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EVALUATING COMPUTER SCIENCE CAMP TOPICS IN INCREASING GIRLS' CONFIDENCE IN COMPUTER SCIENCE

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ABSTRACT

In the field of computer science, there is an evident lack of women. Studies show that girls begin to lose interest in the field from early on, so it is important for initiatives to get girls interested in coding from a young age. There are many outreach initiatives for young girls in computer science, with a wide array of topics. To help increase the number of women in computer science, we held a coding camp for middle and high school girls and offered three topics to choose from. The three camp topics included Scratch, Python, and Unity, and each were a week long. In this paper we look at the impact of the camp and compare the strengths of weaknesses of each topic in increasing girls' interest in coding and confidence in their abilities related to computer science.

INTRODUCTION

There is a significant lack of women in computer science, and there have been many initiatives to "hack" this gender gap. Only 17.9% of computer science bachelor's degrees are earned by women, and women make up only 25.5% of the computer science workforce [4]. To "#include<women>" initiatives that teach girls about computer science, increase their confidence, change their perception about CS and encourage them to pursue the field as a career are necessary.

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Girls begin to lose interest in computer science early on, so it is important for initiatives to get girls interested in programming at an early age [1]. Research shows that experience increases girls' interest and confidence in computer science, however girls still have less confidence in their abilities than boys [3]. It has also been shown that girls-only environments lead girls to have higher confidence in science, technology, engineering, and math fields [1].

In a review of computer science outreach initiatives by Decker, McGill, and Settle it was found that half stated their purpose was to increase gender diversity, and 21% were girls only [2]. There is a wide range of topics in computer science outreach programs focused on getting girls interested in the field, from graphics to drag-and-drop programming to robotics.

Initiatives focused solely on girls to increase their confidence in computer science are essential, as well as exploring the effectiveness of each initiatives' topic in encouraging girls' interest in computer science. The research on the effect of topic in girls only coding camps is limited, and we hoped to increase the literature on this by offering three topics for Camp Codette, a week-long coding summer camp for girls.

In an effort to increase girls' self-efficacy we offered three different topics for a girls coding camp, one in Scratch, another in Python and one in Unity. In this report, we will describe the strengths and weaknesses of each topic in terms of surveys, perceived student engagement and enjoyment.

BACKGROUND

Camp Codette is a week-long summer camp for middle and high school girls at Rhodes College in Memphis, TN. The camp started in 2015 with a Google igniteCS grant. The goal of Camp Codette in its first year was to show computer science as a field. Building on the first camp, the goal of the second camp was to teach fundamental computer science concepts and coding practices. For the second iteration, we wanted to give the students the knowledge and confidence to take concepts learned at the camps and the ability to apply them to personal projects. In 2016 the camp held two sessions with three topics to choose from, one beginner's topic and two more advanced topics. The beginner's topic included Scratch and App Inventor, using drag-and-drop programming languages to introduce girls to computer science. The beginner's camp had two-week long sessions from 9AM until 3PM. Advanced topics included Python and Unity to create games while learning about programming. The advanced topics each were a week long lasting from 9AM to 4PM. Before and after care was provided for those who needed it.



Figure 1: Campers in the camp's #include<women> t-shirts

Campers

The camp had a total of 70 campers from over 25 schools in the Memphis area. Campers ranged in age from 9-17 years old. The racial makeup of the campers was 55% White, 16% African American, 23% Asian and 1% Other. Around six campers were on scholarship to the camp. A large number of girls were return campers from the previous year's camp.

Counselors

There were eleven mentors total, consisting of nine counselors and two camp directors working with Camp Codette. Of the mentors, 82% were female and 18% were male. The mentors were 73% White, 9% African American and 18% Asian. The number of counselors doubled from the previous year, and were more diverse.

The counselors were each in charge of either a lesson to teach or a computer science related activity to lead. Counselors attended a teaching workshop the week before camp in preparation for leading lessons and activities. Examples of counselor led lessons include shapes in PyGame, if and else statements in Scratch and creating objects in Unity.

