

**A MIXED METHODS APPROACH TO UNDERSTANDING THE
IMPACT A VIRTUAL SUMMER CAMP HAS ON BLACK GIRLS'
INTENT TO PERSIST IN COMPUTER SCIENCE**

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ABSTRACT

Several studies have focused on how in-person informal CS learning programs like summer camps and after-school programs impact Black girls' intent to persist in Computer Science; however, virtual informal CS learning programs remain to be studied. This mixed-methods study uses Intersectional Computing and Social Cognitive Career Theory to examine the impact of four virtual CS summer camps on Black middle school girls' intent to persist in CS. Key to the approach of the camps is the recognition that intersectional representation in the camp's community of attendees, teachers, and guest speakers and the content fosters confidence for Black girls in computing. Findings of a pre-and post-survey study of 108 camp attendees show that participating in the camps increased computing confidence and outcome expectations among Black girls at the camps. Semi-structured interviews (n=10) revealed how Black girls' intersectional identities influence their attitudes towards learning CS, both in-person at school and virtually at camp. Implications will help expand or improve virtual informal CS experiences for Black girls to reduce the barriers that may prevent them from learning CS at an early age.

To all of the INTech Scholars, their parents, Board Members, staff, volunteers, and supporters. Without you, none of this would have been possible. And to my late grandfathers, I know you are bragging in heaven.

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CHAPTER 1

INTRODUCTION

Background of the Study

Technology has proven to be both rewarding and impactful to our society. However, for those of us in marginalized communities, tech has caused a significant amount of harm. While tech has advanced our society in many ways, it has also harmed marginalized communities. Issues of surveillance, biased search algorithms, cyberbullying, exclusions of accessible features, and sensors that do not recognize non-White people (i.e., soap dispensers), to name a few, have overshadowed the good that tech has done.

Part of the issue is that many of these technologies were built and designed without diverse team members who could bring these issues to light before products go to market. This is no surprise, given the current demographics of the tech workforce. Women only make up 26% of the tech workforce. Of those women, only 3% are Black, 7% are Asian, and 2% are Latina (“By the numbers: National Center for Women ; Information Technology,” 2021). Women of Color in the US are on track to be the majority by 2060. If we want our tech to reflect our society more, more work must be done to recruit and retain women of color in the tech industry. Currently, there are 500,000+ computing jobs available. By 2030, it is projected that 4M computing jobs will be available (“By the numbers: National Center for Women ; Information Technology,” 2021). If we want to fill these jobs, educating students about CS has to happen before college because our society has changed.

Kids today are receiving access to technology faster than ever before. As a result, more must be done to introduce students to CS. Exposure to CS in K-8 can serve as a gateway to higher-level CS courses like AP Computer Science, which could lead to students selecting

CS as a major in college. In 19 US States, 30% of K-8 schools offer CS courses, but if we look at enrollment, only 3.9% of middle school students are enrolled in CS courses in 17 US States (Code.org et al., 202q). When thinking about how this impacts girls, they only make up 44% of middle school students in CS. Unfortunately, there is no data that supports Black girls specifically. However, we know that Black girls are not exposed to CS as early as their white counterparts (Google & Gallup, 2016).

Black girls do not learn to code as early as their counterparts, which puts them behind when enrolling in CS degree programs. Rankin et al. (2021) called out how the intersection of power and privilege is missing from CS education. Their study interviewed Black women who studied computer science to learn about their experiences in K-12, college, and the computing workforce. One participant reflected:

In my high school, we had one...computer class, but it was more so focused on business...we called it the business computer class, but we didn't do anything technical in it. It was more so about how do you do financing...we played a simulation game where you got money...you had to build more wealth...except for the fact that you played the game on the computer, it had nothing to do with computers.

Another participant stated:

In high school, my instructor, she was just not a very nice person...she wasn't very approachable...she's the type of instructor where if you ask her a question she kind of replies as if you're incompetent, so you don't want to ask her a question...she's going to make you feel stupid.

As a result of these experiences, Rankin et al. (2021) concluded that K-12 classrooms are a saturated site of violence for Black girls. Understanding the experiences of Black girls is vital for designing contexts that could overcome barriers to Black girls' participation, inclusion, equal representation, and promotion of diversity in the CS workforce.

A promising approach is informal learning programs. Summer camps and after-school programs can compensate for the lack of CS classes by providing a counter space for Black girls to learn CS with a Culturally Relevant curriculum. For example, COMPUGIRLS (Madkins et al., 2019) is a culturally responsive technology program for girls ages 13-19 in Phoenix, Colorado, and California that provides summer, after-school, and school break programs for Black and Latina girls. However, in-person programs take more work to scale. Virtual informal CS programs can aid in reaching more Black girls.

The COVID-19 pandemic initially exacerbated the digital divide, which is the gulf between those who have access to the internet and those who don't; however, as a result of the mandatory switch to remote learning, district leaders have reported that one-to-one devices (i.e., one device per students) have increased from 66% to 90%. This metric is imperative for more Black girls in CS, as they will need a computer and internet access. The benefits of a virtual CS camp for Black girls are scale, increasing the number of Black women who can participate as mentors/speakers, allowing for community across multiple locations, and learning how to collaborate online.

Each year, the University of Cincinnati's College of Engineering hosts the Women of Color Summer Engineering Camp (WOCSEC) to increase female students of color intent to major in engineering and applied science by providing hands-on activities and empowerment sessions (Gaskins et al., 2021). Due to the pandemic, WOCSEC hosted a virtual five-day camp using WebEx, Canvas, and Flipgrid. Each day of the camp, students participated in a design challenge, college readiness workshop, interactive panels, women engineer spotlight interviews, and an e-moment of empowerment. Pre- and post-surveys were administered to students during the camp to measure its effectiveness on six measures. There was an increase in every measure, including students being familiar with female engineers and the importance of women of color becoming an engineer. Additionally, there was an increase in students stating that they want to study engineering in college, with 9 of 10 seniors applying to the University of Cincinnati College of Engineering and Applied

Science and eight being admitted. An open-ended question about their experiences revealed that students liked the virtual format of the camp, even though they would prefer to meet face-to-face. The WOCSEC program shows promise in creating an impactful summer camp for Black high school girls to help increase their interest in engineering.

Significance of the Study

Limited CS course offerings, placement of CS courses outside of the academic core curriculum, and lack of teacher preparation and instructional resources contribute to disparities in the availability and quality of computer science learning experiences for students of color in U.S. K-12 schools (Margolis et al., 2012). These structural barriers are compounded by additional social barriers, including classroom and campus climate, stereotype threat, and the lack of role models, mentors, and peers (Google & Gallup, 2016) engaged in computing. Young women are less likely to be aware of learning opportunities for computer science, have a lower interest in learning computer science, and are less likely to be told by parents and teachers that they would be good at computer science compared to their male peers (Google & Gallup, 2016). These social barriers affect enrollment, achievement, persistence, and degree completion among students from underrepresented groups in computing (Scott et al., 2016). Since the amount of Black girls in computing is so low, more needs to be done to understand how Black girls experience and are impacted by informal learning programs.

Research Questions

The following research questions guided my inquiry:

1. How do computing confidence, social supports, and outcome expectations of Black middle school girls influence their intent to persist in Computer Science after a virtual summer camp?

2. How do Black middle school girls describe their experiences at a virtual CS summer camp?
3. How do Black girls describe their interactions with Black women mentors at a virtual CS summer camp?

Positionality Statement

I received a computer for the first time in the fourth grade when I would play on the computer and the internet, learning about its capabilities on my own. The only tech-related courses offered in middle school were keyboarding and digital literacy. I didn't have the chance to learn how to code until high school when I took Programming I-II, AP Computer Science, and Computer Networking electives, where my instructors were primarily Black women. In addition to my classes, I participated in the Black Data Processing Associates (BDPA) High School Computer Competition (HSCC). These experiences contributed to my confidence to later study Computer Science at my state's top engineering school. Years later, I did not see these same out-of-school opportunities for Black girls where I grew up. As a result, I started INTech Camp for Girls, a non-profit that teaches Black and Latina girls how to code. These experiences have equipped me to study how informal learning programs for Black middle school girls will impact their intent to persist in CS, should they be given a chance to learn how to code at an early age from other Black women in CS.

Theoretical Frameworks

The following theories and experiences have shaped my perspective and guided my approach to this research study. These theories and experiences are used better to understand the experiences of Black middle school girls.

Intersectionality

Intersectionality examines how intersecting power relations influence social relations in everyday life (Collins & Bilge, 2020). Researchers use intersectionality to analyze categories of race, class, gender, sexuality, ethnicity, age, etc., as interrelated and mutually shaping one another (Collins & Bilge, 2020). According to Collins (2019), six core constructs of intersectionality inform one another: 1. Social inequality; 2. power; 3. relationality; 4. social context; 5. complexity; and 6. social justice. Additionally, there are four guiding premises to intersectionality, as illustrated in Figure 1.1 (Collins & Bilge, 2020). These core constructs and guiding premises help provide guideposts for thinking through intersectionality as a critical framework. In this study, I will focus on how social context and social justice play a part in the underlying power relations regarding Black middle school girls having access to learn CS.

Intersectional Computing (Thomas et al., 2018) provides the necessary vocabulary and tools for examining how power plays out in computing. One of the core constructs of intersectionality is social context, which helps understand how individuals' and groups' distinctive social locations within intersecting power relations shape intellectual production (Collins & Bilge, 2020). For example, some high school classes are offered under the guise that students will learn computer science concepts; however, students instead use a computer to learn business concepts (Rankin et al., 2021). While this course is essential, it should be defined as digital literacy instead. The conceptual mismatch between the course description and the curriculum illustrates a structural domain of power when the student enrolls in a CS degree program and realizes that what they learned was not CS (Rankin et al., 2021).

Social justice is another core construct of intersectionality that raises questions about intersectional scholarship and practice. Collins and Bilge (2020) posit that social justice is elusive in unequal societies where the rules may seem fair yet differentially enforced through discriminatory practices and where the rules themselves may appear to be equally

CORE CONSTRUCTS	GUIDING PREMISES
Relationality Power Social inequality Social context Complexity Social justice	<p>(1) Race, class, gender, and similar systems of power are interdependent and mutually construct one another.</p> <p>(2) Intersecting power relations produce complex, interdependent social inequalities of race, class, gender, sexuality, nationality, ethnicity, ability, and age.</p> <p>(3) The social location of individuals and groups within intersecting power relations shapes their experiences within and perspectives on the social world.</p> <p>(4) Solving social problems within a given local, regional, national, or global context requires intersectional analyses.</p>

Figure 1.1.: Collins, 2020

applied to everyone. Limited CS course offerings, placement of CS courses outside of the academic core curriculum, and lack of teacher preparation and instructional resources contribute to disparities in the availability and quality of computer science learning experiences for students of color in U.S. K-12 schools (Margolis et al., 2012). These structural barriers are compounded by additional social barriers, including classroom and campus climate, stereotype threat, and the lack of role models, mentors, and peers (Google & Gallup, 2016) engaged in computing.

Testimonial authority (Collins & Bilge, 2020) refers to the credibility and power of personal stories and experiences in influencing others' beliefs and actions. The hierarchies of the intersecting power relations of race, gender, sexuality, class, and citizenship impact the testimonial authority of individuals in a given interpretive community and reflect the inter-

actions among its members (Collins & Bilge, 2020). Dotson (2011) identifies the silencing strategies of testimonial quieting and testimonial smothering as forms of epistemic violence that are used to suppress the ideas of subordinated people. Both strategies illuminate how and why claiming testimonial authority is especially important for intersectionality as a resistant knowledge project. Using testimonial authority can effectively amplify the voices of middle school Black girls attending a CS summer camp because their personal stories and experiences can provide insight into the unique challenges and opportunities they face in this field.

In this paper, I draw on intersectional computing to explore the experiences of Black middle school girls at a virtual CS summer camp. Applying intersectional computing to understand Black girls' CS experiences calls for a deep look into the social context of these girls to understand how systems of power have impacted their ability to access CS courses.

Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT) is a constructivist view on career development from a social cognitive perspective (Brown, 2002). A graphic illustration of the SCCT model is represented in Figure 1.2 Serving as an extension of Social Cognitive Theory (Bandura, 2005), SCCT has three overlapping concepts: self-efficacy, outcome expectations, and personal goals. Self-efficacy is what a person believes about their abilities to learn and perform at a certain level (Bandura, 1977). According to Brown (2002) self-efficacy in the SCCT model “involves a dynamic set of self-beliefs that are specific to particular performance domains and that interact in a complex way with other people, behavior, and environmental factors” (p. 262). Outcome expectations are the consequences of performing various behaviors and look at beliefs about extrinsic reinforcement, self-directed consequences, and outcomes derived from the process of performing a given activity. As for personal goals, SCCT posits that goals constitute central elements in people's

exercising personal agency or self-empowerment. Together, self-efficacy, outcome expectations, and personal goals work together in self-regulating behavior (Brown, 2002).

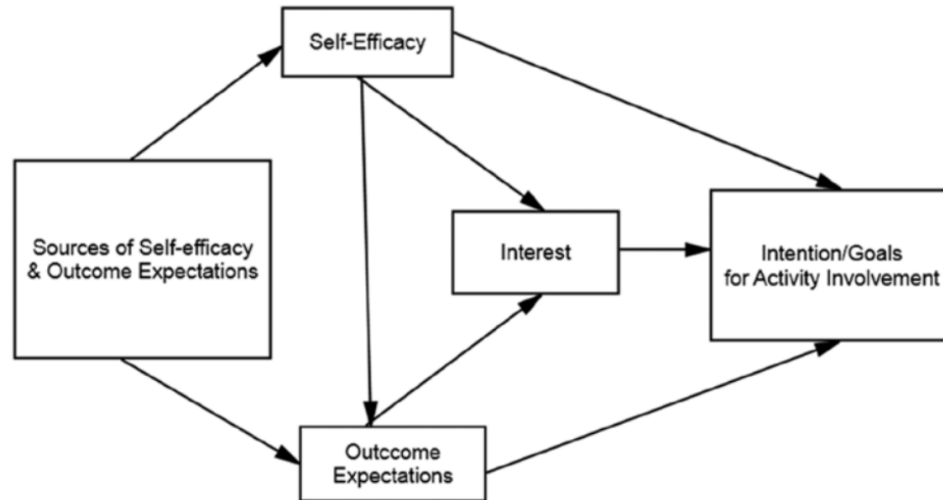


Figure 1.2.: The social cognitive career theory by Lent, Brown, and Hackett (1994, 2000).

Scholars have used SCCT to understand why students choose to study Science, Technology, Engineering, and Math (STEM) more broadly (Sahin & Waxman, 2021); however, this review will focus specifically on how SCCT has been used to examine why girls choose CS as a major or career. Lent et al. (2008) tested the social cognitive choice model (Lent et al., 1994) to predict the interests and choice goals in the computing disciplines of women and students of color. They administered a survey to students majoring in Computer Science across the US. In their study, 30% of the students identified as women and 42% of them identified as Black; however, it is unknown how many Black women specifically participated in this study as the data are not intersectional. Survey measures included self-efficacy, outcome expectations, interests, major choice goals, and social supports and barriers related to pursuing a major in the computing disciplines. They found that the Social Cognitive Career Theory (SCCT) variables yielded adequate fit to the data across each

grouping variable and may be used to help explain the interests and major choice goals of women and students of color (Lent et al., 2008).

