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An Investigation of Pathways to Computing for Middle and High Schoolers in the U.S. South

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Abstract

For two weeks in June 2015, the Computer Science and Engineering (CSE) and English departments at Mississippi State University hosted nearly 80 high school and middle school students at their Bulldog Bytes residential computing camps. The first week, the departments worked with middle and high school boys, and the second week, with middle and high school girls. The camps were offered at no cost to all accepted participants. Primary support came from the NSA's GenCyber program, and secondary support included a private donor, a corporate foundation, and the National Center for Women and Information Technology (NCWIT) AspireIT program.

Over the course of the 4-night (middle school) and 5-night (high school) programs, campers were invited to participate in voluntary survey and interview research. This paper analyzes a small portion of the data from 65 participants in order to better understand (1) participants' motivations for applying to a residential computing camp, (2) participants' access to technological tools and education prior to the camp, and (3) participants' desired access to computing education at the end of the camp. Such knowledge is integral to the increasing amount of computer science education initiatives across the nation, such as President Obama's recently announced Computer Science For All initiative.[1]

Background

Computing is consistently identified as one of the ten most promising areas for career growth; however, the ability to recruit, educate, graduate, and then retain individuals once in the workforce is a significant problem.[2] For example, the cybersecurity workforce is facing a shortage of qualified professionals.[3] To combat this shortage, the National Initiative for Cybersecurity Education (NICE) was created to promote "cybersecurity awareness, education, training, and workforce development that measurably advances the US's long-term cybersecurity posture."[4] Workforce crisis rhetoric is plentiful in the literature,[5] particularly as it relates to girls and women. Such rhetoric is well warranted, however. As the market is projecting growth in computing fields that are already trying to resolve existing gender gaps, there was a 64 percent decrease in the number of first-year female students interested in concentrating in Computer Science from 2000-2012.[6] The problem of representation is even more distinct with regards to race; for example, in 2014, though only 26% of jobs in computing were held by women, only 3% of those jobs were held by African American women.[6]

Such circumstances make it imperative to develop middle and high school initiatives to support computing literacies for all, but particularly for those students whose demographic characteristics are not currently reflected by the populations supporting the computing workforce. Similarly, it is as imperative for researchers to better understand variables that impact adolescents' successful pathways to computing experiences, curricula, and professions and the relationship between gender and race with regards to those variables.[7] Thus, this paper reports on residential summer computing camps, focusing on curricular implementation as well as preliminary analyses of

survey data collected from middle and high school students addressing what drew them to apply for and attend a computer camp as well as what kinds of courses and tools will retain their interest and curiosity beyond an extracurricular summer experience.

Camp Overview

In 2015, 80 out of 154 applicants were invited to attend the camps. 18 middle school (MS) boys, 21 high school (HS) boys, 20 middle school (MS) girls, and 18 high school (HS) girls (77) accepted the invitations. Camper participant selection was based on a personal statement on the application form:

> Please tell us about yourself including your interests (academic and nonacademic) and why you wish to attend this program. What do you expect to learn from attending (the camp)? We are also interested in your plans for college and career. Where do you intend to attend college and what major are you most interested in?

Applicants whose personal statements showed a clear interest in computers, cyber security, programming, and technology as well as beginner- or intermediate-level experiences with such areas were given preference.

2015 was our second year co-designing and –implementing summer computer camps together. In 2014, we worked with colleagues in Art and Sociology and only with females, and in 2015, we worked with colleagues in Education and Communication and both females and males. Our continued goal as an interdisciplinary team was to understand how to engage and sustain the interest of students not traditionally engaged with computer science, a diverse and challenging field that as specialists or not, students will likely need domain knowledge from in order to participate fully in a digital economy. Working through and with the National Security Agency's GenCyber Program,[8] we were particularly focused on implementing a cyber literacy program in 2015. Building off of Stuart Selber's conceptualization of multiliteracy,[9] we understand cyber literate individuals as people who are savvy and safe technology consumers and producers: (1) Computer users who understand the principles of cybersecurity and the applicability of cybersecurity to their everyday lives, and (2) Technological innovators capable of collaboratively anticipating and solving problems posed by a 21st century technological society.

Conceptualizing cyber security as a subject area that is embedded within a broader computer or digital literacy necessary for success in the 21st century recognizes that many professionals outside of typical cybersecurity positions spend much of their workday in the domain. As such, we use computer and cyber literacies to describe our program's curriculum, understanding that knowledge within computer science is inextricably linked to communicative, historical, technical, social, and political knowledge as well. For example, Burley and Bishop point out that non-computer science majors "often program," creating web pages and other programs. Similarly, Hoffman, et.al. suggest a holistic approach to developing a cybersecurity pipeline, recognizing that a variety of disciplines may fill this pipeline.[3]

Descriptions of the programs and information about application and registration were posted on Mississippi State University's summer camp page and also on the Bagley College of

Engineering's summer camp page. Information was also circulated to middle and high schools through the university's continuing education website.