CAMP DESIGN

Topics

Scratch and App Inventor served as introductory topics in computer science. Using block programming, we wanted to teach the fundamentals of programming such as variables, conditionals, and user input. The Scratch programming environment allowed girls to have fun by creating games and animations while also learning important aspects of computer science. To further learn about the applications of coding the campers also made 3D models with Tinkercad and controllers with Makey Makey.

Python was offered as a more advanced topic for learning about computer science. The Python camp covered more in-depth computer science material such as comparisons, conditionals, loops, text-based games, and graphics with PyGame. Compared to drag-and-drop languages, learning Python let the girls learn language syntax while creating fun text-based games. In the latter part of the week the girls got to see some applications of Python by working with PyGame creating simple shapes and games.

The Unity camp was an opportunity for girls to get experience developing 3D games while learning about coding. Through 3D modelling with Unity and scripting with C# campers could create their own projects while learning about many different aspects of game development. Some campers enjoyed the design aspect, some enjoyed toying with physics and even more enjoyed playing with gameplay and level development.

Pedagogy

The aim of the camp was to give girls the opportunity to learn about computer science while also having fun and increasing their confidence in their computing skills. A combination of scaffolding and a constructivist approach was used to maintain campers' interest and motivation and also allowed the campers to learn coding while being creative. Many girls indicated they believed computer programming can be creative before the camp, and we hoped to further this belief through the use of topics that encouraged them to be creative.

Instructors would introduce a concept and a small project to go with the lesson, then allow the girls to learn on their own by personalizing the project. Examples of small projects include a text-based adventure game and RGB based games such as figuring out the world's ugliest color and the average color of the universe. The girls were encouraged to further explore the material themselves and develop individual final projects. This was done in the hopes of building girls' confidence in working on computer science projects on their own and increasing their ownership over the programs they created.

To keep the campers interested and engaged, lessons and activities were scheduled so that time at computers and breaks were balanced. Before each day and after lunch we did CS unplugged activities and icebreakers to teach the girls about a wide array of different CS topics while also having fun and building a sense of community. Some examples of CS Unplugged activities include making binary bracelets, a card game to introduce if/else statements, and a selfie scavenger hunt that included coding a photo viewer.

Daily Schedule

On the first day campers took a presurvey to record their self-efficacy and attitudes toward computing before the camp started. The camp started at 9AM each day with CS Unplugged activities and icebreakers. Icebreakers allowed the campers to get to know each other and counsellors to become better mentors by getting to know the campers. Each camp followed roughly the same schedule with activities in the morning followed by a lesson. Traditional camp activities and coding lessons were each an hour to two hours long with breaks in between. In the advanced sessions breaks were important to

keep the students from getting frustrated or losing interest. Lunch was from 11AM to 12PM with a thirty minute activity afterwards. After the activity, on most days there was a lesson until the camp ended at 3PM. In the afternoon on some days there was activities such as a tour of a virtual reality lab and swimming.

DATA ANALYSIS

Of the seventy campers, fifty-seven took both the pre-survey and the post-survey. The survey consisted of fifteen questions related to their knowledge of computer science as a field, confidence in their science, technology, engineering and mathematic abilities, and future indication to pursue computer science further. The campers were asked to answer each question using a Likert scale of one to five, with one being "I do not agree" and five being "I strongly agree". There was twenty-two complete survey responses from girls in the Scratch camp, eleven from girls in the Python camp and twenty-three from girls in the Unity camp. The Python camp ran out of time and was unable to get all the post-surveys completed. The data was analyzed for overall results and individually by topic.

Results

The fifty-seven pre and post surveys showed that eight of the fifteen questions had a significant change, with a p-value less than .05. The eight questions include "I am a good problem solver", "I enjoy solving problems with computers", "I would succeed in a computer science class if I took it at my school", "I know what computer science is and what computer scientists do", "I know of many different jobs that involve computer science", "I can see myself choosing computer science as a career", "Computer programming can be creative", and "I know of women in science and technology that I can look up to". The question with the smallest p-value was "I know of many different jobs that involve computer science". The questions with the two highest pre and post means were "Computers are fun to use" and "Computer programming can be creative".