DuBow and James-Hawkins (2016) use SCCT as a theoretical framework in a pilot study to understand what influences female interest and persistence in computing among 1,351 women who applied for the National Center for Women & Information Technology (NCWIT) Aspirations in Computing (AiC) award. In their study, they administered a survey with five constructs to examine SCCT: computing interest, self-efficacy, outcome expectations, perceived social supports, and intent to persist in computing, as well as conducted focus groups with girls in the community to understand better how to promote Computer Science to girls. Their sample had an overrepresentation of White and Asian/Pacific Islander girls, with only 7.9% of the sample identifying as Black. The researchers compared the responses of girls who received the AiC award and those who did not and found that AiC awardees reported higher levels on every SCCT construct than the girls who did not receive the AiC award. This finding wasn't surprising, assuming that the girls who received the AiC award excelled in computing. However, when conducting qualitative interviews with the girls who did not receive the AiC award, the researchers learned that issues of imposter syndrome impacted their intent to persist, and receiving this award could have increased their computing confidence. The researchers also found that community and belonging were essential for the social support for both girls to feel like they belong to a like-minded group.

In a follow-up study, Weidler-Lewis et al. (2019) administered a survey measuring SCCT constructs to women in the NCWIT AiC program in 2013 and again in 2016 and interviewed 90 women from the same sample through qualitative interviews and focus groups. With this expanded longitudinal sample, the researchers found that while multiple factors influence women's persistence in CS, the best predictor is access to early computing and programming opportunities. Part of the interview sample included women who identified as "non-persisters" in tech, meaning they did not study CS, engineering, or infor-

mation technology-related majors (Weidler-Lewis et al., 2019). The non-persisters stated that they had little to no CS classes in high school, which is why they did not choose CS as a career choice. Some non-persisters assume that had they taken a few CS classes in high school or sooner, they may have chosen it as a major. It is evident through this study that early exposure to CS is important if we want more girls to pursue CS as a major. While this article did not specify the race of its participants, they did note that they stratified their qualitative sample by race to representation from multiple groups. Since the data in this study are longitudinal, they were able to report on the actual persistence of participants instead of their intent to persist.

Alshahrani et al. (2018) used SCCT as a theoretical framework to conduct interviews with male, female, and gender-neutral students at three universities in the UK to understand why students choose to study CS. The interview questions were based on the four components of SCCT – prior experience, self-efficacy, outcome expectations, and social supports. They found that social support from family, teachers, friends, and mentors is essential for women. Additionally, several women participants note that they did not receive exposure to CS before attending college, which they suggest should be done sooner for girls coming behind them. Female research participants also indicate that more women should be role models for girls in CS by showing up to classes to know that women in CS exist. Given the results of the interviews, the researchers state that SCCT is useful for understanding why students choose to major in CS because it allows them to cover all factors involved with making a choice in college major.

Braswell et al. (2021) administered the NCWIT (Sabin et al., 2017) survey that measures four SCCT constructs (intent to persist, social supports, computing confidence, and computing outcome expectations) to 120 Black and Latina middle girls at the 2020 IN-Tech Summer Camp. Analyses of the pre-and post-survey showed that participating in the camp increased computing confidence and computing outcome expectations among Black and Latina girls. SCCT has been used to help predict women and girls' persistence in

CS (Weidler-Lewis et al., 2019); however, only one study has explicated race and gender, specifically looking at Black girls in CS. In a field that does not have a lot of Black women (Google, 2016), we must understand what factors influence Black girls to persist in CS.

In this dissertation, I will begin with a review of the literature to explore the pathways, barriers, and concerns for Black women and girls in CS, the use of Culturally Relevant Pedagogy in CS, and informal learning experiences for Black girls. I will then outline the research questions I will explore during this project and discuss the methodologies I chose to address my research questions - including the reasons for which I chose the methods presented. Following that, I will present the quantitative and qualitative findings, the discussion and implications, followed by a conclusion.

CHAPTER 2

LITERATURE REVIEW

In this literature review, I will begin by looking at the computer science ecosystem and discuss the barriers and concerns for Black girls and women. Following that, I will discuss the importance of using Culturally Relevant Pedagogy to increase the interest of Black girls in computing. Lastly, I will review informal learning opportunities for Black girls in computing.

Pathways, Barriers, and concerns for the trajectories of Black girls in Computer Science

Limited computer science (CS) course offerings, placement of CS courses outside of the academic core curriculum, and lack of teacher preparation and instructional resources contribute to disparities in the availability and quality of computer science learning experiences for students of color in U.S. K12 schools (Margolis et al., 2012). These structural barriers are compounded by additional social barriers, including classroom and campus climate, stereotype threat, and the lack of role models, mentors, and peers (Google & Gallup, 2016) engaged in computing.

Rankin et al. (2021) identified traditional K-12 Classrooms as a saturated site of violence, which Collins and Bilge (2020) states:

“saturated sites bundles together practices, social institutions, representations, and patterns of everyday social interaction that appear and reappear across seemingly separate systems of oppression. Saturated sites are important be-

cause their hypervisibility and ubiquity make the points of convergence or transactions of intersecting power relations more visible.” (p. 238)

In their study, they interviewed 18 Black women in various stages of the computing pipeline (i.e., graduate students, early-career professionals, and department faculty). They found that there are issues of rural, predominately Black High Schools offering computing courses under the guise that they will teach students about CS principles like algorithms, hardware and software, or programming; however, the students instead use computers to learn about other subjects (Rankin et al., 2021). When Black girls are misled in computing courses at their high school, they face a structural barrier in their CS pathway once they enroll in a CS degree program and are underprepared compared to their colleagues (Rankin et al., 2021). The study suggests that Black women experience epistemic violence everywhere (academically, personally, and professionally), and the CS community should engage in structural change to create a more equitable field of computing.

In response to the need to address the barriers and sites of violence that Black women and girls face, researchers have focused on creating programs that focus on broadening the participation of girls and/or those in racial minority groups in computing at the K-12 level (Amaral et al., 2015; Kafai & Burke, 2014; Kamberi, 2017; Khoja et al., 2012; Scott et al., 2016; Thomas et al., 2015). As the field begins to consider the application of such approaches in computing education, it is important to consider the “double bind” Black girls face with their intersecting gender and racial identities because they introduce additional social barriers (Ong, 2011). There is a need to incorporate a culturally responsive approach in the computing experiences for Black girls.

Using a Culturally Responsive Pedagogy

Several approaches for addressing social barriers faced by students of color in CS learning experiences have been put forward; particularly promising is the application of Cultur-

ally Responsive Pedagogy (Koch & Gorges, 2016; Madkins et al., 2019; Pinkard et al., 2017; Scott. & White, 2013). Culturally Responsive Pedagogy (CRP) was introduced by Ladson-Billings (1995) to provide a way for African American students to maintain their cultural integrity while succeeding academically. Using CRP (Ladson-Billings, 1995) in computing requires teachers to find ways to incorporate the backgrounds of their students with the curriculum. Madkins and her colleagues (Madkins et al., 2019) outline three themes related to CRP instructional practices for computer science: 1) Engagement and Relevance: Increase student engagement in CS by connecting curricular content to students' life experiences; 2) Confidence and Identity: Build up students' computing self-efficacy and belief in themselves as future computer scientists; 3) Social Justice: Support students to make positive impacts in their communities through the use of technology for social change. Specifically, exposure to a broader range of topics should be presented to Black girls that allow for a wide range of skills, including creativity; working with, communicating with, and capturing understandings of users; and learning the technical computing skills needed to design and implement usable systems (Madkins et al., 2019). Increasing interest in computing through CRP is critical in influencing Black girls' intent to persist in CS.

Preliminary work suggests that using CRP to introduce Black girls to computer science is a promising approach (Madkins et al., 2019). COMPUGIRLS is a culturally responsive technology program for girls ages 13-19 in Phoenix, Colorado, and California that provides summer, after-school, and school break programs (Scott. & White, 2013). Scott. and White (2013) evaluated the summer 2007 cohort participating in the COMPUGIRLS program over 2 years in the Southwest, including 41 African American and Latino girls ages 13-18. They used multimedia activities to encourage computational thinking, enhance girls' technosocial analytical skills using culturally relevant practices, and provide girls with a fun learning environment to nurture their self-development. Specifically, girls in the COMPUGIRLS program identified a community issue, researched the issue using a mixed-

methods approach, and ideated ways to position the technology (i.e., Scratch) to describe, analyze, and present solutions to their research questions (Madkins et al., 2019). Their results showed that the girls participating in the program had significantly higher average growth rates in self-regulation than their comparison counterparts.

James (2020) used a culturally responsive approach while teaching 24 Black sophomore women in his 15-week data structures course. Students created software for a drum machine or a D.J. controller using a curriculum about Black music as a final project. James administered two surveys to the students to understand their experience using Black music as a context for the lessons and projects in the course. The students reported that Black music allowed them to have a common ground to relate to the material, understand course concepts, and keep them engaged. James reasons that the computer science curriculum holds power when students learn it through their own experiences.

Similarly, Lusa Krug et al. (2021) conducted a three-week virtual coding camp teaching 45 middle school students how to code by using hip-hop as the main curriculum. The students were mostly male and 23.5% Black. Each day, students learned how to code and created their own beat. The researchers investigated how teaching coding using hip-hop affects the engagement of middle school students towards CS with pre and post-surveys. Survey results showed that after participating in the camp, student engagement increased. When asked on the final day whether they'd take a CS course in school, some of the less confident students responded that they would consider it since they had a lot of fun. The researchers concluded that using hip-hop to teach computer science increased the engagement of the participants.

While having a CRP can help Black girls increase their interest in computer science, curriculum alone is not enough if Black girls don't have access to the courses. In the next section, I will address the lack of access to formal computing classes and discuss informal computer science learning experiences that utilize CRP to appeal to Black girls.

Informal learning experiences for Black girls in computing

As of 2020, only 47% of U.S. high schools teach CS, and only 31% of AP CS test takers were female (Code.org, CSTA, 2020). This is particularly detrimental to Black girls, who already suffer from a lack of early exposure to computing in grades K-12 (Rankin et al., 2019). In fact, most Black women state that they have no prior programming experience before graduating high school; their exposure comes from an introductory programming course in college (Solomon et al., 2018). Compared to their peers, Black girls who enter computer science degree programs are disadvantaged when they can't learn how to code before enrolling. To minimize the psychological and social barriers for Black girls in computing and adequately address their intersectional identities, more informal computer science learning experiences should be created specifically for Black girls before they reach college.

One of the most notable programs designed specifically for Black school-aged girls is Black Girls Code, created in 2011 (Black Girls CODE, n.d.). Black Girls Code aims to increase the number of women of color in the tech industry by introducing underrepresented girls to technology through one-day camps and summer camps. Since then, similar programs have been created for Black girls. In 2014, Robinson and Pérez-Quñones (2014) conducted a week-long computer science workshop that taught Human-Computer Interaction (HCI) concepts to 19 middle school girls (16 out of 19 were Black). They used a concept of HCI called paper prototyping, where students use paper to draw a skeleton-like version of an app at a lower fidelity than what would be seen on the phone. Paper prototyping is used during the ideation phase of application design to ensure that the main flow of an app is captured before moving on to designing on the computer. Robinson and Pérez-Quñones conducted focus group interviews with their participants at the end of their study and found that before the workshop, participants thought that computer science was boring; however, after learning how to create paper prototypes, the participants had a more positive perception of computing. Additionally, some of the participants indicated that they liked

the instructor, who was also a female from an underrepresented population. This summer paper prototyping workshop revealed that this concept could be used as a motivator for a career path in computer science for Black girls (Robinson & Pérez-Quñones, 2014).

Pinkard et al. (2017) used a culturally responsive curriculum to introduce 17 Black and Latina girls to computer science during an after-school pilot program. In their study, Pinkard et al. (2017) use a project-based curriculum using e-fashion, e-paper, and e-dance to transform everyday items like bracelets and greeting cards and practices like dance to create personal objects with circuitry, fabrication, programming, and design. They use design-based research to co-design class materials with participants to create narratives about characters in the tech curriculum that the girls interact with. This creates relatable and meaningful implicit role models of minorities doing tech. Through in-person observations of the sessions, the researchers heard students saying, for example, “The main character is a teenage me, I see her as myself”, which shows that these characters work as a counter-story to the lack of Black women in STEM, creating a positive self-image amongst participants. Their results reveal that using characters who reflect the students in the program curriculum increases knowledge, confidence, and perceptions of inclusivity in STEM (Erete et al., 2016).

Virtual camps for Black girls

As a result of the COVID-19 pandemic, many out-of-school time programs were forced to shut down their face-to-face opportunities or pivot to a virtual model. While the impacts of the digital divide were exasperated during COVID-19 for Black students (McKinsey & Company, 2020), some programs were able to make an impact using a virtual summer camp model.

In 2020 and 2021, INTech Camp for Girls hosted four virtual one-week summer camps for 120 Black and Latina middle school girls. Unique to the camp’s design was the recruitment of staff and speakers that reflected the gender and race of the camp attendees. 13

Black women served as speakers, and 93% of the teachers were Black women (Braswell, 2020). Girls at the camps used HTML, CSS, and JavaScript to create websites and games about social issues of their choice. Final projects explored topics such as LGBTQ+ issues, racism, colorism, and saving the ocean. The pre-and post-surveys revealed that the camp effectively increased confidence and outcome expectations in computing among Black and Latina girls. There were also indicators of increased interest in computer science, as 19 participants returned to the camp for their second or third summer. This program shows promise to increase the number of Black girls interested in Computer Science through virtual summer camps.

To ensure that more Black girls have access to computing before they get to college, it is imperative that they have access to computing programs specifically for them. Continuing to conflate their needs with those who are different from them will not be enough, given the psychosocial, social, and structural barriers that Black girls, in particular, face. There is a need to create more informal learning experiences for Black girls that use a culturally relevant pedagogy coupled with a safe environment that includes Black girls and women who are teachers and mentors. In-person camps are hard to scale, and a virtual model can be the solution to reaching Black girls at a faster rate. This approach has shown promising results in developing computing identity and computing interest for Black girls so far.

CHAPTER 3

METHODOLOGY

In this section, I will outline the methodologies that guided my dissertation study. The purpose of this dissertation is to understand how a virtual CS summer camp impacts Black girls' intent to persist in CS. I investigated how CRP and Black teachers/mentors play a role in addressing the intersectionality of Black girls while learning CS to determine if it impacts their intent to persist through the pipeline. Specifically, I explored the following research questions:

1. How do computing confidence, social supports, and outcome expectations of Black middle school girls influence their intent to persist in Computer Science after a virtual summer camp?
2. How do Black middle school girls describe their experiences at a virtual CS summer camp?
3. How do Black girls describe their interactions with Black women mentors at a virtual CS summer camp?

Research Design

To engage in this study, I took a mixed methods approach to explore the breadth and depth of Black girls participating in a virtual CS summer camp. Mixed methods allowed me to analyze the data set for a large sample of Black girls who took a survey at a virtual CS summer camp and engaged in in-depth interviews with fewer participants. I integrated the findings to interpret the participants' experiences better.

Specifically, I used an explanatory sequential mixed methods design (QUAN → qual), as shown in Appendix A (DeCuir-Gunby & Schutz, 2016). The explanatory sequential mixed method approach involves a two-phase project where I analyze the results of extant quantitative data in the first phase, then use the results to build the second qualitative phase. With this approach, the quantitative results inform the questions that will be asked during the qualitative phase. This design intends to have the qualitative data help explain in more detail the quantitative results (Creswell & Creswell, 2017).