> Middle School Track:
> A 4-night residential computing camp for students in grades 6-8 (entering sixth through ninth). The camp follows a project-based curriculum using entry-level Robotics Kits and is designed to integrate Art, Computer Science and Engineering, and English to foster and strengthen computational thinking and design, programming, and communication skills. Additionally, given the nature of the Internet in the 21st Century, cyber safety will be emphasized and girls will have the opportunity to learn about how computer crimes are investigated.
>
> High School Track:
> A 5-night residential computing camp for students in grades 9-12 (just graduating 9th to just entering 12th). The camp follows a project-based curriculum using intermediate-level Robotics Kits and is designed to integrate Art, Computer Science and Engineering, and English to foster and strengthen computational thinking and design, programming, and communication skills. Additionally, given the nature of the Internet in the 21st Century, cyber safety and digital forensics will be emphasized. Students will get hands on experience learning how to collect and preserve digital evidence and protect computers against malicious attacks.

Other programs with goals similar to the implementation described in this paper have been reported. Researchers at California State University reported on a four-week summer program for high school students and teachers where participants attended lectures that were complimented with hands-on activities. Modules included cryptography, factoring (to analyze algorithms), network security, and social engineering.[10] Bowie State University hosts a summer camp for high school students that includes a cybersecurity component. A teacher workshop is included to provide guidance for teachers who want to implement the summer camp curriculum in their classrooms.[11]

During the 2015 Bulldog Bytes program,, campers learned Snap! (MS) or C programming (HS) using Finch Robots (MS) or Activity Bots (HS). After learning to work with the different coding languages and robots individually, campers worked on a team project where they (1) designed a scenario for their robots to navigate (like moving through a maze, dancing, sensing objects, drawing patterns on paper), (2) drafted a step-by-step plan to help guide their code writing (or drag and drop, which is the case with Snap!), and (3) then worked together, experimenting through trial and error, to figure out how to make their robots do what they wanted them to do.

Breaking up their programming work over the course of the week, campers also attended mini-lectures and participated in activities and workshops on app building, cyber security (password protection), cryptography, and digital forensics. For example, after hearing about digital forensics and hearing about how it is used in the field to solve crimes, campers worked on case studies, learning to think like a digital forensics expert and practicing using digital forensics tools to solve crimes. Additionally, campers also heard from industry speakers who addressed how their careers interact with technological, cyber, and/or computing and the choices they made that led them to their career paths. Speakers joined the camps as mentors and often spent time talking

with students in small groups and one-on-one. Lastly, though as important, unstructured play and bonding time were formalized within the camp structure, including group QR Code scavenger hunts, rock wall climbing, video game evenings, and down time on campus and in the dorms.

The Study

Camp participants were invited to participate in voluntary research while they were at the camp and were also given the opportunity to volunteer to participate in follow-up interview research for the next five years. The overarching goal of the study is to better understand what kinds of variables seem to motivate middle and high school boys and girls in the U. S. South to pursue computer science education as well as what kinds of variables seem to influence educational persistence and successful entry into the computing workforce. The purposes of our larger research project are multiple:

(1) To assess the effectiveness of a project-based camp curriculum that integrates digital composing, rhetoric, and design with computer science and engineering education;
(2) To better understand the dynamics of collaborative/team-based and competitive projects in groups of middle and high school boys and girls;
(3) To better understand, from high school and middle school girls' and boys' perspectives and experiences, why there are so few women in technology degree paths and careers and, particularly, why so few women of color;
(4) To better understand the role of the media in reinforcing stereotypes of gender and race in relation to technology; and
(5) To assemble a 5-year database of adolescents' uses of and exposures to technologies and curricular and co-curricular technological education and opportunities in a southern US state, to map this data by school district, in order to eventually provide a geospatial representation of the landscape of technological literacy and the variables that contribute to successful matriculations of campers into technological degree and career paths.

Understanding what sparks and deflates adolescents' interests in areas like cyber security, computer science, digital forensics, and robots as well as the kinds of tools and knowledge they have access to and want access to, enables educators to consider how to build student-centered programs, courses, and activities to advance the digital literacies of adolescents. Because our research demographic is diverse and because we analyze our data based on age, gender, and race, our camp assessments provide valuable insight for addressing gender and race gaps within the broader field of computer science. Gender gaps are of particular interest for our research demographic because research has shown that girls' interest in computers often declines during the middle school years.[12]

Of the 77 selected camp participants, 65 agreed to participate in research at the camp, and 55 agreed to participate in longitudinal research. Table 1 represents the demographics of campers who agreed to participate in research at the camp.

Table 1. Research Participant Demographics.

	Middle School Boys	Middle School Girls	High School Boys	High School Girls	Total by Race
African American	3	9	7	9	28
Asian	2	2	0	2	6
Mixed Race	1	1	1	0	3
White	8	6	10	4	28
Total by Age	14	18	18	15	

Whereas over 40% of our campers are African American, the NSF reported in 2013 that African Americans in total accounted for less than 10% of "computer/information scientists."[13] Such circumstances make the data we have gathered and report on here critical information if educators are to take serious action toward achieving the goal of a more diverse and equitable workforce. Because of this, as we review the data we have gathered in our paper, we focus in particular on the results with relation to African American (AA) campers.

