IN AND OUT: A CASE STUDY EXAMINING ADOLESCENT BLACK GIRLS' STEM ENGAGEMENT AND STEM IDENTITY FORMATION IN INFORMAL STEM EDUCATION PROGRAMS

by

Deneen S. Dixon-Payne

A dissertation submitted to the faculty of
the University of North Carolina at Charlotte
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in
Curriculum and Instruction

Charlotte

2022

Approved by:

_____
Dr. Greg Wiggan, Chair

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Dr. Brittany Anderson

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Dr. Marcia Watson-Vandiver

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Dr. Gloria Campbell-Whatley

ABSTRACT

DENEEN S. DIXON-PAYNE. In and Out: A Case Study Examining Adolescent Black Girls' STEM Engagement and STEM Identity in Informal Education Programs.
(Under the direction of DR. GREG WIGGAN)

The underrepresentation of Black women in science, technology, engineering, and mathematics (STEM) is a long-standing issue. According to the National Science Foundation (2019), Black women hold less than 10% of STEM degrees, while only 2% work in STEM fields. These disparities can be attributed to structural inequities related to the STEM pipeline. Therefore, to mitigate these disparities, informal STEM education programs can help increase participation in STEM and create more opportunities for Black women and girls. Thus, this collective case study addressed the following research questions: 1). How do adolescent Black girls engage in and respond to informal STEM education programs? 2). How can informal STEM education programs develop adolescent Black girls' STEM identity and increase participation in STEM? 3). What pedagogical practices effectively engage adolescent Black girls in STEM? Purposeful criterion sampling was used to recruit participants for this study. The research process included interviewing four adolescent Black girls who attended informal STEM education programs. To understand each program's process and climate, participants described their experiences through questionnaires, interviews, and written prompt responses. Furthermore, this research used Critical Race Feminism and Black Feminist Thought to analyze five prominent themes from the data. The findings suggested that Black girls who participate in informal STEM education programs (a) benefited from an affirming environment, (b) experienced engaging instructional strategies, (c) utilized support systems, (d) recognized racial representation was significant, and (e) experienced racial microaggressions. In addition, the findings support equitable STEM access for Black girls through informal education programs.

The implications of this study also suggest a need to attend to the psychological and emotional needs of Black girls in informal STEM spaces.

Keywords: STEM, Black girls, informal education programs, Black feminism, critical race feminism

ACKNOWLEDGEMENTS

"When we speak, we are afraid our words will not be heard nor welcomed, but when we are silent, we are still afraid, so it is better to speak,"

-Audre Lourde

I thank God for allowing me to experience this journey. I know that this journey would not have been possible without His grace, strength, and wisdom. I am thankful and grateful.

To the ancestors, thank you. I feel your presence and your strength.

I want to thank my husband, my best friend, and the love of my life, Thomas Payne. Bae, I couldn't imagine my life without you. You have been my Rock! You saw me at my worst and my best throughout this process. You listened to every complaint, witnessed every tear and frustration. You encouraged and comforted me on the many, many days I wanted to quit and throw in the towel. And every time, you kept encouraging me to keep on going! Bae, you're the best. I'm a movement by myself, but I'm a force when we're together. Thank you for being you.

To my dissertation committee, Dr. Brittany Anderson, Dr. Marcia Watson-Vandiver, and Dr. Gloria Campbell-Whatley, thank you for participating in this process. I would like to especially thank my dissertation chair, Dr. Greg Wiggan, for his wisdom, knowledge, encouragement, and mentorship. True mentorship is knowing when to push, encourage, and comfort. I could not have gotten through this process without your leadership, guidance, and belief in me. Thank you for the many opportunities for growth, for pushing me to get this dissertation done and believing that I could. Ubuntu.

I want to thank Dr. Chance Lewis for encouraging me to apply to this program. I don't know if I would have ever taken the chance to start over again had it not been for your nudge. Thank you for the many opportunities as I matriculated through this program.

To the Black girls who contributed to this research, Thank you for your time.

Finally, I would like to thank all of my friends who encouraged, supported, and checked on me throughout this process. Thank you to my urban education cohort folks; you know who you are. I don't know if I would have made it through this process without the phone calls, meetings, the laughs, and the encouragement-We all we got!