Organization Context

The study focused on participants from the non-profit INTech Camp for Girls (<http://intechfoundation.org>), whose mission is to inform and inspire girls to innovate in the technology industry. INTech Camp for Girls was founded to ensure that Black and Latina girls have opportunities to learn about technology, computer science, and engineering and access lucrative tech-focused career paths. Specifically, INTech engages Black and Latina girls in grades 6-12 across the US in out-of-school time experiences through summer camps and after-school programs. These INTech experiences are designed around three pillars:

- **Inform.** INTech provides girls with opportunities to master essential computer science concepts, such as creativity, abstraction, algorithms, and programming, and to learn about potential pathways for technology careers.
- **Inspire.** INTech introduces young Black and Latina girls to women with a background in the technology industry who share their educational and career experiences.
- **Innovate.** INTech provides girls with opportunities to work together in lightweight teams (Latulipe et al., 2015) in which they learn how to create and implement technology solutions. In a team setting, girls reap the benefits of peer teaching, peer learning, and increased student engagement (Latulipe et al., 2015).

Track	Projects	Coding Languages Learned	CSTA Standards
1	Coding Sandbox Eye Chart Online Poster Trivia Game	HTML, CSS, Javascript	1B-AP-09, 1B-AP-11, 1B-AP-12, 1B-IC-19, 1B-IC-20, and 2-AP-16
2	Coding Sandbox Money Saving App Digital Pet App Experiment Log Budgeting App	HTML, CSS, Javascript	1B-AP-09, 1B-AP-12, 2-AP-16, 2-DA-07, 2-DA-08, 2-AP-11, 1B-IC-19

Table 3.1.: Virtual INTech Camp projects, coding languages, and CSTA Standards

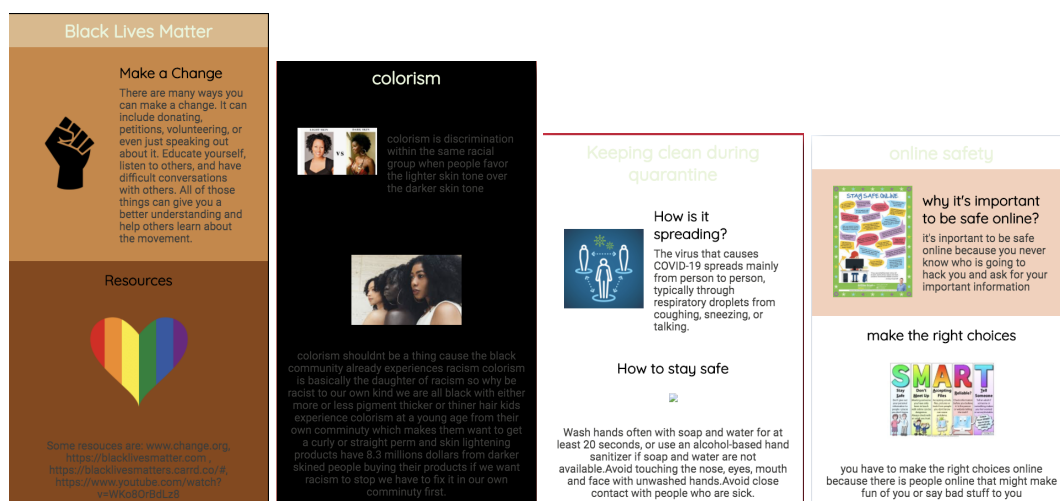


Figure 3.1.: Attendees created posters highlighting interests in the application of computing to solve problems they find important and relevant. Themes included (left to right) racial justice, colorism, COVID-19 health and safety, and online safety.

Student Collaboration

To foster community amongst the girls at camp, Zoom breakout rooms were utilized to promote collaborative work between the students (Kamberi, n.d.; Latulipe et al., 2015; Rowan-Kenyon et al., 2012). Students from all over the country were able to connect and work alongside each other, sparking relationships that would not have formed if the camp were in person. Community building for Black girls is essential as they continue to build up their confidence and provide support for each other in their careers.

Intersectional Representation in Staff and Speakers

One of the main ways INTech seeks to increase the confidence of Black and Latina girls in tech is by intentionally ensuring a significant representation of Black and Latina women as part of the camp staff and guest speakers. In ensuring representation among staff and speakers, INTech addresses a social barrier, providing girls with an opportunity to see someone like themselves "doing CS" (Google & Gallup, 2016) and to benefit from implicit mentorship (Margolis et al., 2012).

Hosting a virtual camp allowed INTech to have more Black and Latina women in tech represented through camp activities, with speakers from across the country joining the camp to meet with attendees online. 93% of the instructors were Black and Latina women. Of the men who served as an instructor, 66% of them also identified as Black. All camp staff members were paid a stipend at the end of camp.

To further emphasize the intersectional representation of Black women in tech, students heard from 12 Black women and two Latina women for a 30-minute guest speaker series. By highlighting one woman each day of camp, our students were exposed to entrepreneurs, cyber security engineers, data scientists, test and computing automation engineers, and iOS and hardware engineers. Knowing that girls at this age lack exposure to computing careers, which could impact their advancement in tech (Scott et al., 2015), INTech let them know that these options exist for them. The Black girls who attended camp now have knowledge of tech roles like Senior Software Engineering, I.T. Program Director, HR Consultant, Assistant Professor, and Senior Developer Advocate at companies like Facebook, Salesforce, Bank of America, Microsoft, SAS, Calm, and what it's like to build their own tech company as a CEO.

In an attempt to increase the exposure of the students, Tech Talks were created. Tech Talks is a time allotted each day where a PowerPoint goes more in-depth about the guest speaker for the day and the company they work for. The PowerPoint outlines the company's history, what they're known for, pictures of minority employees, different career options,

resources to get closer to career options, and a notable Black woman employee. By mainly focusing on the company in the PowerPoint, the girls see that CS careers are obtainable. By focusing on Black employees, specifically women, the girls will be more inclined to believe these careers are obtainable. Explaining what companies are known for can spark interest in the students as they will see products they use every day.

Table 3.2.: Speaker Demographics

Race/Ethnicity	Gender		
African American	11	Women	13
Hispanic	2	Men	0

Participants

One hundred and twenty Black girls participated in the INTech Virtual Summer Camps. Of those, 110 (97%) completed pre- and post-surveys and will be considered for the quantitative part of this study. Based on an analysis of the surveys, I used maximum variation sampling (Creswell & Poth, 2019) to select 10 participants to participate in semi-structured interviews. I selected five girls who have attended an INTech Summer Camp in person and virtually. This allowed me to understand what motivated them to return, which camp they liked best, and the impact INTech camps had on their intent to persist in CS. I also selected five students who have only attended the INTech Virtual Summer Camp (either once or more) to get an understanding of their experiences.

Data Collection

I used three instruments in this study. For the quantitative component, demographic questions were considered in addition to the NCWIT Computing Interest Confidence Perception Survey (Sabin et al., 2017) (See Appendix B for the NCWIT Survey). I analyzed

the extant data from these surveys. For the qualitative component, I used a semistructured interview protocol (see Appendix D for Interview Protocol).

Demographic Questions

During registration, INTech asks demographic questions about students, such as age, race, grade, and SES (based on whether or not they receive free or reduced lunch). Additionally, INTech asks parents whether or not their students participated in a coding class or camp before their summer camp experience. This information assisted in the participation sampling.

NCWIT SCCT Survey

The NCWIT survey comprises 22 items that align with four key concepts: Computing Confidence, Social Supports, Intent to Persist, and Computing Outcome Expectations. Each concept is based on SCCT (Lent et al., 2008), which predicts correlations between interest and confidence in the field to the eventual pursuit of the field. Computing confidence scales from 1 (Don't know/Never tried) to 5 (Very Confident). Social supports and Computing Outcome Expectations are scaled from 1 (Strongly Disagree) to 4 (Strongly Agree). Intent to persist scaled from 1 (Not at all) to 3 (A lot) (see Appendix B for the survey).

Semistructured Interview Protocol

I use a semistructured interview protocol featuring broad, open-ended questions to conduct ten one-hour interviews over zoom. This approach will allow me to ask the same questions to each participant and allow flexibility to cater to their individual experiences. This interview protocol allowed me to understand their experiences as Black girls who participated in a virtual summer camp and their intent to persist in CS. Students were asked to select their own pseudonyms to protect their identity.

Data Analysis

To adhere to the sequential explanatory mixed methods design, my data analysis will take place in two phases. I will first analyze the quantitative data, then analyze the qualitative data. Once all the data are analyzed, I will integrate the findings and make relevant conclusions.

Quantitative Analysis

After I received the survey results from INTech Camp for Girls, I ensured that the data set was complete. Only students with pre- and post-survey responses were included in the analysis. Data were analyzed using R studio (version 2022.12.0). Scores for each of the four SCCT concepts were calculated using an exploratory factor analysis (EFA). The analysis was performed on the complete sample (using both the 2020 and the 2021 data) using all 21 items of the SCCT survey (see Appendix B). Before EFA analyses, the data were tested for sampling adequacy using the Kaiser-Meyer-Olkin test (KMO). The average KMO was 0.85, with the lowest value for individual items being 0.78. Therefore, it was concluded that sampling adequacy was satisfactory.

The following fit indices were used to assess the model fit: root-mean-square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI). Following Browne and Cudeck (1992) and Hu and Bentler (1999) recommendations, RMSEA values less than .08 were considered a fair fit, and values less than .05 as an acceptable fit; and CFI and TLI values larger than .90 were considered acceptable fit and values greater than .95 a good fit.

Qualitative Analysis

I transcribed the interviews using Otter.ai to prep them for coding by reading through the text and making margin notes to form initial codes. Before I began the qualitative

analysis, I used deductive coding to create a codebook (shown in Appendix G) with an initial set of codes based on my research questions, the SCCT framework, and my interview protocol. I used this codebook to do the first round of coding on my interview transcripts and used inductive coding to add new codes to my codebook as they emerged from the data. During my second round of coding, I began to group my codes into categories. I conducted a third coding round using thematic analysis to find themes within my dataset. I grouped similar codes to create my final themes and used interview quotes to support each theme and sub-theme.

Once the data were ready, I used the computer software ATLAS.ai to conduct a categorical aggregation (Creswell & Poth, 2019) to establish themes or patterns that emerged across the ten case studies. I also provided direct interpretation and developed naturalistic generalizations about what was learned (Creswell & Poth, 2019). The interviews provide rich descriptions of the experiences of Black girls who attended a virtual summer camp. To ensure that internal validity is achieved, member checking occurred through ongoing dialogues with interview participants, allowing them to read the results to ensure that my codes aligned with their reality to ensure the true value of the data. The case studies are ideographic, and the purpose is not to generalize but rather to illustrate ten cases to help others gain insights into the lived experiences of Black girls in virtual CS camps. This analysis will lean on the proponents of Intersectional Computing to give testimonial authority to Black middle school girls and allow them to share their lived experiences. By sharing their experiences, they can help raise awareness about the need for more diversity and inclusion in tech and inspire others to take action to address this issue. Additionally, their stories can provide valuable feedback to camp organizers and educators to improve the camp's effectiveness in supporting and empowering young black girls in CS.

Data Integration

After I analyzed both the quantitative and qualitative data, I engaged in data integration. To follow the explanatory sequential design, the quantitative and qualitative data will be discussed separately and together. The qualitative data will be used to support, contradict, or expand the quantitative findings.

Reliability/Credibility

In this study, I used a variety of techniques to demonstrate the consistency of my research findings. To address reliability in the quantitative section, I calculated Cronbach's alpha on the survey results. Additionally, I ran a Confirmatory Factor Analysis to show how well the items on each scale correlate with each other or measure the same construct. I develop a codebook for the qualitative section featuring theory-driven, data-driven, and in vivo codes. The codebook ensured a systematic coding process. Peer reviews will also be used to code a subset of the interviews.

Significance of the Study

The proposed study is significant in the field of computer science education in various ways. First, little research examines the impact of virtual summer camps and how they impact Black middle school girls' intent to persist in CS. Second, there is a paucity of intersectional research (i.e, research on those with multiple minoritized identities) in the larger area of computer science education that explicates identities in data collection; this study makes a significant contribution to the computing literature. Last, a limited number of research studies within the area of Black middle school girls' intent to persist in CS have been conducted using mixed methods approaches; this study will make a significant methodological contribution.

Chapter 3 presents the methodology for the collection of data for this study. Chapter 4 presents the results of the quantitative and qualitative analyses.

CHAPTER 4

RESULTS

In this chapter, I will present the results of this study's quantitative and qualitative parts. This chapter will begin outlining the quantitative analysis, followed by the qualitative analysis.

Quantitative Results

The first research question I sought to answer was "*How does computing confidence, social supports, and outcome expectations of Black middle school girls influence their intent to persist in Computer Science after a virtual summer camps?*". I will now share the results of my statistical analysis that answers this question.

EFA Results

For this study, I conducted analyses based on data from 108 students who attended the INTech Virtual Summer Camp in 2020 and 2021. The data came from the 21-question pre & post surveys measuring SCCT. I tested sphericity using Bartlett's test, which shows that the correlation matrix differs from an identity matrix ($\chi^2(210) = 1842.839, p < .001$). Based on the Scree plot criterion Figure 4.1, it was determined that four factors describe the data best, which was in line with the expected four constructs. Since Shapiro-Wilk tests showed that the variables were not normally distributed, principal axis factoring (PAF) was utilized as the extraction method. Upon assessing the factor loadings of items on factors, the factors were labeled, and four items were removed (as shown in Table 4.1. Variables for each question can be found in Appendix F). Then, another EFA was fitted without the

four items, and the scores on this EFA were used as scores on the four constructs. Each of the four subscales showed good reliability expressed through Cronbach's α (all above .75).

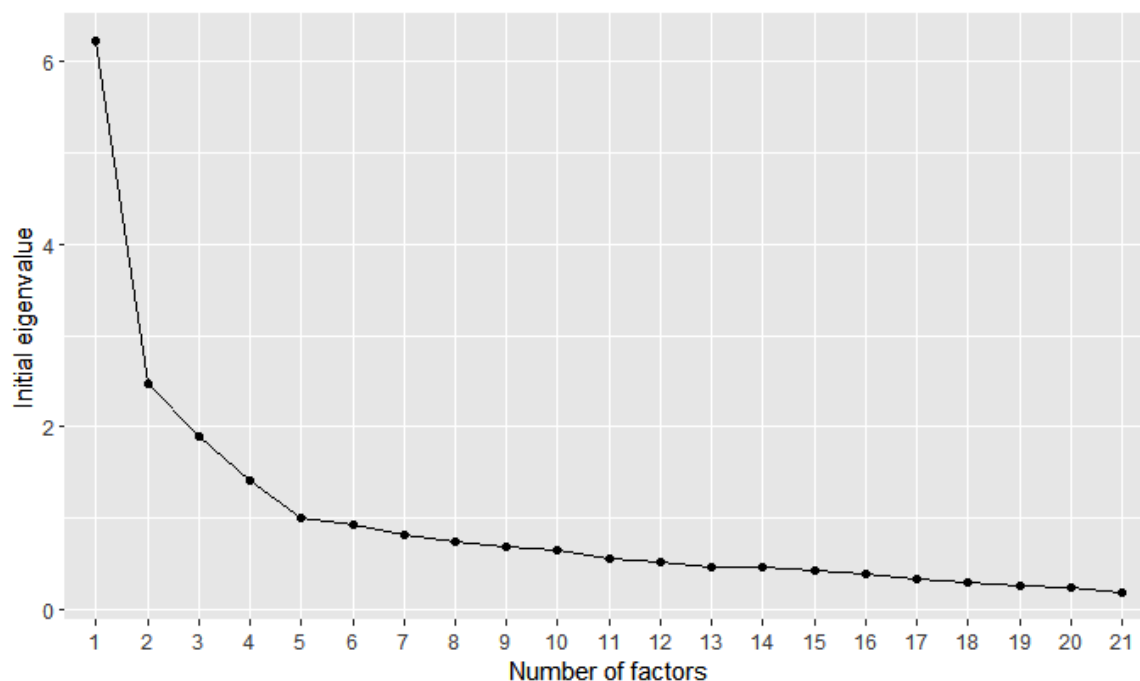


Figure 4.1.: Scree Plot Results

T-test Results

To determine if there were significant differences in scores on the four aspects of SCCT before and after taking part in the program, paired-sample t-tests were utilized. This was done separately for 2020 and 2021 data. As the 2021 dataset has a smaller sample, the dataset was assessed for normality of differences. In cases where the difference was not normally distributed, a Wilcoxon test was performed instead of a paired-sample t-test.