We received consent and assent to collect a variety of data throughout the camp and to archive and map that data based on participant zip codes: (1) Camp Application; (2) Intro Survey; (4) Access Survey; (5) Social Media Survey; (6) Camper Exit Survey; (7) Camper Group Interviews: Gender and Media; (8) Final Presentations produced for the camp; (9) Any non-identifying images collected to document camp activities; (10) Field Notes (observation notes) regarding camp activities; (11) Reflective Memos (in-process reflections on observations recorded in field notes, preliminary theories); (12) Participation on Social Media related to the camp—posts that included the camp's various handles and hashtags on social media.

The four surveys are the richest sources of information and were all administered in lab environments using Google Forms: (1) Introductory Survey, (2) Access Survey, (3) Social Media Survey, and (4) Exit Survey.

For this report, in addition to closed survey questions that allowed us to easily quantify results (like the number of computers participants have in their homes), we also analyzed open ended survey responses to inform our findings. Table 2 matches the specific cluster of research questions we address in this report with open ended survey questions that inform our qualitative findings.

Table 2. Research Questions and Relevant Open-Ended Survey Questions.

Survey questions consulted to determine participants' motivations for applying to a residential computing camp.	
INTRO SURVEY	How did you hear about (the) camps?
	Who encouraged you to apply to the camp?
	Why did you apply to the camp?
	What are you hoping to learn?

Survey questions consulted to determine participants' access to technological tools and education prior to the camp	
ACCESS SURVEY	Does your school have any technology or computer afterschool programs or clubs?
	What kinds of computer classes does your school offer?
	What kinds of things do you use computers for in school?
Survey questions consulted to determine participants' desired access to technological tools and education at the end of the camp.	
EXIT SURVEY	If your school had a technology or computer-related afterschool program or club, would you participate?
	What would you want to learn or do in a technology or computer afterschool program or club?
	After going through the camp, what computer classes do you wish you could take at your school?

Preliminary Findings

Motivations for applying to a residential computing camp

Results from the introductory survey indicate that 33.8% of all campers heard about our computing summer program from their mothers. Campers themselves (12.3%) and teachers or schools (10.8%) also appeared to guide students to information regarding the camp. Similarly, 49.2% of all campers reported that their mothers encouraged them to apply to the camp. Parents (13.8%), campers themselves (12.3%), and family members (10.8%) were the next most common people encouraging campers to attend. For African Americans in the study, 61.54% reported that they heard about the camp from a family member, including parents, grandparents, and cousins. The majority of African American students (84.6%) reported that a family member encouraged them to apply to the camp. Nineteen percent of African Americans reported they heard about the camp from a teacher or school counselor.

Results from the introductory survey also indicated that campers applied to the camp for a variety of reasons. The most popular reasons across all cohorts included: they were interested in engineering or computer engineering (23.1%), the camp sounded interesting or fun (21.5%), they felt it would be applicable to their future careers (16.9%), they were interested in robots (13.8%), and because they were generally interested in learning more about computers and technology (13.8%). Campers also reported applying because they were interested in learning about programming (9.2%), computer science (6.2%), cyber security and online safety (6.2%), meeting new people (6.2%), and learning something new (4.6%).

However, there were differences across cohorts. The most popular reasons for high school boys applying included an interest in engineering (4), an interest in programming and coding (4), an interest in cyber security (4), and because of future career goals (4). For high school girls, an interest in robots (4) and future careers (3) were the most common responses. For middle school

girls, an interest in future careers (4) and that the camp sounded interesting and fun (3) were strong motivators. Middle school boys applied because they thought the camp sounded fun and interesting (6). For African American participants, campers reported wanting to learn about programming, engineering, and technology (42.3%) and that the camp sounded like it would be fun (26.9%). A sample of responses to the survey question: "Why did you apply to the camp?" is included in Table 3 below.

Table 3. Camper responses to introductory survey question about why they applied to the camp.