Figure 2: Campers and counselors during a CS Unplugged activity

Topic Results

Scratch had the most questions with a significant change, with eight questions total. The eight questions were similar to the overall results, except "Computer programming can be creative" did not have a significant change after the camp, and "I can see myself taking more computer science classes in HS/college" did have a significant change. "I know of many different jobs that involve computer science" had the most significant change in means between pre and post surveys.

The Unity camp had a total of six questions with a p-value lower than .05, including "I would succeed in a computer science class if I took it at my school", "I know what computer science is and what computer scientist do", "I know of many different jobs that involve computer science", "I can see myself choosing computer science as a career", "Computer programming can be creative", and "I know of women in science and technology that I can look up to". The question with the lowest p-value was "I know what computer science is and what computer scientist do".

Python had the least amount of questions with a significant change, with only two questions total. The two questions include "I am a good problem solver" and "I enjoy problem solving with computers". Both questions had the same p-value.

DISCUSSION

The results of the survey show that overall the camp helped to increase girls' knowledge of computer science as a field and their confidence in their problem solving abilities as well as their interest to further pursue computer science. The camp also provided girls with women in computer science to look up to as they further explore their interest in the field. Women mentors in technology have been shown to greatly increase women's persistence in computer science, so campers now have mentors they can look up to as they continue to learn about coding [3].

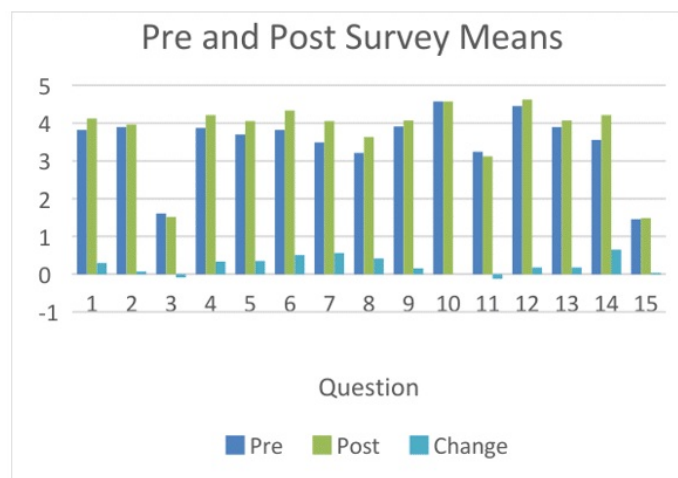


Figure 3: The mean of the pre-survey, the post-survey and the difference between the surveys

The Scratch camp had the highest number of survey questions with a significant change after the camp. The research on the effectiveness of drag-and-drop programming languages for introducing computer science is extensive, and the survey results support that research as well. However, the question "Computer programming can be creative" was not significant, showing Scratch is not as creative as other computer science camp topics.

The Unity camp was the only camp with a significant change for the question of whether or not computer science can be creative. The Unity camp was also the only camp to not have a significant change for the questions "I am a good problem solver" and "I enjoy solving problems with computers", and had the highest post-survey mean for the question "Computer programming is hard". Unity allowed campers to be creative but may have been too difficult and discouraged girls' confidence in their problem-solving abilities.

The Python camp had the smallest number of completed surveys and the least amount of survey questions with a p-value less than .05. A possible reason for the small amount of significant changes in responses could be the small sample size. Despite that, the Python camp significantly changed girls' confidence in their problem-solving abilities and enjoyment of solving problems with computers.

CONCLUSION

Camp Codette encouraged girls' confidence and interest in computer science, with Scratch being the most effective topic. Scratch and drag-and-drop programming languages are good for introducing computer science without being too difficult. We recommend a topic such as Unity for advanced students wanting to learn more about computer science. Too difficult of a topic can decrease girls' confidence in their abilities, so it is essential to have a camp that is engaging but not overwhelming. The Python camp was not overwhelming, but it may have not been engaging enough to get girls interested in pursuing programming further. Overall the camp met our goals of increasing girls' confidence and interest in computer science, and Scratch was the topic that was the most effective at meeting our goals for Camp Codette.

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