As seen in Table 4.2, the paired-sample t-tests showed a significant increase in confidence after the summer camp. However, the remaining three constructs did not significantly change. The results for 2021 are in Table 4.3. Due to the non-normality of differences for

Variable	Intent	Confidence	Expectations	Social	h2	u2	com
conf_program (c1)	0.13	0.79	0.08	0.03	0.644	0.36	1.1
conf_use (c2)	0	0.66	0.2	0.04	0.481	0.52	1.2
conf_design (c3)	0.16	0.7	0.09	0.07	0.525	0.47	1.2
conf_solve (c4)	0.1	0.68	0.08	0.14	0.496	0.5	1.2
conf_imagine (c5)	0.16	0.72	0.01	0.12	0.558	0.44	1.2
social_people	0.26	-0.02	0.39	0.32	0.316	0.68	2.7
social_learn (s1)	0.07	0.07	0.27	0.74	0.627	0.37	1.3
social_cool	0.13	0.2	0.42	0.18	0.263	0.74	2.1
social_dowell (s2)	0.26	0.19	0.26	0.65	0.585	0.41	1.9
social_create (s3)	0.16	0.24	0.14	0.72	0.619	0.38	1.4
intent_apps (i1)	0.68	0.06	0.14	0.26	0.546	0.45	1.4
intent_compsystems (i2)	0.68	0.17	0.19	0.13	0.538	0.46	1.4
intent_degree	0.12	-0.08	0.16	0.13	0.064	0.94	3.4
intent_computingdegree (i3)	0.77	0.11	0.12	0.05	0.622	0.38	1.1
intent_computingjob (i4)	0.76	0.17	0.15	0.06	0.639	0.36	1.2
expect_money (e1)	0.11	0.13	0.65	0.18	0.478	0.52	1.3
expect_respect (e2)	0.06	0.08	0.68	0.13	0.496	0.5	1.1
expect_enjoywork	0.6	0.19	0.3	0.16	0.506	0.49	1.9
expect_proud (e3)	0.27	-0.03	0.52	0.21	0.385	0.62	1.9
expect_makedifference (e4)	0.18	0.16	0.56	0.11	0.382	0.62	1.5
expect_findjob (e5)	0.1	0.1	0.56	0.02	0.33	0.67	1.1

Table 4.1.: Factor loadings of study items.

confidence, a Wilcoxon signed rank exact test was conducted as well, which confirmed that there was a significant difference between the two time points ($V = 334$, $p < .001$).

Time	Mean	SD	Median	Min	Max	t (df = 80)	p
Confidence							
Pre	-0.482	0.972	-0.374	-2.577	1.530	9.4891	<.001
Post	0.457	0.620	0.581	-1.199	1.588		
Intent							
Pre	0.094	0.825	0.063	-1.772	2.158	-0.8809	0.381
Post	0.033	0.871	-0.010	-2.322	1.427		
Expectations							
Pre	-0.026	0.852	-0.068	-3.256	1.668	0.9593	0.34
Post	0.058	0.887	0.059	-4.021	1.501		
Social							
Pre	-0.062	0.922	-0.112	-2.843	1.630	0.7342	0.465
Post	0.005	0.803	0.028	-3.048	1.252		

Table 4.2.: Descriptive statistics and paired samples t-test results for the 2020 data

Time	Mean	SD	Median	Min	Max	<i>t</i> (df = 26)	<i>p</i>
Confidence							
Pre	-0.338	0.896	-0.333	-2.053	1.206	3.9529	<.001
Post	0.413	0.602	0.408	-0.750	1.481		
Intent							
Pre	-0.229	1.041	-0.293	-1.708	1.359	0.4084	0.6863
Post	-0.151	1.072	0.115	-2.053	1.502		
Expectations							
Pre	-0.253	0.861	-0.172	-2.912	1.157	2.4021	0.02374
Post	0.155	0.695	0.197	-1.245	1.242		
Social							
Pre	0.198	0.934	0.289	-2.166	1.659	-1.2709	0.215
Post	-0.028	0.876	0.069	-1.659	1.128		

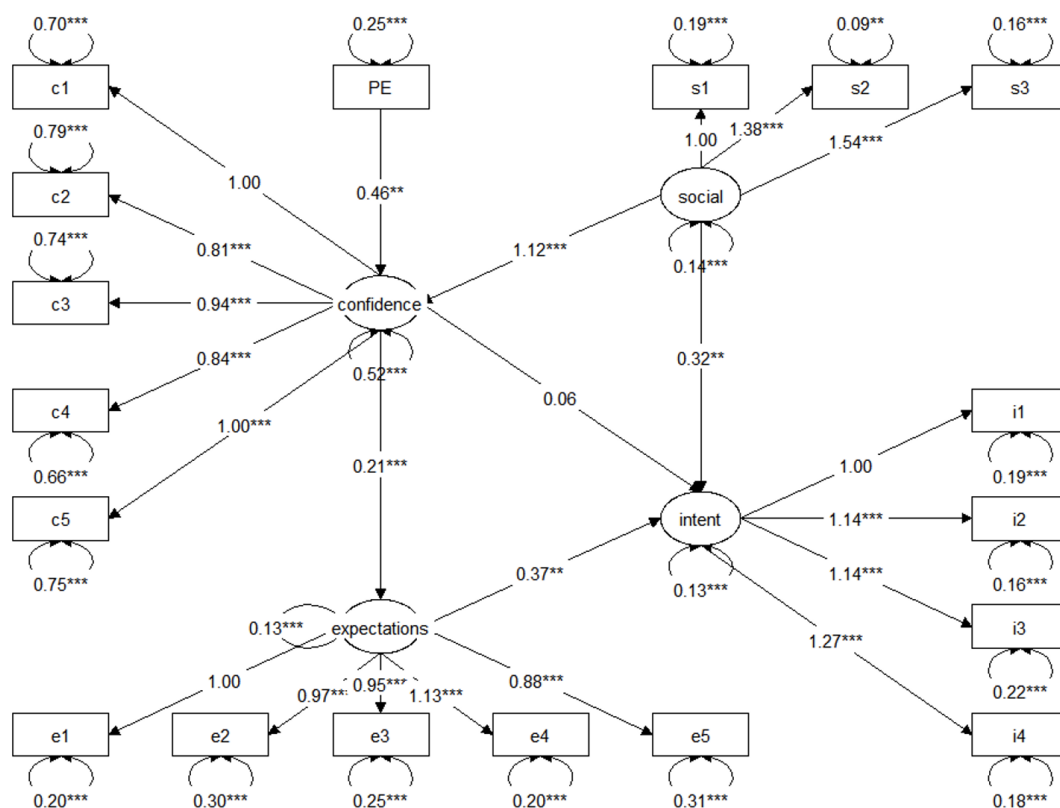
Table 4.3.: Descriptive statistics and paired samples t-test results for the 2021 data

CFA Results

To determine the relationships among the main study variables, I conducted a confirmatory factor analysis (CFA) using the lavaan package. Due to the ordinal nature of survey data, a WLSMV (weighted least squares mean and variance adjusted) estimator was utilized, as it is less susceptible to bias and estimates the parameters more precisely Beauducel and Herzberg (2006). A correlation table with means are shown in Table 4.4. Results indicate good model fit (χ^2 (130) = 240.058, $p < .001$, CFI = .952, TLI = .943, RMSEA = .063). Standardized parameter estimates are provided in Figure 4.2; unstandardized estimates are shown in Table 4.5.

SEM Results

My hypothesized SEM is described graphically in Figure 4.3. I performed a SEM analysis based on data from 108 students in the INTech Virtual Summer Camp with the



*** $p < .001$, ** $p < .01$

Note. PE = previous experience; other item names may be seen in Table 4.1.

Figure 4.2.: CFA Model

lavaan statistical package in R on the 21-questions from the pre- and post survey measuring SCCT. Results indicate a mediocre model fit ($\chi^2(130) = 310.998$, $p < .001$, CFI = .877, TLI = .855, RMSEA = .080). The overall model showed a significant paths from Social Supports to Confidence in Computing/Self-efficacy ($\beta = 0.371$, $p < 0.000$); Confidence in Computing/Self-Efficacy to Computing Outcome Expectations ($\beta = 0.339$, $p < 0.000$), and Confidence in Computing/Self-Efficacy, Computing Outcome Expectations, and Social Supports to Intent to Persist ($\beta = 0.183$, $p < 0.038$; $\beta = 0.246$, $p < 0.05$; $\beta =$

0.224, $p < 0.09$). One insignificant path was found from Prior Exposure to Confidence in Computing/Self-Efficacy ($\beta = 0.130$, $p < 0.63$). Figure 4.4 shows these results.

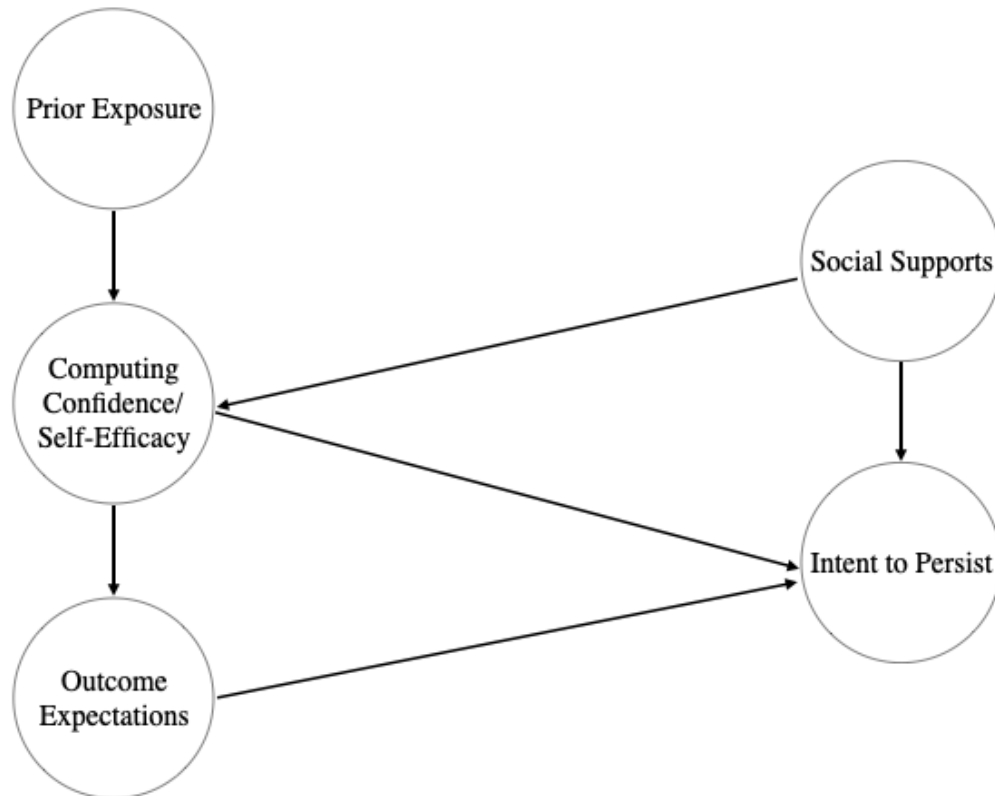


Figure 4.3.: Hypothesized Structural Equation Model with Standardized Results

Qualitative Results

For the qualitative portion of this study, I conducted ten semi-structured interviews with Black girls who participated in the INTech Virtual Summer Camp. The second and third research questions asks: “*How do Black middle school girls describe their experiences at a virtual CS summer camp?*” and “*How do Black girls describe their interactions with Black women mentors at a virtual CS summer camp?*”. Research question two and three were both answered through the semi-structured interviews conducted with 10 students at camp.

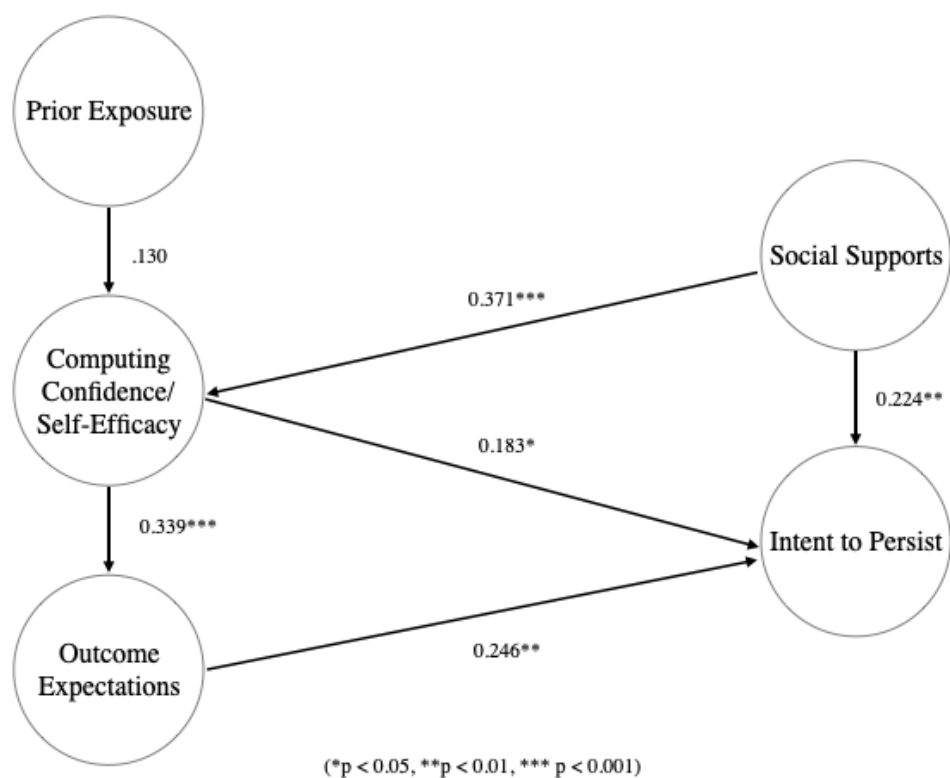


Figure 4.4.: Hypothesized Structural Equation Model with Standardized Results

	c1	c2	c3	c4	c5	s1	s2	s3	i1	i2	i3	i4	e1	e2	e3	e4	e5
c1	0.000																
c2	0.127	0.000															
c3	0.081	0.006	0.000														
c4	0.077	0.050	0.028	0.000													
c5	0.029	0.031	0.152	0.057	0.000												
s1	-0.142	-0.054	-0.088	-0.064	-0.032	0.000											
s2	-0.063	-0.025	-0.056	-0.025	-0.092	0.009	0.000										
s3	-0.004	-0.043	-0.059	0.047	-0.028	0.052	-0.095	0.000									
i1	-0.083	-0.187	-0.010	-0.041	0.070	0.104	0.095	0.047	0.000								
i2	0.059	-0.076	0.000	0.022	0.046	-0.013	0.006	0.004	0.123	0.000							
i3	0.003	-0.034	-0.029	-0.035	-0.059	-0.063	0.068	-0.041	-0.043	-0.060	0.000						
i4	0.022	0.004	0.032	-0.035	-0.010	-0.043	0.042	-0.032	-0.071	-0.110	0.213	0.000					
e1	-0.052	0.050	-0.041	-0.022	-0.040	0.245	0.211	0.136	0.009	-0.038	-0.038	-0.026	0.000				
e2	-0.015	0.050	-0.037	-0.062	-0.099	0.223	0.142	0.110	-0.007	-0.038	-0.045	-0.021	0.149	0.000			
e3	-0.149	-0.132	-0.045	-0.099	-0.102	0.226	0.270	0.108	0.080	0.093	0.036	0.080	-0.073	-0.017	0.000		
e4	-0.057	0.037	-0.018	-0.040	-0.011	0.138	0.142	0.126	0.051	0.054	-0.068	-0.039	-0.070	-0.011	-0.007	0.000	
e5	-0.007	0.033	-0.053	-0.011	-0.125	0.106	0.096	0.050	-0.072	0.048	-0.010	-0.011	0.011	0.022	0.049	-0.001	0.000
PE	-0.046	0.015	-0.012	-0.042	-0.026	0.213	0.269	0.193	0.128	0.168	0.124	0.152	-0.005	0.003	0.015	-0.061	-0.106