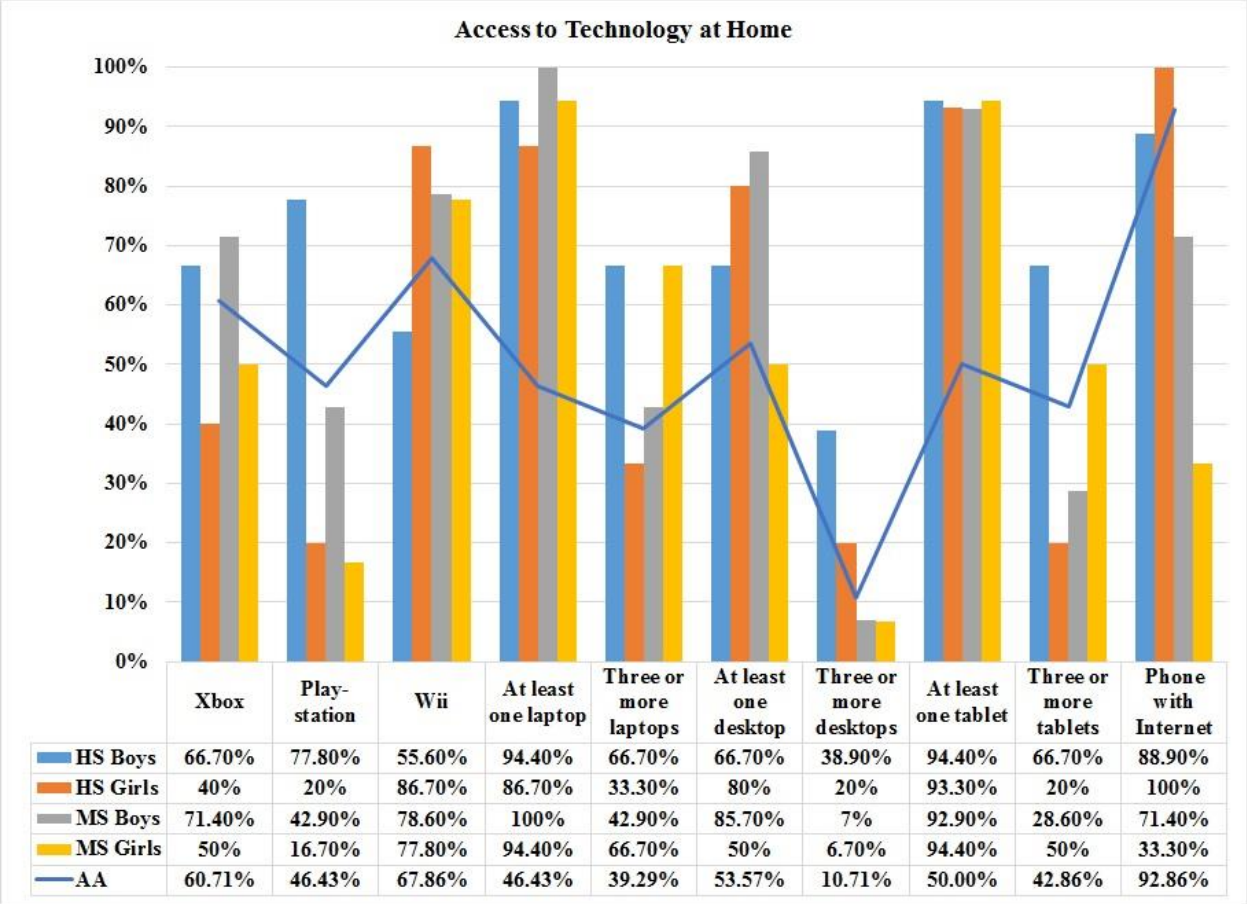
HS Boys	• "I like engineering and want to be a computer engineer when I grow up so I thought it would be fun and interesting." • "To gain more information in what computer science and robotics is like and what campus life is like." • "I applied to you all because it did interest me and I was interested in meeting people of similar interest." • "I applied to the camp because I wanted to learn more about programming, coding, and cybersecurity."
HS Girls	• "I would like my future job to be working with computers and programming." • "I applied for this camp because I wanted to gain more knowledge about computer engineering and want to experience robotic engineering." • "Because I thought it would be fun and I enjoy learning about computers and robotics." • "My mom encouraged me to apply. I decided to because when I was on my school robotics team, I really enjoyed working with robots and coding. I think technology is something everyone should be familiar with, which is what this camp can offer. I enjoy working with and learning about and how to use different computers, robots, and forms of technology. I also think the amount of females working with technology or in science is extremely low, and applying would help the number of females change."
MS Boys	• "This camp looked fascinating and I was interested." • "I applied because I wanted to learn something new." • "I looked over the camp and I thought it would be really cool and fun to attend. I liked the idea of having a roommate and spending the night. I also wanted to learn about computer engineering." • "I applied to the camp because computers are my life and it was a computer camp. My mom can only get me to clean my room and do chores."
MS Girls	• "I am considering a career in engineering and technology." • "I wanted to learn more about computers and technology." • "I wanted to learn about robotics and meet some new people." • "I applied for this camp because I have been becoming really interested in engineering and digital things dealing with the computer. I have also been doing a lot of video editing and video production

	lately and I also attend an engineering program [at another institution] for engineering. I have really been enjoying working in their field lately."

In terms of what they wanted to learn while at the camp, across all cohorts, programming or coding (36.9%), robots (24.6%), cyber security and digital forensics (16.9%), and engineering (15.4%) were the most frequent responses. High school boys were most interested in learning about programming and coding (61.1%) and cyber security and digital forensics (44.4%). High school girls were most interested in learning more about programming and coding (33.3%) and robots (33.3%). Middle school boys were most interested in learning about programming and coding (35.7%) and computers in general (35.7%). Middle school girls were most interested in increasing their knowledge of engineering (18.9%). While only one African American boy reported wanting to increase knowledge of engineering, 40.9% of females did. African American males did report (60%) wanting to learn about robotics, programming, and cybersecurity.