DEDICATION

This study is dedicated to my family. First and foremost, I must thank my parents, Donald and Maggie Dixon, for their unconditional love and support throughout my life. There has never been a doubt in my mind that I was loved, supported and that I could be whatever I put my mind to because I have always felt your encouragement and love. I thank God for giving me the BEST parents. I hope I have made you proud. Mommy, thank you for always picking up the phone to talk when I need an ear and for the many, many, many meals. Daddy, your jokes, and our funny conversations kept my spirits lifted. I want to thank my husband, Thomas Payne, for his continued support and belief in me. I want to thank my son, Kendall Dixon, for allowing me to complete this work even when it meant that there were times that mommy was busy. You continue to challenge me to be the best version of myself. Last but not least, I would like to thank my family members who are gone but not forgotten. To my Aunt Edna Harris and Aunt Sue Belmont, though you are gone from this earth, I felt your spirit rooting me on every step of the way.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

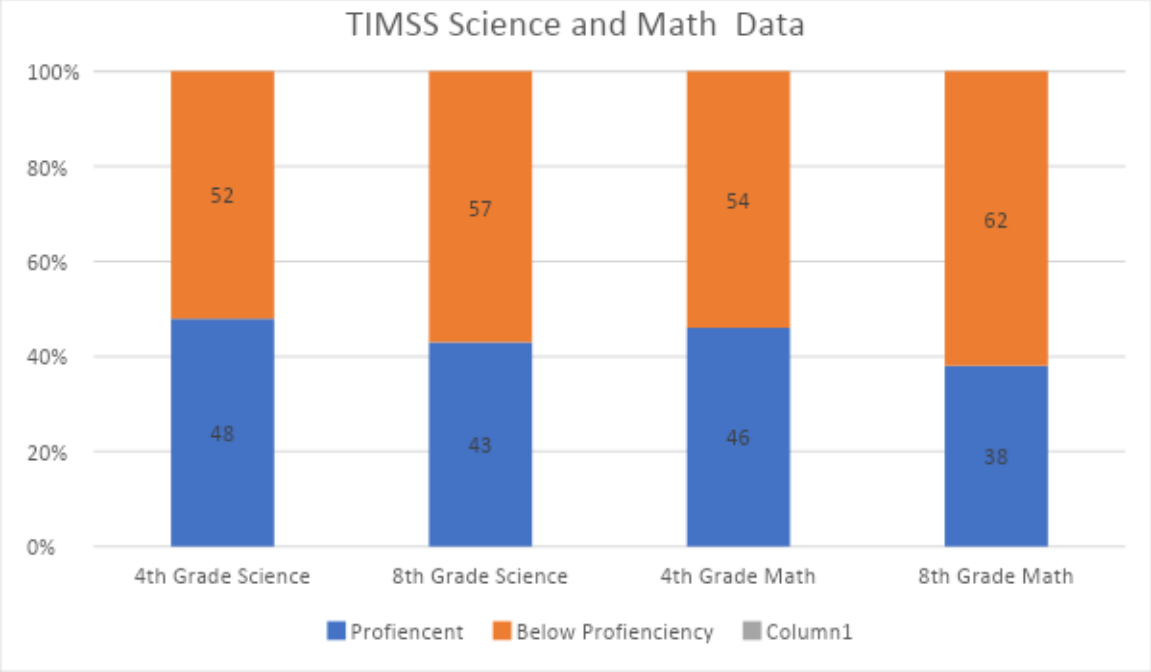
This qualitative case study was designed to examine the experiences of adolescent Black girls who persist in informal STEM education programs. This study examined pedagogical practices in informal STEM education programs that contribute to adolescent Black girls' participation and STEM identity. In this chapter, I provide a brief history of the persistent issues in education related to the underachievement of Black students and, more specifically, the need for more research with a focus on Black girls. An overview of these issues supports a particular focus on Black girls because their experiences are uniquely different from Black boys, White girls, and disadvantaged in ways often not given attention in research (Anderson & Martin, 2018; Evans-Winters & Esposito, 2010). Additionally, I explain the fundamental problem this research addresses, specifically STEM participation and STEM identity.

