and National Runner-up. She represented NCWIT at the 2013 White House Science Fair, hosted by President Obama. Rian has long had an interest in computing, and hopes to launch her own technology company in the future. Reflecting on her role as project leader in the 2013 middle school girl camp, she says that one of her most rewarding moments occurred while helping a participant. Rian stated, “She was eager to get my attention to show me that she had completed her project, but she was interested in taking the project further. and it further solidified my reasoning to work in computer science.”