Access to technological tools at home

Figure 1 demonstrates that most campers had at least some kind of access to technological tools at home, and many had more than basic access (multiple laptops, desktops, and tablets).



	Xbox	Play-station	Wii	At least one laptop	Three or more laptops	At least one desktop	Three or more desktops	At least one tablet	Three or more tablets	Phone with Internet
HS Boys	66.70%	77.80%	55.60%	94.40%	66.70%	66.70%	38.90%	94.40%	66.70%	88.90%
HS Girls	40%	20%	86.70%	86.70%	33.30%	80%	20%	93.30%	20%	100%
MS Boys	71.40%	42.90%	78.60%	100%	42.90%	85.70%	7%	92.90%	28.60%	71.40%
MS Girls	50%	16.70%	77.80%	94.40%	66.70%	50%	6.70%	94.40%	50%	33.30%
AA	60.71%	46.43%	67.86%	46.43%	39.29%	53.57%	10.71%	50.00%	42.86%	92.86%

Figure 1. Percentages of campers with access to technology at home.

For example, every camper had at least one computer in his or her home. The majority of campers in each cohort had a smartphone, and with the exception of middle school girls, a smartphone that was connected to the internet. The majority of campers also had access to at least one laptop, desktop, tablet, and gaming system at home.

100% of campers has at least one television at home; however, as may have been predicted, high school and middle school boys were more likely than high school and middle school girls to have an Xbox or Playstation game console at home. However, high school girls (86.7%) were more likely than high school boys (55.6%) to have a Wii. Middle school girls were almost as likely as middle school boys to have a Wii.

Smartphones connected to the internet proved to be the most striking difference between ages and genders in terms of access to technological tools at home. Whereas 100% of high school girls and 71.4% of middle school boys had an internet-enabled smartphone, only 33.3% of middle school girls reported having a smartphone that was connected to the Internet.