The underachievement of Black students has been a part of the national dialogue for decades (Boykin & Noguera, 2011; Ford, 2011; Ford et al., 2008; Ford & Moore, 2013; Ladson-Billings, 2006). Traditionally what has followed is a pursuit to fix the problem with yet another program or scripted curricula; however, the situation continues to be a concern (Boykin & Noguera, 2011). At its inception, the achievement gap assumes that the gap in achievement is between one group successfully performing and the other failing. Furthermore, some commonly perceive that minority students and, more specifically, Black students are the only groups underperforming in science, mathematics, and literacy. However, when examining international and national science/mathematics and data, we begin to grasp that the United States is doing an inadequate job educating and improving performance for all students (Allen et al., 2019; NAEP, 2019; TIMSS, 2019). Examining data from the 2019 National Assessment of Educational Progress (NAEP), also known as The Nation's Report Card and 2019 Trends in International

Mathematics and Science Study (TIMSS), we identified the underperformance of 4th and 8th-grade students in mathematics and science. TIMSS data is an international comparative study that measures mathematics and science achievement trends in the 4th and 8th grades and makes comparisons internationally (TIMSS, 2019). Likewise, NAEP is a national evaluation of education and measures reading, mathematics, and science achievement and constructs comparisons among states and urban districts in the United States (NAEP, 2019).

Table 1

Percentage Proficient and Below Proficient 4th and 8th Grade Students in Science and Mathematics

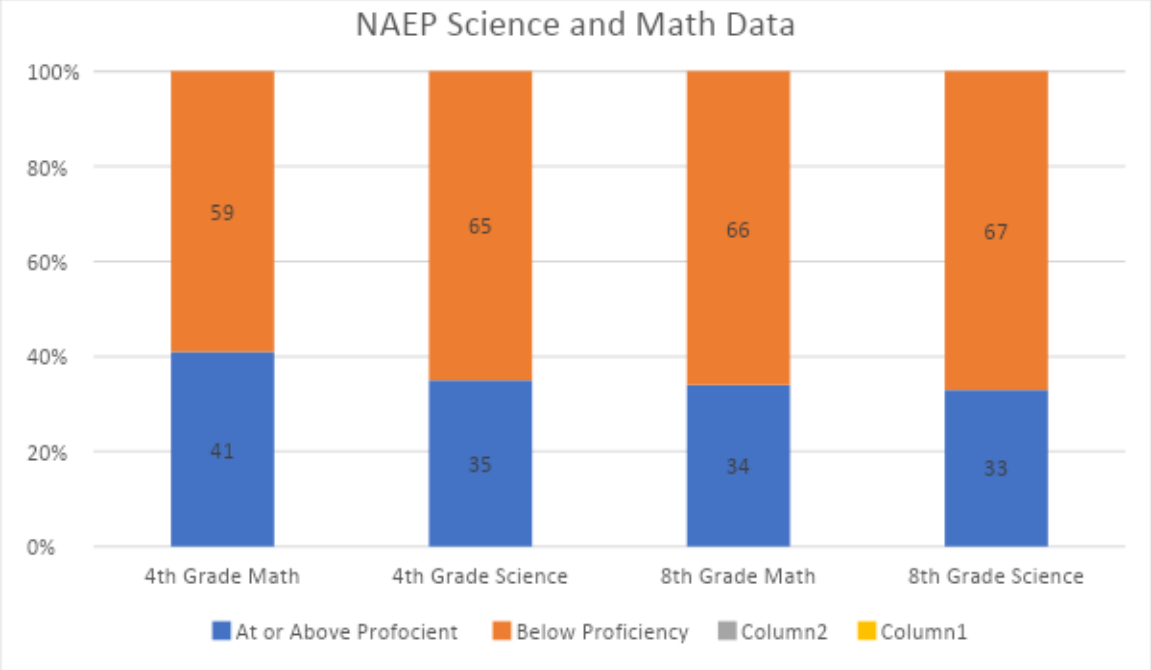


Note. Data adapted from Trends in International Mathematics and Science Study (TIMSS, 2019).

As seen in Table 1 above, 54% of 4th grade U.S. students are below proficiency in mathematics, and 52% are below proficiency in science. Subsequently, 62% of 8th-grade students are below proficiency in mathematics, and 57% are below proficiency in science.

Table 2

Percentage Proficient and Below Proficient 4th and 8th Grade Students in Science and Mathematics.