Table 4.4.: Correlation Matrix

Item	Unstandardized Loadings	S.E	Standardized Loadings	R Square
conf_program	0.697	0.117	0.519	0.481
conf_use	0.785	0.116	0.388	0.612
conf_design	0.740	0.112	0.475	0.525
conf_solve	0.661	0.087	0.447	0.553
conf_imagine	0.752	0.128	0.501	0.499
social_learn	0.186	0.035	0.434	0.566
social_dowell	0.092	0.029	0.747	0.253
social_create	0.163	0.042	0.675	0.325
intent_apps	0.190	0.026	0.498	0.502
intent_compsystems	0.162	0.025	0.603	0.397
intent_computingdegree	0.223	0.032	0.521	0.479
intent_computingjob	0.179	0.032	0.627	0.373
expect_money	0.196	0.034	0.455	0.545
expect_respect	0.302	0.043	0.339	0.661
expect_proud	0.251	0.039	0.372	0.628
expect_makedifference	0.203	0.040	0.507	0.493
expect_findjob	0.311	0.041	0.288	0.712

Table 4.5.: Standardized and Unstandardized Coefficients for CFA

The qualitative results are structured into two sections beginning with participant profiles of each participant in Table 4.6, using pseudonyms provided by the participants to protect their identity, and including information about their grade level, prior exposure to CS, location, and free/reduced lunch status. Next, I present the themes that emerged from interview data analysis taken from each girl's experiences.

Participant Profiles

Asia. Asia is a sophomore who attended two in-person INTech Summer Camps and one virtual Summer Camp. The only CS camp experience Asia has participated in is the INTech Camp. In school, Asia participates in Agriculture Club, band, and theater and has taken marketing and an animation course. Asia is pretty confident in her abilities to study computer science or tech. Asia plans to study at a local community college and then

Name	Camp(s)	Grade while at Camp	Exposure to CS before INTech	Camp Scholarship	Free/Reduced Lunch	Location
Asia	2020 Virtual Camp 2 In-Person Camps	7	No	No	No	NC
Victoria	2020 Virtual Camp 3 In-Person Camps	8	No	No	No	NC
Naomi	2020 Virtual Camp 2 In-Person Camps	8	No	No	No	NC
Madeline	2020 Virtual Camp 3 In-Person Camps	8	Yes	No	No	NC
Gabrielle	2020 Virtual Camp 1 In-Person Camp	6	No	No	No	NC
Jaylee	2020 Virtual Camp	6	No	No	No	NC
Leigh	2020 Virtual Camp 2021 Virtual Camp	6, 7	No	No	No	NC
Diamond	2020 Virtual Camp 2021 Virtual Camp	5, 6	No	Yes	Yes	NC
Alexandria	2020 Virtual Camp 2021 Virtual Camp	6, 7	Yes	No	No	NC
Eseer	2020 Virtual Camp	7	Yes	No	No	CA

Table 4.6.: INTech Summer Camp Participant Demographics

transfer to a 4-year university with plans to work at the U.S. Environmental Protection Agency studying agriculture.

Victoria. Victoria is a junior who attended three in-person INTech Summer Camps and one virtual Summer Camp. The only CS camp experience Victoria has participated in is the INTech Camp. In school, Victoria participates as a school ambassador and is a member of the equity club, knitting club, and book club. Victoria is taking visual and digital design courses on the Adobe Gaming Pathway at her school. Victoria will receive an Adobe Certificate for each course she completes. Victoria is confident in her abilities to study computer science or tech and plans to attend a 4-year university studying Computer Science or IT. She would ultimately like to be a teacher.

Naomi. Naomi is a junior in high school who first attended an INTech Camp in person while in middle school. INTech is her only CS camp experience, and she has only had one experience with CS in school. While she does not plan to study CS in college and has not taken any CS classes in high school, Naomi stated that on a scale from 1-10, her

confidence in her ability to study CS is 6.5. Naomi plans to study pharmacy and get a degree in business.

Alexandria. Alexandria is a rising eighth grader who has attended a local university's summer camps for science, engineering, and technology for several years. She enjoyed the flexibility of the virtual INTech Camp and the ability to attend with some of her friends. Alexandria intends to study a health-related major and feels she can apply some of what she learned about CS to her future career in medicine.

Leigh. Leigh is a current high school freshman who attended all four sessions of the virtual INTech Camps in 2020-2021. CS is not offered at her middle school or high school. Despite the lack of access to formal K-12 Computing education, Leigh is "somewhat confident" in studying CS. Leigh participates in competitive dance and is uncertain about her career goals.

Gabrielle. Gabrielle is a current high school freshman with sophomore credits who attended one INTech camp in person and the 2020 Virtual Summer Camp. While Gabrielle's high school offers a technology curriculum as a pathway to college, she is not taking those courses. She is interested in a career in computing; however, her main focus is to become an entrepreneur and open a dance studio.

Jaylee. Jaylee is a current high school freshman who attended the 2020 Virtual Summer Camp. While Jaylee would like to remain in STEM with a career in medicine, she does not intend to persist in CS. Jaylee has two parents in the tech field who wanted her to be exposed to CS as a possible career option; however, even after attending INTech Camp, Jaylee is not interested in CS.

Madeline. Madeline is a current high school sophomore who attended three in-person INTech Camps and two Virtual Camps. Madeline has taken several tech and computer science-related courses in elementary, middle, and high school, including AP Computer Science Principles. Madeline has a high CS self-efficacy and plans to major in CS when she goes to college.

Diamond. Diamond is a current seventh-grade student who attended the Virtual INTech Camp in 2021 as a fifth grader. Diamond is very confident in her ability to study CS, and she plans to major in CS when she gets to college. Diamond plans to bring CS to her current middle school because she feels it is a wonderful learning experience for everyone. To supplement not having CS instruction at school, Diamond still codes using the STEM Lingo kit provided to her during the INTech camp to learn about hardware and software design.

Eseer. Eseer is a freshman in high school who attended the Virtual INTech Camp in 2020. Eseer is neutral about her confidence in studying CS because she is unsure whether it will be easy or hard for her to understand. Since her mom has engineering degrees, she has had a lot of exposure to CS and Engineering. Eseer plans to enter the medical field and potentially get a separate degree in CS.

Becoming a Black Girl in Tech

Analysis of the girls' interactions at the camp revealed two themes most salient to their experiences. All students in this study self-identified as Black (or African American) girls. These intersectional identities impacted their experiences as they learned how to code projects related to these identities in the INTech camp; thus, the theme "*Becoming a Black girl in tech*" emerged from the data, with three sub-themes, *Coding at School vs. Coding at INTech* and *Learning to Code Virtually with BSD Education, Tech for Good*.

Coding at School vs. Coding at INTech. The INTech Summer Camps welcome students who do not have prior exposure to CS and those who do. There are two learning tracks available depending on the student's prior exposure to CS, as outlined in Chapter 3. Out of the ten students interviewed for this study, only Alexandria and Eseer had prior exposure to CS before attending the INTech Summer Camp. All of the elementary school students at Alexandria's school are required to take a coding class. Middle school students can take

a STEM class and participate in a CS enrichment program after school where they use 3D Printers and learn about robotics, film, and editing. Alexandria shared that *“every summer for as long as I can remember, I’ve done some form of computer science camp during summer.”* Despite this exposure, Alexandria mentioned that during her INTech experience:

We did a lot more coding, and we kind of got down to the basics of it. So we can really have a good foundation. Because at my school, a lot of times, it’s just they kind of assume you know a lot of the stuff and then you just start off running. But, um, so this was like a good foundation. And I learned a lot of things that I didn’t know about the deeper portions of coding and computer science.

Eseer shared a similar sentiment about the value of the approach taken in her experiences when comparing coding at INTech and school:

Computer Science at school, I feel like it would be more like how it would be more, like, I’m trying to use like an example. Like Spanish that you learned inside school versus a Spanish that you’re actually going to use when you go like to Spanish speaking countries. It was like more personal or something that you could actually like do and it wasn’t like more formal I guess. It’s not like a bad not formal, [it] is just like a quicker, easier way to do it.

Other girls had exposure to CS after attending an INTech Summer Camp. Asia, a current high school sophomore, shared a similar sentiment when comparing the approaches taken with coding at INTech to her school experience. Asia first learned to code at an in-person INTech Summer Camp as a sixth grader and attended the camp again virtually while in the seventh and eighth grades. When comparing INTech to her high school tech courses, Asia felt that INTech was *“definitely more engaging, because, um, I said earlier that, like, I’m really hands-on. And I think I did more in the virtual camp than I did, like, for that one week, or that set of time, then like, the whole school semester.”* Asia talked about her

instructor at school, saying, *"I mean, no, no shade to the teacher, but like she, I just don't think that you know, that was like her best class, I guess because it was kind of hard to grasp what she was saying. And she wasn't really engaging. And it was like; it wasn't fun. It was not fun. Definitely did not have like that touch I'm looking for. You know what I mean?"* Creating a welcoming and engaging environment for Black girls to learn how to code is imperative both in the classroom and for virtual camp experiences.

In addition to having welcoming and engaging instructors, INTech has Black and Latina women as instructors, who also have careers in CS, which was a highlight amongst the students. Since the instructors could speak directly from their lived experiences at work, it provided more credibility to the students at camp. It contrasted the experiences students had in their school classrooms. Victoria observed:

it was, you know, a little bit cooler here because you're in tech, and my teachers were in tech. So I get hands-on experience. I remember my leaders telling me stuff about what they did at their jobs, like their jobs that they had. So I think that was cool that that was something that was different that it was people based on the actual, like experience in that field."

Leigh mentioned something similar:

I liked how like supportive, like the teachers were and how like if you had a question or like if he was lagging behind a little bit they helped you a lot and they like. They were just very, like, it seemed like they genuinely cared about the students. And they had like, such like a passion for what they were doing and it kind of like showed through their teaching.

During the virtual INTech Summer Camp, students are placed in small classrooms to better get to know other camp attendees and allow instructors to create a welcoming environment. When comparing her experiences learning at INTech with her experiences at school, Jaylee asserts that *"...INTech was more personal, and they tried to relate to you*

more.” While Jaylee does not intend to persist in CS, she found value in the camp, “*I do think they were able to expose me to something that I probably wouldn’t have been exposed to. Although I didn’t like [coding], I like the experience of getting to see something else.*”

INTech uses text-based coding to teach students about HTML, CSS, and Javascript instead of block-based coding methods like Scratch to mirror industry standards. Madeline spoke about using block-based coding at other camps and in school. She “*... would have preferred doing what we did at INTech where we were actually doing code. Because higher up in the future, we probably won’t be using as much block code.*” Madeline recognizes the need to learn how to code using a text-based programming language in her future studies with CS. Similarly, Victoria agrees when she says:

I felt like being at INTech really had some, like, lasting things. I will never forget what HTML means. Hypertext Markup Language. We talked about it every year, and I will just never ever, ever forget it. And I remember being at school, and one of the first questions we got on the first day of school was what does HTML mean? And I was the only person who knew what it meant.

Black girls attending INTech Camps know that coding is a fundamental skill they need to persist in CS and feel that INTech provides a strong foundation because the concepts they learn at INTech are rigorous.

Learning to Code Virtually with BSD Education. During the Virtual INTech Camp, students had the opportunity to code several self-guided projects using the BSD platform that were related to their interests. Most students loved creating the Digital Pet project (described in Chapter 3), as it tied directly to their animal interests. Asia stated “*I loved the pet coding thing that we did and I think it’s because I’m like an animal person. And I liked how it was interactive*” (Figure 4.5). Madeline felt similarly:

I like that you could set like, the cleanliness, the happiness, and the energy to different amounts. And for different actions that you did, they gave a different

outcome. And then, over time, it was supposed to go back down, and you had to keep feeding it and keep it alive. So it was kind of like the, I don't know what it's called, the Tamagotchi, something like a little keychain.

Since the projects were relevant to the students, they could recall their joy while completing them.

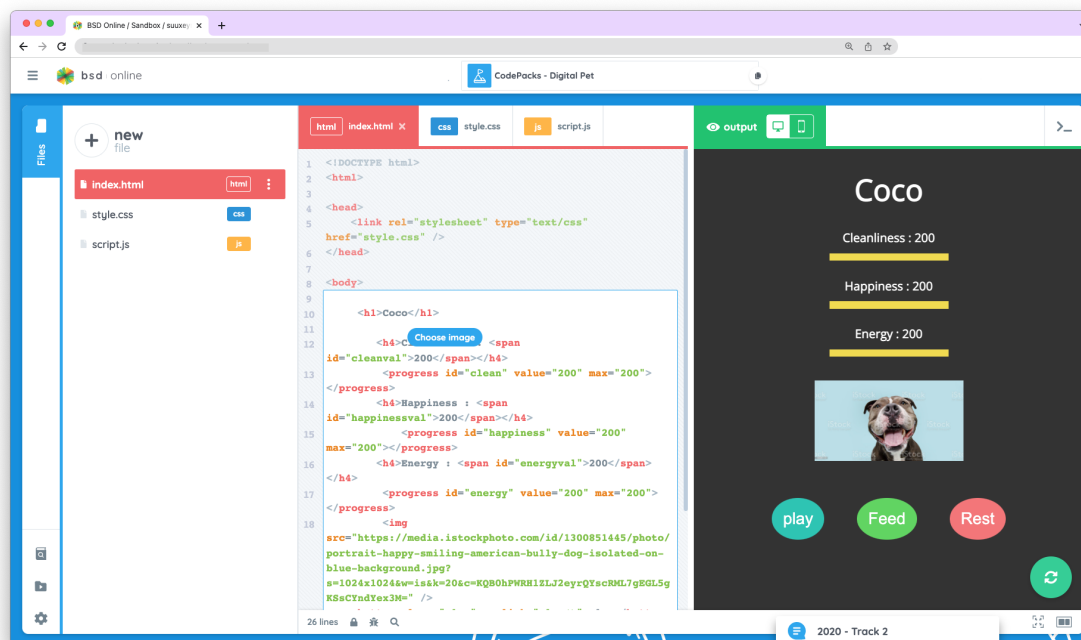


Figure 4.5.: Asia's Digital Pet Project

In addition to enjoying the curriculum, students also mentioned that they liked using the BSD platform to learn how to code. Diamond asserts:

I liked creating the eye chart because it gave you the experience of coding. BSD would give you the directions, but if you didn't understand, I think asking for clarification helped me out because I struggled a little bit on BSD, and then I got used to it my second year. I actually liked creating eye charts because I think it could help people during doctor visits, and you can make money from coding.