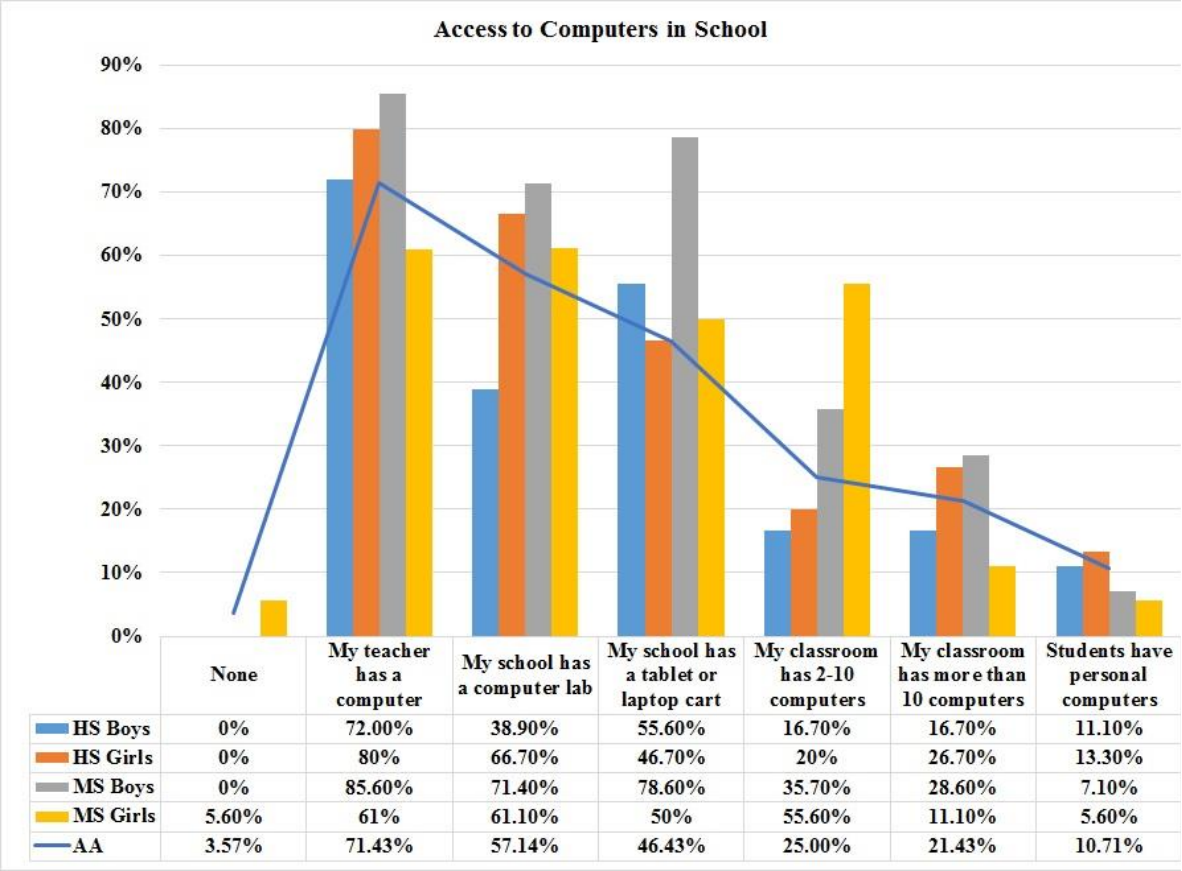
Access to computers in school

Campers' reported access to technology in school was less encouraging. For example, one camper reported being in a classroom with no computers. 73.8% of campers reported that their teacher had a computer; however, only 52.3% of campers reported that there were computers in their classrooms, only 58.5% reported that their school had a computer lab, and only 56.9% reported that their school had a laptop or tablet cart. Figure 2 demonstrates how these statistic broke down for individual cohorts.

Access to curricular and extracurricular computing opportunities

The access survey asked campers if their school had an afterschool computer or technology club. Across all cohorts, only 29.3% of campers reported having or being aware of an afterschool program. 66.2% reported that there were no such opportunities at their schools or that they were not sure if there were opportunities (4.6%). A greater percentage of African American campers across all age groups reported there were not after school programs related to computing (70.37%). Based on a variety of survey responses, robotics teams seemed to be the most popular afterschool or co-curricular technology opportunity for middle and high schoolers in our region.

In terms of curricular opportunities for computing or technology knowledge, campers acknowledged a variety of courses. However, the majority of those courses were focused on typing, information communication or communication technology, basic computer applications, or humanities-based media or digital composing classes. Very few campers reported having access to computing courses that engaged them in the acquisition of advanced computing skills, even advanced humanities-based computing skills. For example, though several students referenced an Information and Communications Technology (ICT) course, one middle school male participant clarified that this course "offers typing lessons and teaches me how to change my typing to what I like. It also teaches me how to make PowerPoint presentations." Though another middle school boy mentioned learning about cybersecurity, he clarified in his response



	None	My teacher has a computer	My school has a computer lab	My school has a tablet or laptop cart	My classroom has 2-10 computers	My classroom has more than 10 computers	Students have personal computers
HS Boys	0%	72.00%	38.90%	55.60%	16.70%	16.70%	11.10%
HS Girls	0%	80%	66.70%	46.70%	20%	26.70%	13.30%
MS Boys	0%	85.60%	71.40%	78.60%	35.70%	28.60%	7.10%
MS Girls	5.60%	61%	61.10%	50%	55.60%	11.10%	5.60%
AA	3.57%	71.43%	57.14%	46.43%	25.00%	21.43%	10.71%

Figure 2. Percentages of campers who had access to particular technological tools at school.

that this was with the Boy Scouts rather than in one of his classrooms in school. Excepting the ICT course, almost no middle school girls reported curricular opportunities for computing education. One middle school girl indicated that she learned "typing and parts of the computer" in an unnamed course, and one additional camper in this cohort made reference to an "Enrichment" course that taught "21st century skills" and a "tech class." The majority of the middle school girls had not taken any kind of computer class. The comment of one of the campers from this cohort explains, "At my school, we don't take computer classes. We can just use them in one of our periods." Similarly, high school girls reported limited opportunities. The ICT class was mentioned again as were computer applications courses and a STEM class. However, a high school male camper clarified that the computer applications course was very basic: "Computer Applications in 8th grade but that's not really anything." Though high school male campers reported some additional opportunities, their access to formal and advanced computing curricula in school was also primarily limited to applications and introductory courses to basic technology and computers.

Advanced opportunities within current schools appear limited. A single middle school camper mentioned a course that covered computer hardware. One high school boy, one middle school boy, and one high school girl mentioned robotics courses. Two high school boys mentioned courses in programming. One high school boy mentioned an introduction to engineering course,

two campers of the same demographic mentioned and Advanced Placement computer science course, and one additional high school boy mentioned a computer science course.

To better understand how each cohort was interacting with technology in their schools, we asked campers what they used computers for during their regular school hours. The results confirmed that computer usage in schools is not, for the most part, introducing middle and high school students to advanced computing skills. For example, only one high school male camper indicated using a computer for STEM work, three campers of the same demographic for programming work, and one additional camper for work on CAD. Male high school (2) and middle school (1) campers and middle school female campers (6) did mention using computers for an Information Technology course or for online technology education opportunities. However, the majority of campers reported using computers in school to type papers, do research for papers, make PowerPoints, read online textbooks, do homework or assignments, or take tests or school surveys. A sample of survey responses is included in Table 4 below.

Table 4. Responses to survey questions asking how they use computers in school.