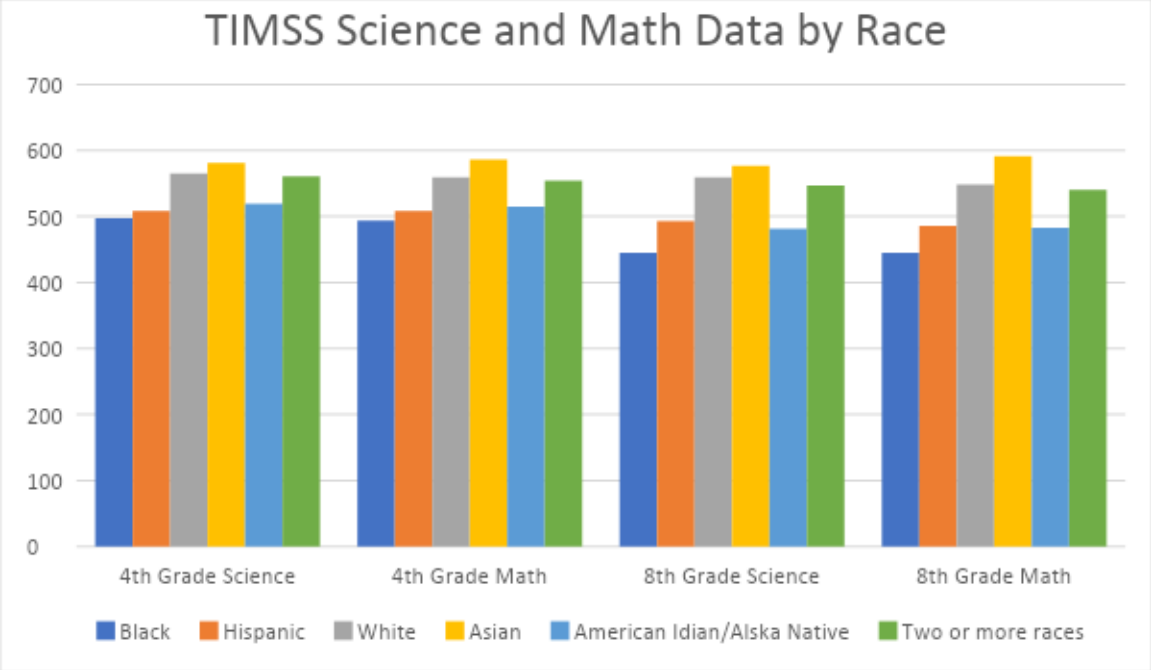


Note. Data adapted from National Assessment of Educational Progress (NAEP, 2019).

Additionally, Table 2 displays data which shows that among all 4th-grade students, only 41% are at or above proficiency in mathematics, and 35% are at or above proficiency in science. Moreover, among 8th-grade students, only 34% are at or above proficiency in mathematics, and 33% are at or above proficiency in science. When isolating the data to focus on race, Table 3 displays Black students in the United States perform lower than any other group in 4th and 8th-grade science and mathematics.

Table 3

Percentage Proficient and Below Proficient 4th and 8th Grade Students in Science and Mathematics by Race.



Note. Data adapted from Trends in International Mathematics and Science Study (TIMSS, 2019).

Thus, although Black students are experiencing more challenges in these subject areas, their underperformance is not unique. This data provides evidence that U.S. performance in science and mathematics is deficient among all students.

Much of the research about Black students uses a deficit framework (Ford et al., 2018). Conversely, there is a gap in the research that focuses on learning through an anti-deficit model. In other words, as researchers, we need to learn more about how Black students are achieving success in schools. Thus, even as some efforts have focused on the achievement of Black students, or a lack thereof, the central focus is typically Black males (Ford et al., 2018). There is no denying that the Black male experience is filled with oppression, missed opportunities, and