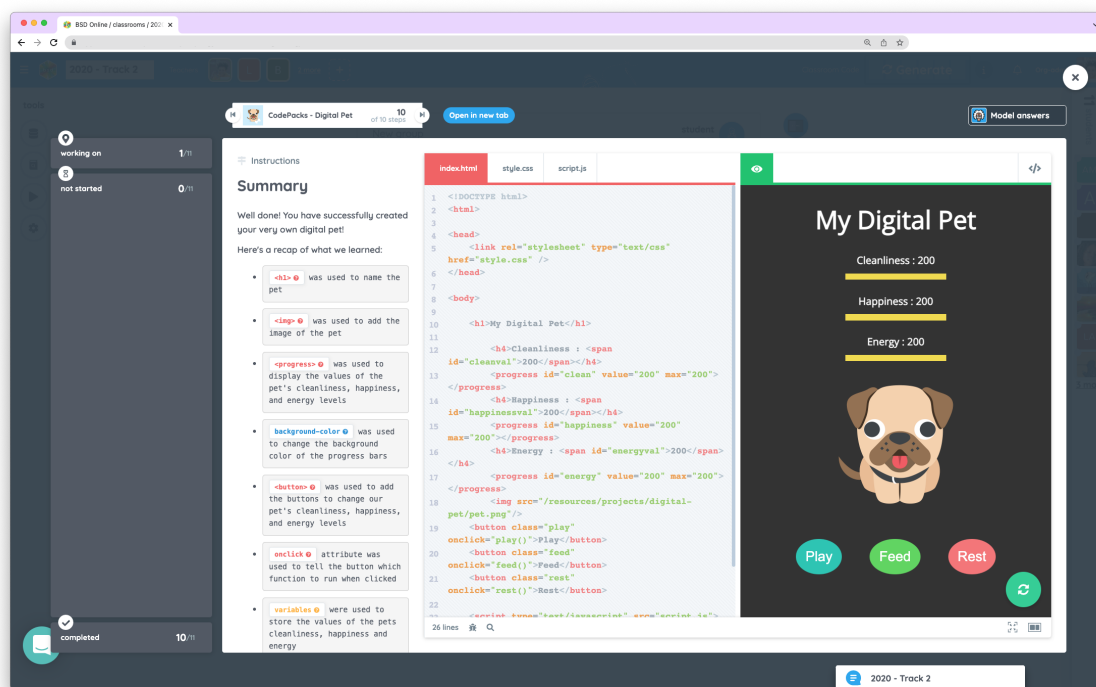


Figure 4.6.: Madeline’s Digital Pet Project

Diamond understood the value of coding and liked the guided instruction that BSD provided, along with the support of her teacher. Gabrielle agrees by saying:

The reason I enjoyed it was being able to, like, type in some things and see how it reacts and see how a computer will react or how it doesn't react to something. So like, when I put in some code, and it worked or didn't work, and you could see how it didn't work, or why it didn't work like it all had a system, and that was helpful to me.

Despite the virtual nature of the camp, students were able to learn how to code and generally enjoyed the process the BSD program provided them.

While virtual learning has downsides, one participant stated, “I thought it was pretty cool how we did all of that over zoom.” A few students mentioned how they prefer the hands-on nature of in-person instruction; however, they liked that they could code an app

during a virtual camp. Asia said, *“I usually need hands-on [instruction], and I’m a visionary listener, so I need to, like, see real people to learn how to do things. But the fact that I did that whole app, website thing, like over the computer, I thought was pretty cool.”* Gabrielle also mentioned that she prefers in-person instruction; however, she recognized that *“it was easier to some people to have it all in one place. So I have a teacher right here. And I have, like, the slides open and when in the code in another slide. So it was easy to switch back and forth.”* Conversely, Naomi mentioned that virtual instruction was challenging. *“Like, if you had a question [it] was very hard to actually, like, understand what the teacher might be saying or how to fix a problem if you ask the teacher a question.”*

While a virtual camp is not an ideal experience for some, it provides flexibility for others. Alexandria felt that the virtual camp *“gave more flexibility, and I felt like that everyone got to have a computer in front of them, so we all got to be using the computer consistently. So that was really nice.”* Alexandria shared that in other in-person STEM camps, all students couldn’t be on the computer. The INTech Virtual Camp gave every student an equal opportunity to be on the computer. The INTech Virtual Camp also allowed students to fit summer learning into their busy schedules. Jaylee states, *“I don’t think I could have gone if it wasn’t virtual. Just with how busy I am. So I liked it.”* Overall, the participants spoke positively about their virtual camp experiences. While the experience wasn’t the perfect solution for everyone, it allowed them to learn and build technology solutions that they felt were useful.

Tech For Good. In addition to building projects about digital pets, students created a digital poster about a social issue of their choice to use tech for good. Alexandria recalled creating a poster about Global Warming where she was able to teach *“people good ways to keep plastic out of the ocean and things you can’t and can’t recycle.”* She felt these posters were *“...a really good thing because you can, if I wanted to, I could have printed those out and posted those around and talk to people about that, and I’m sure that would have*

helped.” Alexandria could see how her poster connected to doing good in the world around her.

Gabrielle had a similar reflection about the Budget (Figure 4.7) and Nibus (a nutrition app shown in Figure 4.8) apps she created during her time at the virtual camp when she asserts, “Okay, like there, I felt like I could do something for good. You know what I mean? And I had all of the, how to log all the information yet, but I feel like it was a step in the right direction of realizing that this can help people.”

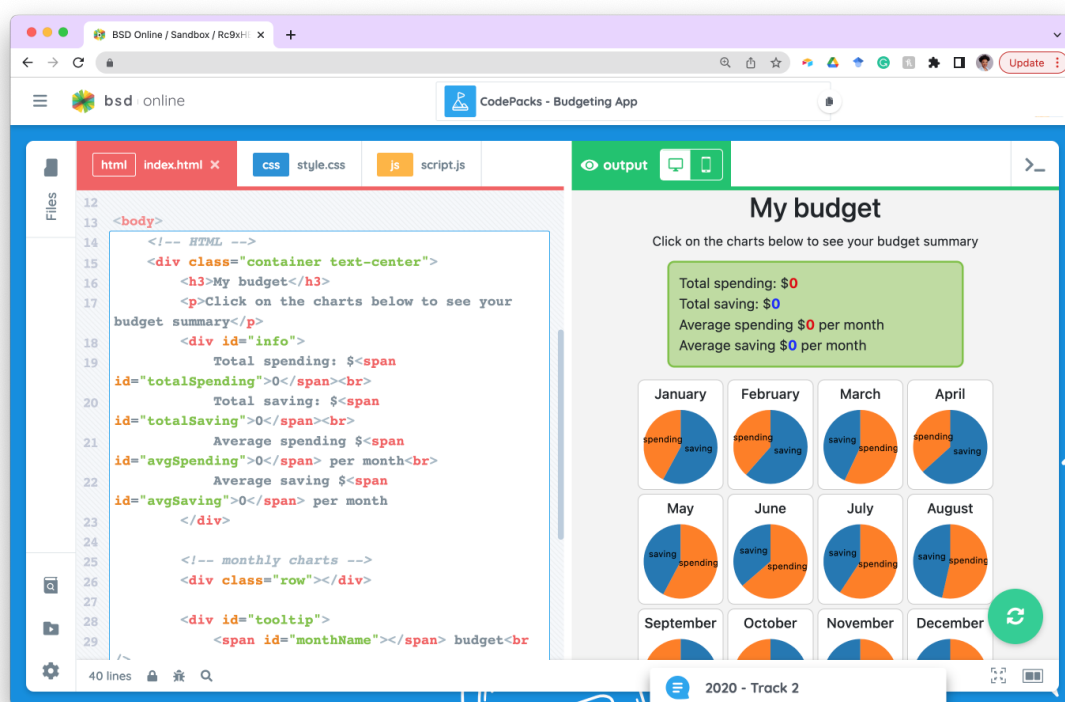


Figure 4.7.: Gabrielle’s Budget Project

Being a Black Girl in Tech

The Black girls who participated in this study discussed their perceptions of being a Black girl in tech. They spoke at length about learning how to code by Black women in

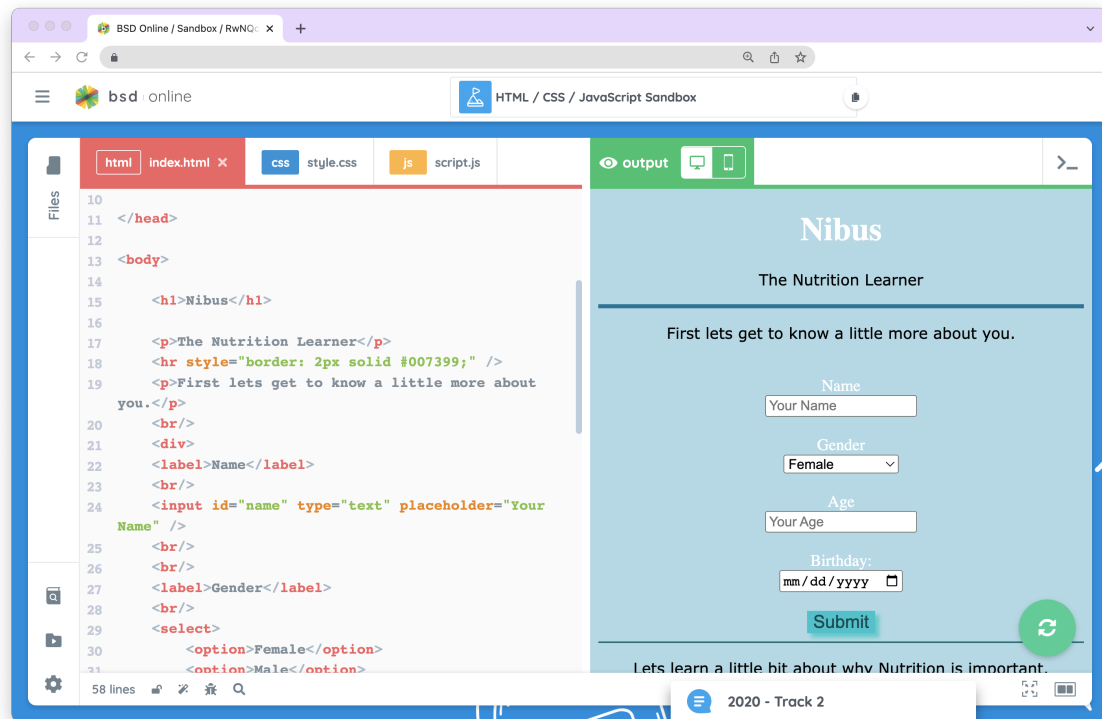


Figure 4.8.: Gabrielle’s Nibus Project

CS, with other Black girls; thus, the theme of Being a Black girl in tech emerged with four sub-themes: *Breaking the Stigma*, *Black “Tech” Girl Magic*, *Intersectional Representation Matters* and *Intent to Persist/Self-efficacy*.

Breaking the Stigma. Even though the Black girls who participated in this study are in middle school and high school, they are well aware of the stigmas in tech and STEM careers. Asia suggests:

I think it’s very important for Black girls to get into technology because I think there’s this stigma around girls and Black, especially minority women, about things about what we can and can’t do. And I think technology is one of those things that falls into things that minority women can’t do.

Asia shared how she felt *“INTech is a really big gateway to get rid of those stereotypes and stigmas. Um, and I liked it. I definitely liked how it was targeted toward minority girls. And you know, especially young Black girls.”* Despite their age, the Black girls who participate in the INTech Camps understand the uniqueness of the camp’s design, stressing the importance of having the majority of Black girls attend the camp to learn about a field that has not broadly included them.

As previously mentioned, the projects students worked on allowed them to explore topics that impacted them and their communities. Students felt that the overall INTech community could break the stigma that Black girls and women can’t “do” tech since INTech normalizes Black girls and women “doing” tech. Victoria felt that the camp activities *“can improve the Black community by having people know that the more people that we can get into these fields, it won’t be such a stigma that we can’t be in these fields, to begin with.”*

As previously mentioned, the projects students worked on allowed them to explore topics that impacted them and their communities. Students felt that the overall INTech community could break the stigma that Black girls and women can’t “do” tech since INTech normalizes Black girls and women “doing” tech. Victoria felt that the camp activities *“can improve the Black community by having people know that the more people that we can get into these fields, it won’t be such a stigma that we can’t be in these fields, to begin with.”*

When asked if careers in CS are attractive to Black girls, Victoria states:

I don’t think so. Because I feel like it’s never something that has really been advertised to us before, that is appealing, or that is attractive. You don’t really see it in the news. You don’t really see it, you know, in games, movies, TV shows, books, and all that other thing. So it’s not something that catches the eye. So it leaves you with your own stigma of it, of you’re just sitting at the computer all day typing away letters and numbers. I don’t think that to a lot of people, it is, which I feel like is a stigma that needs to be broken. And advertise more like more representation and books, TV shows, movies.

Black girls come to INTech with the notion that tech and CS is not marketed to them, thus it is not an attractive career path.

Black "Tech" Girl Magic. Having a peer group, a camp staff, and speakers that looked like them proved powerful for the camp's Black girls. Seeing other girls who looked like them and were interested in CS empowered the students to learn and prove others wrong. Diamond attests to this when she says, "*...I think a lot of people don't think that us Black girls can do a lot of stuff. But if we can show them that we can do a lot of stuff that other people from other races can do, I think it would strive to put us to the top a lot, and so Black girl magic.*" Diamond's use of the slogan "Black Girl Magic", made popular in recent years to express the uniqueness and power of Black girls, shows her resilience in CS. Despite the previously mentioned stigmas that exist in CS careers, the Black girls who attend INTech camp recognize the power that they have as a community, thus serving as the main theme for the interviews.

Gabrielle shared that her middle school was predominately white, so it was "*nice to have other girls who look like me who were interested in the same things as me.*" Gabrielle went on to say:

... the whole idea of having Black girls go into code was like super powerful to me. And it was nice to see everyone wanted to learn about this or everyone signed up to learn about this, you know what I mean? And so it was definitely like a representation of Black girls trying to try to get somewhere, you know what I mean? Because a lot of the times [tech] is very closed.

Naomi shared that she enjoyed meeting new friends and still texts one of the girls from camp. Alexandria attended the camp with friends and stated, "*I feel like I got to see a lot of other girls who looked like me. And it was just nice to be around people. And often, I had a friend or two there with me. And it was just doing something that I enjoyed and having a good time having fun with it.*" Having a peer community of Black girls was salient

throughout the interviews with the camp participants, as they felt it was powerful to be in a virtual space with other girls who looked like them.