HS Boys	• "Typing essays, Research for projects, instructional videos." • "We use computers to type essays or do research." • "Homework, Assignments, and games for when I'm not doing assignments."
HS Girls	• "We use them for research, group projects, making presentations, and typing papers." • "For projects, research things, Powerpoints, games, etc." • "Typing tests, PARCC Assessments, MAP testing, typing essays, and research."
MS Boys	• "Looking up facts about historical figures and important people that led to the 21st century. Also, to take quizzed over things that we learned in the past year or during the present year of school." • "We use them for Accelerated Reader to take quizzes, sometimes we do educational things like iPass and Compass Odyssey. We also sometimes have some free time, so we can go onto websites the teachers allows." • "Typing essays, making research projects, changing word documents, taking tests, and more."
MS Girls	• "When we take the PARCC test and have to write an essay." • "I use the computer to help me prepare for debate tournaments, evidence for my essays, and sometimes just for fun." • "Well, since every student at my school owns a laptop, we don't have textbooks or books. We use online textbooks and books. In class, we get on educational websites."

Desired access to technology and computing classes after the camp

100% of male high school campers, 100% of male middle school campers, 85.7% of female high school campers, and 77.8% of female middle school campers indicated in the exit survey that

they would participate in an afterschool program or club if their school offered such an opportunity.

Similarly, when asked on the exit survey what kinds of classes they would like to have the opportunity to take in their schools, the majority of campers across cohorts indicated they wanted to take additional digital forensics and cyber security (27.7%), programming (24.6%), and robotics classes (13.8%). Campers also requested courses in computer science and computer engineering (10.8%), and engineering (3.1%). Among the 26 African Americans participating in the research, the most frequent response for type of classes desired upon leaving camp was cybersecurity/forensics (8), and six of those respondents were girls. Tied at eight responses and equally divided between genders was no desire to take computer classes upon leaving the camp. Male middle school campers expressed desire for increased access. One of these campers wrote as his response, "I wish I could take the classes that don't exist," and another wrote, "I wish there were at least some computer programming/cyber security programs at school." Though less interested in pursuing computing after the camp than other cohorts, female middle schoolers explained in their responses, "I would take a computer class that involves solving a problem," and "Anything really. Though, I'd like to improve on my typing the codes and commands in the code language itself, not just the dragging blocks with certain programs." Likewise, female high school campers' responses also indicated being open to taking anything that was offered above and beyond the basic courses currently offered at their schools. One camper responded, "I wish that I could take a class that focuses on coding, instead of a basic computer class," and another echoed her sentiment, "I wish I could take computer programming and get the basics of it before I go into college not knowing a thing about it."

Discussion

Our current results are preliminary; however, as we continue to grow the number of participants each summer, we anticipate having a large enough sample size in coming years to be able to present statistically significant results based on both race and gender.

Based on the data from surveys we collected from 65 participants, though the majority of students from the study have access to technological tools in their schools, they do not have access to education within school that goes beyond the very basic fundamentals of using a computer to consume texts or produce texts (primarily traditional linear and alphabetic texts). It appears that technology in schools is used, both by formal curricula and by teachers, as instructional aids, tools to occupy advanced students, to test students' knowledge, to keep textbook costs low, to administer assessments, and for students to write with. Our survey data, however, suggests that students—both male and female at the middle and high school levels—desire more, particularly as relates to programming, computer science and engineering, robotics, and cybersecurity.

Though there are clearly technologies in use in middle and high schools as well as basic introductory classes to technology, campers across the board were eager for advanced knowledge. Our introductory survey responses indicated that middle and high schoolers are interested in pursuing career paths in computing; however, our access surveys indicated that these students are not being prepared to enter and be successful in two-year and four-year programs that will lead them to these careers paths. For example, the exit survey asked campers

to explain what teacher they would send to a computer camp and why. A female high school camper wrote: "I would send my computer technology teacher to camp so she could learn more about computers, and be able to teach us more. Then, we could learn different things instead of repeating the same lessons all the time." Another camper of the same gender and age responded similarly: "I would send my ICT teacher so she can learn more about code and programming and forensics and teach it all to us during school." After spending five days at a computing camp, when participants suggest that out of their entire school, it is their technology teachers who they would like to send to camp to learn more, there is something awry with not only current curricula but with teacher preparation as well. As the United States continues to advance and advocate for computer science classes in secondary schools, teacher preparation will need to be at the fore of that discussion.

We are cautiously optimistic about what we have learned from our survey data. For instance, we know that middle and high schools have technology, that students are using that technology, that there are technology designated courses, and that there are teachers who are teaching those courses. The two survey responses sampled above related to sending their technology teachers to a computing camp do suggest that if they have tech-knowledge, teachers will incorporate it into their classrooms. Most importantly, we also learned that students want more. They want more advanced classes. Even within our own camp, one of the middle school girls, after experiencing a drag-and-drop coding system, wanted to learn to produce her own code. All of this is to suggest that even if the in-school curriculum is not yet there, the infrastructure and interest are, and these things are important for the success of something like President Obama's Computer Science For All.