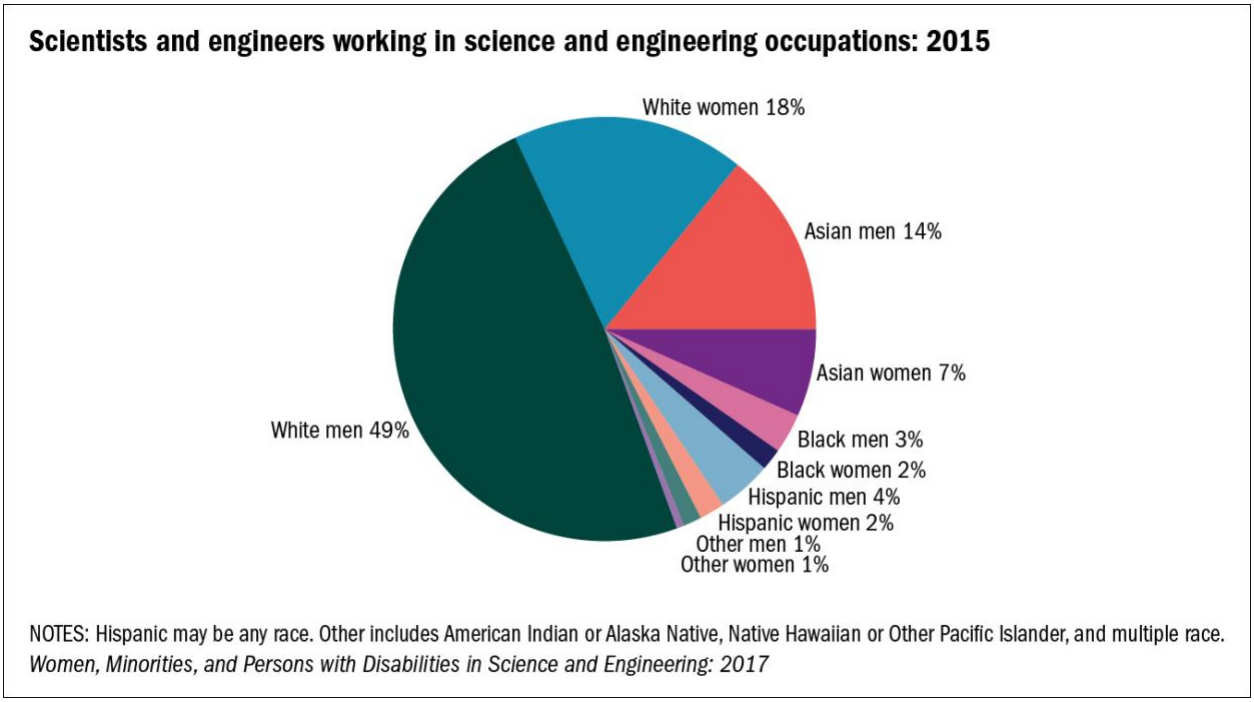
significant needs. However, the work regarding Black achievement should not be an either/-or solution; it must take a both/and approach to provide equal opportunities for success. "In race-based work, the experiences of Black females are equally important" (Ford et al., 2018, p. 255). Therefore, catastrophic experiences of Black boys should not overshadow those of Black girls. Essentially, the absence of responsiveness to the unique needs of Black girls has caused their needs to be treated as invisible and left them vulnerable. The intersection of race, class, and gender can make it harder for Black girls to navigate through the educational system and causes inequitable experiences. (Davis, 2019; Edwards et al., 2016; Evans-Winters & Esposito, 2010; Joseph, 2020; Morris, 2013; Ricks, 2014). Black girls often combat many difficulties that negatively shape their school experience (Davis, 2019). Research shows that Black girls more frequently attend schools that don't have adequate resources and are underserved (Davis, 2019; George, 2015; Ricks, 2014). These circumstances correspond with them being taught by teachers who are inadequately trained and who may have deficit notions of their capabilities (Evans-Winters, 2007; Francis, 2012).

Moreover, Black girls obtain a disproportionate number of behavioral referrals (Chavous et al., 2008). According to the National Data on School Discipline, "while boys receive more than two out of three suspensions, Black girls are suspended at higher rates (12 percent) than girls of any other race or ethnicity and non-Black boys" (U.S. Department of Education, Office for Civil Rights, 2014). Moreover, these experiences make school an unwelcoming place and deprive Black girls of the space to develop their gifts and talents. As a result, Black girls are often the least prepared for college and career success in several disciplines such as STEM (Science, Technology, Engineering, and Mathematics) (Charleston, et al., 2014; Morris, 2013).

At present, there have been numerous initiatives to increase the field of STEM with an express need to include more women, more specifically women of color (Collins, 2018). Research indicates that only 7% of Black women major in STEM-related fields (NPSAS, 2008; Sharpe & Swinton, 2012; U.S. Department of Education, 2008). Furthermore**,** Black women make up 1.6% of STEM professionals with bachelor's degrees and only 1.4% of those with doctoral degrees (Lehming et al., 2013). A further examination of the contributions of Black individuals to STEM as scientists and engineers in 2015 is found in Figure 1.

Figure 1

Scientists and Engineers Working in Science and Engineering Occupations



Note. Adapted from National Center for Science and Engineering Statistics (NCSES, 2017).