Intersectional Representation Matters. Core to the design of the INTech Virtual Summer Camps is the makeup of the staff and speakers. All of the guest speakers are Black or Latina women. While this approach is intentional, it surprised Diamond, who reveals, “I didn’t think that most of our speakers will look like me. But when I saw that they did, I was like, that’s amazing to see what Black girls can do in the future. And now!” Victoria, a participant who has attended INTech camps both in-person and virtually, conveys:

Aspects that I enjoyed at INTech was number one, the makeup of it, which was Black women, because I didn’t really see that a lot. That’s probably my number one thing that I really did like about [camp], seeing people that looked like me, and making sure that when we went to other places, when we did our [company] visits, also looking at other people who look like me work here.

Many students mentioned that the guest speakers were their favorite part of the camp. Alexandria recalls:

The speakers were one of my favorite parts of the day. I just loved hearing what they had to say. And it was just amazing. I love them. It was really good. My friend and I, we were both in the same camp the both years we did it. So after we would FaceTime each other, and we would talk about the speakers and we would just talk about the camp day. It was really nice.

Gabrielle agreed:

So it was definitely one of my favorite parts because not only did they tell their story, they told their struggles, because I mean, that’s part of your story but they told how positive all of it was for them. And like how people really found their thing, like, it’s so inspirational for me to hear someone talking about

something that they love. Because it's like, I think it'd be like, wow, I love that, or I love that for you. And so you can take out what they have and a lot of times to get these really important, permanent jobs, you don't have to know everything about it; you can learn it as you go along. So it helped me to realize that, like, I don't have to know everything to try something, you know what I mean?"

When asked what it felt like to hear from speakers who looked like them at camp, Asia shared:

I think it felt really comfortable because, like, um, I think it felt better than like, just some guy mansplaining computers to a bunch of girls. Um, but yeah, I felt really, genuinely like, I feel better listening, like, to girls who look like me because I know what they've gone through. And I know that we have something in common. So obviously, it felt like a lot more hearing from somebody I have some things in common with.

Naomi felt that this aspect of camp “...taught me how to be very powerful, and accept myself as a Black woman. And that I can do anything that men can do.” Victoria went on to share that the camp motivated her to want to serve as a representation to other Black girls in STEM:

I feel like after participating in the camp to be a Black woman in STEM, I feel like I'd inspire other girls and have an impact on their point of view. And if I were to go into STEM and be like a mentor or teacher, my goal would be to impact and change other people's point of views and specifically Black girls point of views and stem like how they did on mine.

The impact of Black women on these young students is evident as they recall how important it was to see other Black women and Black girls doing CS. It was helpful for these young Black girls to see someone in a position they aspire to be in one day.

Intent to Persist/Self-Efficacy. Even though the INTech Virtual Summer Camps teach coding and other CS principles, none of the students defined CS correctly. The closest correct definition was *“a type of science that has to do with technology and architecture.”* All the students knew that what they were doing at camp was coding and could articulate their ability to code their projects; however, they could not define CS. In contrast, all participants were confident in their ability to study CS or something tech related. Gabrielle specifically credits INTech’s impact on her ability to learn CS *“I say on a scale of one to 10, I feel like INTech has put me a little higher, and I feel like I’m at a seven.”* While Jaylee is unsure about her career plans, she is *“pretty confident”* that she could study CS because both of her parents have careers in tech and could support her on that journey.

While the students’ self-efficacy proved high, I asked them about their school and career plans. Out of the ten students, only three stated that they would like to pursue CS, while one is undecided and considering CS. Three would like to study something STEM-related, like pharmacy, medicine, and agriculture. Two students mentioned that they were interested in studying business, and two were undecided. Some students expressed other interests like cheerleading, dance, or film, showing a connection to the arts.

Chapter 4 has presented quantitative and qualitative research findings addressing the three research questions of this study. Chapter 5 represents discussions, limitations, recommendations for practice, suggestions for future research, and conclusions.

CHAPTER 5

DISCUSSION

Chapter 5 provides conclusions based on research findings from data collected during the 2020 & 2021 Virtual INTech Camps, as well as discussion and recommendations for future research. This chapter will review the purpose of the study, research questions, literature review, and findings of the study. It will then present limitations, recommendations for practice and further research, and conclusions.

Summary

This study aimed to understand how a virtual CS summer camp impacted Black girls' intent to persist in the study of computing. I investigated how CRP and Black teachers/mentors play a role in addressing the intersectionality of Black girls while learning CS to determine if it impacts their intent to persist through the CS pipeline. Below I share insights based on the results of this study.

Discussion

Black Girls are Confident in Their Ability to Study CS

A Google report released in 2016 revealed that 57% of students overall are “very confident” they could learn CS; however, this decreases to 47% among female students, compared with nearly two-thirds of male students (65%). Black students are more likely than White or Hispanic students to say they are very confident they could learn CS, with about two-thirds of Black students (68%) who say they are very confident, compared to 56% of

White students and 51% of Hispanic students. Data from this study support this, as the quantitative and the qualitative data revealed that the two virtual CS summer camps increased the computing confidence of the Black girls who participated and took our surveys during the 2020 and 2021 INTech Virtual Summer Camps. Gabrielle stated that INTech raised her confidence to a seven out of ten. These findings show that the one-week INTech virtual summer camps are effective in helping Black middle school girls become confident in their ability to do CS. This is imperative as these students are young and may want to take advantage of CS opportunities in the future.

The social context construct in the Intersectionality framework (Collins & Bilge, 2020) helps us understand how the social locations of individuals within intersecting power relations shape their intellectual production. For example, some high school classes are offered under the guise that students will learn computer science concepts; however, students instead use a computer to learn business concepts (Rankin & Thomas, 2020). The conceptual mismatch between course description and curriculum illustrates a structural domain of power when the student enrolls in a CS degree program and realizes that what they learned was not CS (Rankin & Thomas, 2020). During my interviews, I asked each student to define Computer Science. None of them had a correct working definition of Computer Science. The closest correct definition was “a type of science that has to do with technology and architecture.” A possible explanation for this might be that CS is broad, and the INTech Camp may not have clearly explained the definition of CS to the students. While this is not detrimental to their success in CS, when we talk about structural domains of power (Rankin et al., 2021), Black girls must know the difference between digital literacy, information technology, and computer science regarding what they are learning in the classroom. Having a correct working definition of CS will allow them to discern whether or not what they are learning is CS. Camps or clubs targeting Black girls should be intentional about defining what computer science is and is not. Being able to define CS correctly and understand how broad the field is can empower young Black girls to seek out more CS op-

portunities in the future and give them the ability to distinguish when a program is teaching CS.

As was pointed out in the Chapter 4 sub-theme '*Tech experiences/involvement*,' Black girls attending INTech Camp know that coding is a fundamental skill needed to persist in CS. They feel that INTech provides a strong CS foundation because the concepts they learn at INTech are rigorous. They recognize that what they learn at school or other informal learning experiences is less rigorous, like when Asia stated that she learned more in a week at INTech Camp than in her high school animation course. The third core component of the Culturally Responsive-Sustaining Computer Science Education Framework (Scott et al., 2021) states that pedagogy and curriculum are rigorous and aligned with CS standards. The BSD curriculum used at the virtual INTech Camp, outlined in Chapter 3, aligns with CSTA core concepts. When Black girls do not have access to rigorous CS education in their schools, informal CS learning programs become increasingly important for building their confidence. Even when there is access in schools, these informal programs can provide more rigorous CS learning opportunities.

Learning Environment is Essential for Black Girls to Learn Computer Science

Students in underserved groups face structural, social, and psychological barriers in CS. These include a lack of diverse role models and peer networks, stereotype threat, and stereotypical cues in the classroom and workplace environments (Scott et al., 2016). Given the recent literature about Intersectional Computing (Rankin et al., 2021), we know that the K-12 classroom is a saturated site of violence for Black girls, and camps such as INTech are imperative for Black girls to learn CS. Since its inception in 2014, INTech Camp for Girls has lowered the structural, social, and psychological barriers for Black girls by ensuring that other Black girls and women surround them at camp. The qualitative results of this study illuminated the need for Black girls to have a safe space to learn CS and break down stereotypes (King & Pringle, 2019). Asia specifically stated that INTech was a gateway to

breaking stereotypes and stigmas by targeting minority girls. Gabrielle, a student attending a predominately White middle school, expressed that learning with other Black girls was “powerful.” These findings further support the idea that the environment in which Black girls learn CS is important.

Another benefit to the virtual camp model is the ability to invite more Black women who have careers in CS to serve on the camp staff and as speakers since they can join via zoom from any location. Even though social support was not a statistically significant predictor in the quantitative results, the qualitative results suggest that Black girls prefer a community with Black peers and Black women. As discussed in the qualitative results, the Black girls attending this camp become inspired by the stories of Black women as they make a career in CS feel attainable. Many of the students interviewed in this study have people in CS and STEM in their lives; however, the INTech community reinforces that Black girls and women belong in the CS community. Further, they enjoyed having Black women as speakers and teachers during the camp, instead of men who would “mansplain” lessons to them, as Asia pointed out in Chapter 4. The makeup of INTech helps Black girls break down stigmas about CS because they see other Black girls and women “doing CS” (Google & Gallup, 2016).

Virtual CS Camps Show Promise

Access to CS instruction is a massive discussion amongst those looking to close the digital divide. The impacts of the digital divide were exasperated during COVID-19 for Black students (McKinsey & Company, 2020). Virtual camps allow organizations to scale and reach more students who may not have the opportunity to learn how to code where they live. Offering a virtual camp option allowed INTech Camp for Girls to reach students in seven rural communities in North Carolina. This is huge as it relates to the social context of intersectionality because students should not be penalized for where they live. Instead, technology camps should be able to meet them where they are. Meeting via zoom and

utilizing the BSD curriculum that aligns with CSTA standards and CRP help make projects enjoyable and allow students to have agency and build confidence in their CS abilities.

While virtual camps are not the best model for all students, they can serve as an alternative for Black girls who do not have access to a CS learning experience where they live. Even though many students in the qualitative study mentioned they prefer in-person instruction, the study shows that a virtual CS camp is a promising approach for teaching Black middle school girls how to code. One unanticipated finding was that of the ten students I interviewed, the five who attended both an in-person and virtual INTech Camp experience had rich examples of how the company tours and camp counselors impacted them. Victoria and Asia both brought up a company visit they remembered from the in-person camp, where they met a Black woman and were very interested in her career. Both students recalled the impact meeting this Black woman left on them. The five students I interviewed who only attended the virtual INTech Summer Camp could not recall any of the speakers precisely and provided broad statements about being inspired by them. While the representation of Black women was powerful for them, one could argue that the in-person experience of seeing someone physically at their place of employment doing CS is more memorable than hearing from guest speakers via zoom.

Using the SCCT Model to predict Black girls' intent to persist

As mentioned in the theoretical framework in Chapter 1, scholars have used SCCT to predict the interests and choice goals in the computing disciplines of women and students of color (Alshahrani et al., 2018; DuBow & James-Hawkins, 2016; Lent et al., 2008; Weidler-Lewis et al., 2019). Very little was found in the literature on the question of whether or not SCCT could be used to predict if Black middle school girls would persist in CS. In this present study, I have used SCCT (Lent et al., 1994; Lent et al., 2008) to help demonstrate the influences on Black girls' intent to persist in CS.

The quantitative results of this research show that social supports and computing outcome expectations significantly impact intent to persist in CS. In addition, prior exposure to CS is found to mediate the effects of computing confidence. Overall, the model predicts a good portion of the variance in the ultimate outcome of whether or not a Black girl intends to persist in CS. The only non-significant relationship was between confidence (self-efficacy) and intent to persist, which is also supported by the qualitative data, where only three students stated that they intended to persist in CS, despite all of them sharing that they were confident in their ability to study CS. A possible explanation for this is that for Black girls, it may take more than a one-week camp to impact their intent to persist in CS. While one week of exposure is great for their CS confidence and breaking down stereotypes about Black women in CS, more CS learning experiences may be necessary for them to decide whether or not they would like to choose CS as a major in college or as a career choice.

Additionally, we need to rethink what "intent to persist" means. With CS and STEM being broad fields of study that often overlap, only measuring "intent to persist" by a degree in CS or a career in CS may not be productive, specifically for Black girls. There are other ways to engage in CS other than coding, for instance, taking a design thinking course, joining a robotics club, or combining CS with other primary interests, like Alexandria, who would like to go into the medical field. She could combine her love for medicine with technology and invent a new medical device. Once students understand how CS could overlap with their interests and we as a community shift our definition of "intent to persist," we may see more Black girls saying that they plan to study CS.

I added prior exposure to CS to my SCCT model because I wanted to see how this variable would impact intent to persist since many of our students do not come to INTech with prior exposure to CS. Additionally, prior work using SCCT to predict intent to major in IT (Luse et al., 2014) indicates that students must be reached during years before college. Since so little research focuses on students in middle school, I felt that adding prior

exposure to the model was essential to see how receiving access to CS education in K-8 impacts intent to persist. Since there was a significant positive effect between prior exposure and confidence, more work should be done to explore the impacts of prior exposure, confidence, and intent to persist in CS for Black girls in K-12 education.

Limitations

Several important limitations need to be considered. First, the data cannot be generalized due to the small sample size of the camps. Gathering more quantitative and qualitative data points is ideal for understanding Black girls' experiences in CS. Secondly, some of the qualitative interviews were conducted one to two years after the camp took place. Interviewing attendees directly after their experience at virtual learning experience may provide richer anecdotes about their experiences. Third, although this virtual camp reached students all over the U.S. and Canada, most of the students interviewed were from NC and one from CA. It would be ideal to interview students from different geographical areas to compare their experiences. This can be addressed in future work.

Recommendations for Practice

These findings suggest several courses of action for future virtual CS camps for Black girls. First, virtual CS camps that aim to reach Black girls should have staff and speakers that reflect them. It is clear from the data presented that having an intersectional representation of staff, speakers, and peers positively impacted the students at the camp, allowing them to break down previous stigmas about Black women and girls in CS and feel welcome in the environment. The data presented in this research shows that it is not enough to host a camp specifically for girls or specifically for Black students without recognizing the importance of girls who sit at the intersection of these two identities. I suggest reaching

out to Black women in the CS workforce to serve as camp staff and guest speakers, as they are more than willing to share their stories and inspire young Black girls.

Secondly, virtual camps targeting Black girls should be intentional about defining what computer science is and is not. Given the broad definition of CS, Black girls need to be able to identify when a learning experience, whether informal or in middle and high school, constitutes rigorous CS instruction. Relatedly, mapping out college majors and career paths available in CS is essential so that Black girls will understand what options are available to them. My interviews showed that Black girls are unaware of how a college major and their overall career interests align.

Lastly, much should be done in K-12 schools to ensure that classrooms are not saturated of violence for Black girls. If a Black girl decides to take CS classes within her school, she should not be met with racism from her teachers or an inadequate curriculum. She should be able to take advantage of a rigorous CS education that will prepare her for a CS degree program. Informal CS learning programs can only collaborate if we want to change the landscape of the CS workforce and degree programs.

Suggestions for Future Research

Future research should use Intersectional Computing to understand the experiences of Black girls in CS. There is not enough data in CS that disassociates Black girls from their white and male peers. To continue to group Black girls by their gender or racial identities will continue to ignore their distinct experiences. If we want to ensure that CS is inclusive and equitable, intersectional research is vital.

Future research should also consider a longitudinal study to determine how virtual informal learning programs impact Black girls over time. INTech hosts a 9-week virtual program for high school girls, including many participants from the virtual summer camps. Research focusing on what impacts these students to keep signing up for virtual instruction could be instrumental in developing these programs to scale even further. For example,

Thomas et al. (2017) conducted a longitudinal between-subjects research project and a free enrichment program for Black middle school girls called Supporting Computational Algorithmic Thinking (SCAT). Even though SCAT is an in-person program, the longitudinal study shows promise in designing a CS program for Black girls, who start the program as consumers of technology, become producers of technology, and later facilitators as they teach other students game design. A similar study should be conducted to measure the impacts of a virtual program.