Anecdotally, the combinations of collaborative, project-based, and process pedagogies our program enacts have proven to be a successful model for engaging students' interests in computer science while also increasing their proficiencies in communicating, programming, engineering, and problem-solving, as well as their understandings of cyber security as a national safety initiative and everyday priority for their digital lives. Our observations and experiences suggest that process is an already interdisciplinary pedagogical approach that educators can draw on as they consider with increasing frequency and urgency how to implement communication and computing initiatives across their districts, campuses, schools, and curricula.

In our informal observations, we have also have found robot kits to be an effective curricular tool because of the instant feedback a robot provides for programmers. Whereas a computer reads code, a robot can embody code, allowing code writers to experience and identify problems in their scripts and to develop a more engaged understanding of the function of programming. Our observational findings are consistent with other research**.** Balch et. al. describe a joint project between Georgia Tech and Bryn Mawr institutions in which a curriculum was designed to utilize robotics to enhance the perception of participants' about computing.[15] Similarly, the Increasing Student Participation in Research Development (INSPIRED) project used robots in a one-day workshop with a focus on females and under-represented minorities. Results of INSPIRED revealed that the robot-based curriculum increased interest, confidence, and knowledge in computing among the middle school participants. [15]

Future Plans

Recruiting middle and high school teachers in our projected 2016 program for a one-week teacher's institute will help us to further explore the kinds of pedagogical overlaps between methods from different disciplines that are well-suited to support the acquisition of advanced computing literacies for middle and high school students. Mississippi State University's recent adoption of a policy for having minors on campus for summer programs requires formal training for all camp facilitators. In response to this requirement, we have prepared a week-long mini course in order to prepare undergraduate students in CSE to work with middle and high school campers. Formalizing training for our college student camp leaders to design and deliver an intense but low-stakes and fun-centered project-based curriculum will also help us to understand the kinds of professional development opportunities educators who plan to implement such curricular innovations on a larger scale (across a semester, for instance, rather than just one week) will benefit from and need.

We have only analyzed a portion of survey data that was collected in 2015 in this report. We are also working with interview transcripts and additional survey data in order to generate a student-centered profile of the "woman problem" in technological degree and career paths, paying particular attention to women of color given their underrepresentation in the field as well as the demographic of our local context.

In light of such workplace realities, we met with project groups (group interviews) to discuss gender and race. Our conversations with groups from each of the camps were rich. For example, one high school male camper explained that a female on his robotics team quit when the group leader tasked her with paperwork. Another of the same demographic explained why he thought there were fewer women in technology careers:

> "I think that with our age through tenth grade, from when you first start going to school, tenth grade girls think … they're gonna get made fun of because they think it will be like nerdy or something because they enjoy stuff like that [computers and technology]. And then, if you don't take up an interest before you get into high school, you're probably not gonna want to pursue a career in it because you won't know much about it. So, but like guys, they don't really care as much because it's not like they'll get made fun of or anything."

Similarly, a female high school camper, asked to reflect on why there are less women in technology fields, explained that this was a reflection of a larger culture clinging to gender roles in the workplace: "if a female grew up and then after college decides she wanted to be a housewife, people would be like 'ok you can do that.' If a male grew up and decided he wanted to stay home then everybody would look at him crazy and be like, 'no you need to work.'" A female high school camper in a different interview group used an example from her everyday life to help explain how the "woman problem in technology" was complicated and deeply culturally engrained: "Well my brother, well they do it as a joke mostly, but if I'm like playing video games, they'll be like 'you need to stop. That's for boys'. I'm just like 'yeah ok.'"

While NCWIT[2] and the American Association of University Women[16] are exploring solutions for interesting and retaining girls and women in technology on a national scale, the kinds of first-

person narrations our research has collected can help to ground those national statistics as well as national crisis rhetoric in the experiences of middle and high school students in our local context, helping us to formulate a grass-roots approach to recruiting girls for computing curricula and careers in the U.S. South. Additionally, embedding a humanities-based approach to research within the camp, which includes sending consent and assent information to campers and their families that explicitly seek their permission in understanding the gender gap, helps to draw attention to gender in relation to computing and creates a space for productive conversation not just about problems but about solutions.

As the project extends over the next four years, we plan to collect follow-up data from existing participants, checking in with them at the end of the academic year to hear about and if the camp had a lasting impact on them, what they are planning for their futures, the kinds of applications and machines they are using to communicate and learn, and if they have thought any more about the relationships between gender and race and computer science. We also hope that our continued involvement with interdisciplinary summer camps will allow us to recruit additional participants. Collecting longitudinal data in our state about the kinds of computer access (tools, education, and experiences) different cohorts of campers have had over the course of five years is valuable data for educators and policymakers in the state. Similarly, following students' paths to or away from computer science for four consecutive years after a summer camp enables a better understanding of variables that motivate and deter particular individuals from pursuing computer science as well as the impact factor of particular variables (like access to a computer science course in middle school versus access to an internet enabled smartphone).

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