CS@SC Summer Camps - a week-long program to teach local K-12 Students about Computer Science

Jeffrey Miller, Saty Raghvachary, Andrew Goodney
Department of Computer Science
University of Southern California
{jeffrey.miller, saty, goodney}@usc.edu

ABSTRACT

In this paper we provide an overview of the CS@SC Summer Camps, a week-long program at the University of Southern California (USC) that exposes local K-12 students to computer science. Students attend the program on campus at USC, experiencing life as a college student while learning about a valuable field that is currently in high demand. Although the contact hours with the students are limited to 35 hours per week, the camps have shown that the program increases interest in computer science, in girls (over 40% attended), minorities (over 70% attended), and students from low income families (over 80% of attendees have an annual family income less than $40k). We hope that fellow educators in other colleges will launch similar initiatives to reach under-served K-12 student populations in their local communities.

INTRODUCTION

There is no doubt that computer science is currently a popular discussion topic for educators. The New York Times has added “coding” to the traditional educational areas (“Reading, Writing, Arithmetic, and Lately, Coding” [1]), while The Washington Post has tried to add a fourth “r” instead (“reading, writing, arithmetic, and algorithms” [2]). Regardless of the vocabulary, competing in an increasingly technological society will require some basic knowledge of computer science. Michael Resnick, a professor of learning research at the MIT Media Lab, said, “Coding is the new literacy. To thrive in tomorrow’s society, young people must learn to design, create and express themselves with digital technologies” [3]. In fact, President Barack Obama even made computer science a priority in the State of the Union Address in 2016, saying, “But tonight, I want to go easy on the traditional list of proposals for the year ahead. Don’t worry, I’ve got plenty, from helping students learn to write computer code to personalizing medical treatments for patients” [4]. He continued to say, “In the coming years, we should build on that progress by providing Pre-K for all and offering every student the hands-on computer science and math classes that make them job-ready on day one” [4]. All the hype surrounding computer science education does not come without a number of challenging questions, such as:

- Should computer science be included in the normal K-12 curriculum?
- If so, what subject(s) get removed or reduced?
- How do we encourage students to be interested in computer science?
- As the demand for computer science increases, will we be able to diversify across gender, ethnicity, and family income equally?
- Will academic institutions be able to keep up with the rising enrollments as demand increases?
One way to try to increase the number of students enrolled in computer science programs is to provide students with exposure to the field in a manner that will generate interest. There are many models that provide students with this exposure or to ongoing education in the field, including traditional curriculum in K-12 or post-high school institutions, coding boot camps, after-school programs, continuous engagement programs, and summer camps, among others. In this paper, we provide a study of a one-week, free or low cost summer camp that exposes K-12 students to computer science through coding. Although the exposure is limited to one week, students benefit through:

1. an increased interest in computer science and science, technology, engineering, and mathematics (STEM),
2. an opportunity to learn about computer science,
3. an experience with diverse peers that varies from the current trends in industry,
4. the excitement of realizing that computer science is a challenging field but that it is not impossible,
5. relating to mentors with similar backgrounds or experiences

The following section discusses the specifics of the CS@SC Summer Camps (http://summercamps.usc.edu), which is a program organized by the primary author of this paper at the University of Southern California.

CS@SC SUMMER CAMPS

Founded jointly by the Viterbi School of Engineering at the University of Southern California (USC) and the Institute for Education (IFE), the CS@SC Summer Camps provides free and low cost computer science exposure to K-12 students in a university environment. To coincide with the typical K-12 academic day, the camps run daily from 8:00a.m. to 3:00p.m. for one week at a time. Multiple camps for different age ranges are run simultaneously, with the following topics taught for the specified grade levels:

- Scratch Jr., for Kindergarten-2nd grade students
- Scratch, for 3rd-8th grade students
- Java or Python, for 7th-12th grade students

There are multiple levels of each camp, enabling students to attend a camp based on their own experience level or to allow students to attend multiple weeks if desired. The curriculum has been custom-developed by the primary author of this paper in collaboration with USC Rossier School of Education faculty and K-12 teachers.

The camps are hosted on campus at the University of Southern California to provide students with a college experience. They are taught by USC undergraduate and graduate computer science students, and they are exposed to college life through changing classrooms, eating in the dormitory cafeteria, and being immersed in the natural environment of college students. The teaching assistants (TAs) also act as mentors to the students, eating lunch with them, interacting with them throughout the day, and hopefully relating to them in a manner that encourages the students to realize that they are capable of pursuing career in a STEM field, just like the TAs.
Schedule
All campers and TAs begin the day together in a large auditorium where they work together to solve a thought-provoking question or puzzle. This activity reinforces the idea that computer science involves critical thinking skills.