Additionally, future research should interview parents of the INTech students to understand what persuaded them to register their daughters for the camp and other informal CS learning experiences. Parents play an essential role in shaping their children's interests and career aspirations. Researchers may want to understand the extent of parental involvement in encouraging their children to attend the summer camp and the impact of this involvement on their children's attitudes toward computer science. Relatedly, parents can provide additional insight into the summer camp's impact on their students' interest in computer science, their motivation to pursue a career in the field, and their overall perception of the subject. By interviewing parents, researchers can gain insights into the effectiveness of the summer camp. They can identify the strengths and weaknesses of the camp, the areas that need improvement, and the aspects that worked well. Parents can provide valuable feedback on the curriculum and teaching methods used in the summer camp. Researchers can use this feedback to improve the curriculum and teaching methods and make the summer camp more effective. Researchers may want to explore the impact of demographic factors such as gender, ethnicity, and socioeconomic status on the students' interest in computer science and their motivation to pursue a career. Parents can provide valuable insights into how these factors may have influenced their children's experiences at the summer camp.

It would benefit the CS Education community to understand what motivates Black women to sign up to teach in such programs and how intersectional representation affects CS learning for Black girls. Advancing this understanding can inform the design of recruit-

ment and training experiences for Black women who lead informal CS learning experiences for Black girls. Drawing on the work of Rankin and Thomas (2020), we (Braswell et al., 2023) interviewed the Black women who served as staff members and guest speakers at the virtual INTech Summer camp to understand the role that intersectional representation played in their persistence in computing. The Black women in our study report seeking to fill a gap in mentorship that they experienced themselves, to share their knowledge and experiences to support the development of others who can relate to that intersection of identifying as Black and a woman. They provide positive representation to encourage young Black girls to pursue tech in their career paths.

While INTech is the setting for this study, several informal CS learning programs with Black and LatinX leaders create spaces for Black girls to gain confidence and rigorous CS skills to prepare them for the future. More federal research funding should support research-practice partnerships to examine these programs' impact on Black girls in CS. From my experience as someone who created an organization and then decided to research our impact, my peers in this space need to be made aware of federal research opportunities. The founders of these programs are deep in their communities and can provide their expertise on solving problems within CS education. They can also provide rich anecdotal evidence of the success of these programs on their students.

Conclusion

This study aimed to understand the impact a virtual CS summer camp has on Black Girls' intent to persist in CS. Through the theoretical frameworks Intersectional Computing (Thomas et al., 2018) and SCCT by Lent (Lent et al., 1994), computing confidence, social supports, and computing outcome expectations were explored. Key findings of the study indicated that 1) The virtual INTech Summer Camp increased the CS confidence and computing outcome expectations of Black middle school girls; 2) Most Black middle school girls enjoyed learning how to code virtually using Zoom and the BSD Education

platform; 3) Black middle school girls prefer their experiences learning CS at INTech over their classroom experiences; 4) Black middle school girls are inspired by Black women in CS and enjoy having them as teachers; and 5) SCCT is a promising model for predicting Black girls' intent to persist in CS.

This research was essential to address because Black girls are not receiving early access to CS education at the rate of their counterparts. For this to change, more research must be conducted to understand how virtual learning can scale CS opportunities for Black girls. Research that centers Black girls may serve as an insightful guide to changing the diversity problems in CS.

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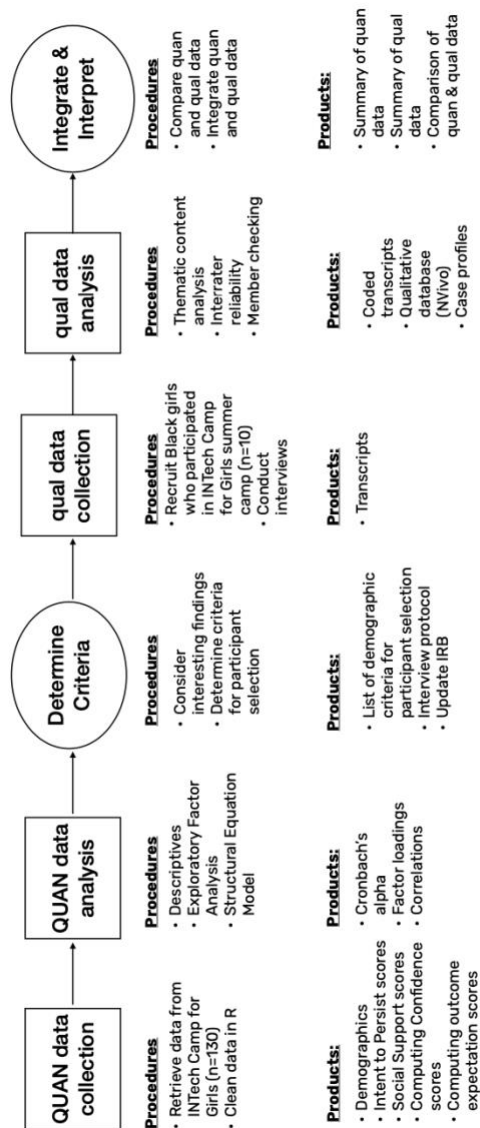
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APPENDIX A

MIXED METHODS DIAGRAM



APPENDIX B

NCWIT Survey

Computing Confidence	Social Supports
<p>Right now, how confident are you in your ability to: <i>Response options: Don't know/Never tried, Very confident, Confident, A little confident, Not at all confident</i></p> <ol style="list-style-type: none"> 1. Program computers 2. Use new software programs 3. Design new software 4. Solve computing problems 5. Imagine new computing inventions 	<p>Please mark your level of agreement or disagreement with the following sentences: <i>Response options: Strongly agree, Agree, Disagree, Strongly disagree</i></p> <ol style="list-style-type: none"> 6. Important people in my life think it's good for me to learn computing 7. People like me can do well in learning computing 8. Other students think it's cool that I learn computing 9. People like me can do well in computing jobs 10. People like me can create new computing inventions
Intent to Persist	Computing Outcome Expectations
<p>How much would you like to ... <i>Response options: A lot, Pretty much, A little, Not at all</i></p> <ol style="list-style-type: none"> 11. Take future classes to learn how to make apps 12. Take future classes to learn how to create new computing systems 13. Get a college degree 14. Get a computing-related college degree 15. Get a computing-related job when you get older 	<p>If I were to get a college degree in computing, I would probably ... <i>Response options: Strongly agree, Agree, Disagree, Strongly disagree</i></p> <ol style="list-style-type: none"> 16. Make good money 17. Get respect from other people 18. Do work that I would enjoy 19. Get a job that my family would be proud of 20. Do work that can 'make a difference' in people's lives 21. Find a job easily

APPENDIX C

INTERVIEW PROTOCOL

<i>Construct</i>	<i>Questions</i>
Prior Experience	<ol style="list-style-type: none"> 1. When did you start using computers? 2. Where did you use your first computer? 3. Tell me about any Computer Science/technology camps you've attended, what aspects did you enjoy? 4. Which aspects did you not enjoy? 5. How many Computer Science/technology camps have you participated in? 6. Of the CS/tech camps that you've participated in, how many of them were virtual? 7. What were some of the things that you liked about the virtual tech camp environment? 8. What were some of the things that you did not like about the virtual tech camp environment? 9. In your opinion, do you think it is important for everyone to study technology at school? <i>If yes:</i> why do you think technology is important? <i>If no:</i> why? 10. Have you had any tech/programming courses at school? 11. Have you tried to learn to program on your own?
Social Supports	<ol style="list-style-type: none"> 12. What does mentorship mean to you? 13. Have you gotten any encouragement to study tech/programming? <i>If yes:</i> Who encouraged you? How did they encourage you? 14. Is there someone who inspired you to pursue tech/programming? <i>If yes:</i> Please describe your experience with them? 15. What was it like to hear from speakers who look like you? 16. What did you take away from the speakers while at INTech Camp?
Expectations/Intent to Persist	<ol style="list-style-type: none"> 17. What do you believe are the potential outcomes of pursuing computer science? 18. What do you expect to major in when you graduate from high school? 19. What do you know about possible careers with a CS degree? 20. Do you think that careers with a CS degree are attractive to girls and women? <i>If yes:</i> why? <i>If not:</i> why not? 21. Do you think that careers with a CS degree are attractive to Black girls and Black women? <i>If yes:</i> why? <i>If not:</i> why not?
Self-efficacy	<ol style="list-style-type: none"> 22. How confident are you in your ability to study CS/tech? 23. Could you tell me about your skills with programming or any related disciplines? 24. How do you think that these skills and ability in programming or similar such as problem solving can influence a student's choice to study CS?
Additional Questions	<ol style="list-style-type: none"> 25. Is there anything else that you would like to add? 26. <i>Interviewer summary of participant claims for verification: What I have heard you saying in many of these responses is that _____ . Is that an appropriate summary?</i>

APPENDIX D

PARENT CONSENT FORM

RESEARCH CONSENT SUMMARY

You are being asked for your consent to take part in a research study. This document provides a concise summary of this research. It describes the key information that we believe most people need to decide whether to take part in this research. Later sections of this document will provide all relevant details.

What should I know about this research?

- Someone will explain this research to you.
- Taking part in this research is voluntary. Whether you take part is up to you.
- If you don't take part, it won't be held against you.
- You can take part now and later drop out, and it won't be held against you
- If you don't understand, ask questions.
- Ask all the questions you want before you decide.

How long will I be in this research?

We expect that your taking part in this research will last 60-120 minutes

Why is this research being done?

The purpose of this research is to examine the relationship between persistence in computer science courses and confidence in computing among Black and Latina middle school girls. We also would like to explore the differences in a virtual summer camp and an in-person summer camp.

What happens to me if I agree to take part in this research?

If you agree to be in this study, we will ask you to answer two surveys that will ask about your experience with computer science, technology, and camp. We will also ask that you share your project(s) from camp with us.

Could being in this research hurt me?

There are no physical risks to participating in this study. There is a risk of the loss of confidentiality. This is a risk everyone experiences any time they provide information online. We're using a secure system to collect this data, but we can't completely eliminate this risk.

Will being in this research benefit me?

It is not expected that you will personally benefit from this research

What else should I know about this research?

Other information that may be important for you to consider so you can decide whether to take part in this research is that your project may be used for research papers. Your name will be removed from the project.

What if I would like to withdraw from the study?

If you wish to withdraw from the study during camp, you can contact a member of the research team and request an exit interview if you desire. The information collected during your participation will be deleted. Your child will still be able to participate in camp, despite withdrawing from the research study.

If you decide not to participate in advance of the study, you may contact the investigator and request an exit interview if you desire one. Your student will still be able to participate in the camp without their data being collected for the study.

Statement of Consent:

- All children are required to assent.
- If assent is obtained, have the person obtaining assent document assent on the consent form.

Your signature documents your permission for you or the individual named below to take part in this research.

<hr/> Signature of adult subject capable of consent, child subject's parent, or individual authorized to consent to the child subject's general medical care	<hr/> Date
<hr/> Printed name of adult subject capable of consent, child subject's parent, or individual authorized to consent to the child subject's general medical care	
<hr/> Printed name of subject	

(not required if subject personally provided consent)

- I have explained the study to the extent compatible with the subject's capability, and the subject has agreed to be in the study.

Signature of person obtaining assent

Date

Printed name of person obtaining assent

Signature of assenting subject

Date

Signature of person obtaining consent

Date

Printed name of person obtaining consent

APPENDIX E

SURVEY VARIABLES

Survey Question	Variable
Right now, how confident are you in your ability to program computers?	conf_program
Right now, how confident are you in your ability to use new software programs?	conf_use
Right now, how confident are you in your ability to design new software?	conf_design
Right now, how confident are you in your ability to solve computing problems?	conf_solve
Right now, how confident are you in your ability to imagine new computing inventions?	conf_imagine
Important people in my life think it's good for me to learn computing	social_people
People like me can do well in learning computing	social_learn
Other students think it's cool that I learn computing	social_cool
People like me can do well in computing jobs	social_dowell
People like me can create new computing inventions	social_create
How much would you like to take future classes to learn how to make apps?	intent_apps
How much would you like to take future classes to learn how to create new computing systems?	intent_compsystems
How much would you like to get a college degree?	intent_degree
How much would you like to get a computing-related college degree?	intent_computingdegree
How much would you like to get a computing-related job when you get older?	intent_computingjob
If I were to get a college degree in computing, I would probably make good money.	expect_money
If I were to get a college degree in computing, I would probably get respect from other people.	expect_respect
If I were to get a college degree in computing, I would probably do work that I enjoy.	expect_enjoywork
If I were to get a college degree in computing, I would probably get a job that my family would be proud of.	expect_proud
If I were to get a college degree in computing, I would probably do work that can 'make a difference' in people's lives	expect_makedifference
If I were to get a college degree in computing, I would probably find a job easily.	expect_findjob

APPENDIX F

CODEBOOK

Code	Description	# of times code used
Access to Tech	Participants describe what types of tech devices/internet they have available to them either at home or at school	3
Belief that Black girls can code	Participants describe whether or not they believe that Black girls have the ability to code	11
Break stigma	Participants discuss breaking the stigma that girls/women or Black girls/women aren't in CS or STEM	6
Careers in CS	Participants view on careers in CS	35
Coding	Participants discuss their experience coding	17
Coding stigma	Participants share their own stigmas around coding and share stigmas about women and girls in CS or STEM	3
Counterspaces	References to space (physical, mental, or virtual) where they could cope from experiencing microaggressions, isolation, etc.	10
CS Inspiration	Participants describe tech mentors or tech role models they have experienced	30
Definition of CS	Participants define what they think	10
Encouragement in Computing	Mention of someone who encouraged participant to pursue computing	4
Experiences with Black girls	Specific references to experiences with Black girls while at virtual camps or in their classes	6
Experiences with Black men	Specific references to experiences with Black men while at virtual camps or in their classes	2
Experiences with Black women	Specific references to experiences with Black women while at virtual camps or in their classes	21
Family support	Participant experiences with their families providing support with respect to them pursuing CS	5
In-Person Camps	Participants describe their experience at a in-person tech camp or class, including INTech Camp	48
Inclusion	Participants describe their	1
Intent to Persist	Participants future plans for college - CS or other	11
Intersectional Identity	Reference to a description of more than one identity (ex: race, class, gender, sexuality, class, nation, ability, ethnicity, age) and how these might overlap or inform one another within the context of learning or pursuing CS	11

Lack of representation	Participants discuss the lack of representation in CS and STEM	6
Mentorship in Computing	General definition of mentorship	2
Motivation to be Representation	Participants discuss their motivations to become the representation that they've received	4
Peer Community at Camp	Participants speak about the other girls in the camp	4
Prior Experience	Participants describe technology classes or camps that they attended prior to INTech Camp, as well as, INTech Camp experiences	2
Representation	Participants describe their takeaways from hearing from Black women in tech	26
Self-efficacy in CS	Participants describe their confidence in their ability to study CS	13
Social justice	Participants discuss the social impacts of their INTech Camp projects	6
Tech at Home	Participants describe their experiences using tech at home	1
Tech at School	Participants describe their experiences taking tech classes in school which can include their experiences with their teachers and peers	44
Virtual Camps	Participants describe their experience at a virtual tech camp or class, including INTech Camp	104