The students are then broken into the individual camps that consist of up to 20 students. The camps maintain no more than a 1:10 ratio of teachers-to-students. The students then walk through campus with their TAs to their classrooms.

There are two 15-minute breaks during the day – one in the morning and one in the afternoon. There is also lunch in the middle of the day at the dormitory cafeteria (which is typically one of the highlights of the camp for many students).

Instruction Method
The curriculum is based on scaffolding to ensure that students acquire specific skills before moving onto more advanced ones. Since the camps are focused on teaching students how to program, there is a three-step model that is followed:

1. Students are taught a topic by the TAs and shown a small example demonstrating the topic.
2. The TAs write a program with the students that use the newly-learned topic. The program is displayed on a projector so students can copy the code.
3. The students are given a description of a program that reinforces the topic and are tasked with writing the program on their own. The TAs are available to help students if there are questions.

Some of the programs that fall under the third step build on each other so the students are able to create an application with more features. Some of the example programs for that are as follows:
- Storyboarding (Beginning Scratch Jr.)
- Catching Falling Fruit (Intermediate Scratch Jr.)
- Pac-Man (Beginning Scratch)
- Flappy Bird (Intermediate Scratch)
- Hangman (Java, Python), with additional features being added on during subsequent levels of the camp

In addition, the students are provided with USB drives so they can save the programs they develop for use at home.

Advertising
Because of the free and low cost nature of the camps, advertising has not been a major concern. During the first year, the camps were advertised through fliers and emails to 15 elementary, middle, and high schools that surround USC’s main campus in downtown Los Angeles and USC’s health sciences campus in east Los Angeles (known as the USC Family of Schools [9]). A web site was also developed (http://summercamps.usc.edu) that allowed parents to add an email address to a mailing list. Although there was only space for around 200 students to attend during that first summer, there were over 600 applicants.
In subsequent years, advertising was done only through the web site and emailing the constantly-expanding mailing list, which has now grown to over 2,000 addresses. In 2017, there were over 1,200 students who applied to attend nearly 3,000 camps.

**Funding**

The number of spots available for students each summer is typically limited by two factors – space and funding. The amount of space available at a university is a hard problem to solve that typically needs institutional support from upper administration. If the administration is supportive of the activity requesting the space and can prioritize it, space is easier to reserve. However, regardless of the priority of the activity, there is still a limit to the amount of space available without constructing new buildings (which is a very expensive venture) or renting space off campus (which does not provide the same experience for the students). For the purposes of this paper, let’s assume that there is space available on campus, which is the case for the CS@SC Summer Camps.

The issue of funding is a more tractable problem that is within the control of the organizers of the program. With the need for computer scientists continuing to grow, many organizations are happy to support efforts to increase enrollments and interest in the field, even more so if the program is designed to increase interest amongst under-represented groups. The Institute for Education (IFE), a non-profit based in Washington DC, understands this problem and partnered with the Viterbi School of Engineering at USC to create the CS@SC Summer Camps in 2015. Through the joint efforts of the primary author of this paper and IFE, additional organizations have provided funding for students to attend the program free of charge. Individuals, specifically parents of some of the students who have attended the camps, have also generously provided donations to allow other students to attend.

As the program continued to grow and expand, local school districts saw the benefit in sending their students to the camps. Title I funding has been used to allow students from low income schools to attend the camps, and funding from technology education accounts has helped as well. In 2017, nearly 400 of the students who attended the camps were from school districts who supported students to attend free of charge.

Although the massive response of parents who are interested in their children being exposed to computer science is impressive, there are many other interesting statistics about the demographics of the attendees. For example, the percentage of girls related to boys is shown in Figure 2, with the number of girls attending each year being over 40%, with the first year being 60% (though this is due to an all-girls camp that was offered the first year, skewing the numbers from subsequent years). The national average of girls graduating from STEM fields is currently 18% [10], providing more than double that percentage being exposed in the camps. To support this even further, USC’s Viterbi School of Engineering boasts an incredible 40% of incoming freshman students in the 2017-2018 academic year are women.

The percentage of students broken down by ethnicity is provided in Figure 2. Most likely due to the ethnic makeup of the communities surrounding the USC campus, minority ethnicities (Hispanic, African American, and Other from the figure) account for between 70-80% of the attendees each year. With more programs providing similar exposure to minority students, we can hopefully try to bridge the gap between the percentage of the minority population and the percentage of minority students graduating college with STEM degrees.
CONCLUSION

We shared some details (overview of the syllabus and schedule, instruction technique, advertising, funding) about CS@SC, our successful summer program that exposes K-12 girls, minority students and low-income family students, to computer science. Our hope is that similar programs get launched by our educator colleagues, to get under-served K-12 populations in their own surroundings, further interested in computer science. More information on our program can be found at http://summercamps.usc.edu.

REFERENCES