The lack of Black women in engineering and science careers is also highlighted in Figure 1. Various factors have been identified as contributing to this issue, such as the lack of role models and the institutional structures, that prevent Black girls from feeling valued (Davis, 2019). Unfortunately, the pipeline for Black girls in STEM careers is flawed due to the inequitable

school practices they face (Joseph, 2020). Therefore, it can only be assumed that schools are insufficiently preparing Black girls for educational success in their formidable and post-secondary school experience for college and career readiness in STEM. This dilemma presents another missed opportunity for Black girls.

The utilization of informal STEM education programs provides an opportunity to increase Black girls' STEM participation and develop STEM identity. Black girls must receive opportunities that develop their gifts and talents in STEM.

Problem Statement

Despite the progress that women have made in the field of science, technology, engineering, and mathematics (STEM), Black women are still underrepresented in these fields. (Jackson & Charleston, 2012; National Academy of Sciences, National Academy of Engineering, Institute of Medicine, & National Research Council, 2010). With over eight million Black girls in the US, it is important that they have the necessary skills to excel in STEM fields. (U.S. Census Bureau, Current Population Survey, 2014). The aforementioned data causes researchers to question how educators encourage, and support Black girls to successfully enter the STEM pipeline and prepare for careers in STEM professions. One primary access point to STEM careers is early proficiency in mathematics, science, and high school college preparation courses such as Advanced Placement mathematics and science courses. Despite the progress that has been made in the field of education, the percentage of students who are proficient in mathematics and science is still not increasing across racial and gender lines. (Corbett et al., 2008; National Science Foundation, National Center for Science and Engineering Statistics, 2017). The statistics in this study deeply reflect the challenges that Black girls face despite the progress that has been made. There still remain disparities in science and mathematics which has the potential to limit

their career choices. (Pringle et al., 2012). The underrepresentation of Black females in the STEM profession begins early during their mathematics and science educational process and continues into post-secondary education and later occupations. Literature indicates that though Black girls demonstrate a positive self-concept in mathematics and are interested in science and mathematics, they consistently feel unwelcomed and experience racism, sexism, isolation, alienation, and tokenism in STEM classrooms (Else-Quest et al., 2013; Evans-Winters, 2007; Lane, 2016). Even more concerning are the findings from research which indicate that Black girls are counseled out of STEM fields altogether (Smith-Evans et al., 2014). This literature speaks specifically to the harmful dispositions toward Black girls that some educators demonstrate. To increase the number of Black women in STEM fields, the culture of STEM must be changed to make it more welcoming and valued. (Aud et al., 2010; George et al., 2001; Hanson, 2008; Hernandez-Gantes & Fletcher, 2013 Joseph, 2020). Innovative ideas and strategies are necessary to nurture STEM interest, STEM identity, and Black girls' understanding of how STEM connects to their everyday lives.

Informal STEM education indicates STEM learning that happens outside of formal or traditional schooling (Dierking et al., 2003). Examples include activities such as visiting museums, participating in afterschool programs, and reading books about science. (Dierking et al., 2003; Rennie, 2015). The National Research Council (2009) reported that due to the federal policies that encourage the use of literacy and mathematics in schools, the instructional time for science has been reduced. To make up for this lost in science instruction informal education is one approach that can help increase and engage the number of Black girls STEM which have been known to experience more academic success in these informal educational spaces (Barton, 2007; Ladson-Billings & Tate, 1995; Shujaa & Mwalimu, 1994). Therefore, due to the need to

make there STEM education accessible to Black girls by providing a non-threatening and low-stakes environment. These environments would allow Black girls to thrive in a safe space to explore their interests in STEM. The use of informal education programs has been used as a way many marginalized students receive supplemental, engaging, affirming support often not found in schools (King & Pringle, 2018; Ladson-Billings & Tate, 1995). STEM informal education has been a way that Black girls build identity and increase engagement in STEM (King & Pringle, 2018; Ladson-Billings & Tate, 1995). In addition to STEM informal education, educators must be prepared to systematically educate Black girls in a way that develops and recognizes their brilliance.

Purpose of the Study

The purpose of this dissertation is to examine the experiences of adolescent Black girls who persist in informal STEM education programs. Specifically, this dissertation examines factors that influence STEM participation and STEM identity. Focusing on adolescent Black girls in informal STEM education programs presents an opportunity to understand a population often marginalized in many STEM spaces by race and gender. This study aims to enhance the existing knowledge about the utility of informal STEM education programs and their role in STEM identity and STEM participation among adolescent Black girls in order to enrich the STEM pipeline.

Research Questions

The study explored the following research question and three sub-research questions:

R.Q.1 What are the experiences of Black girls in informal STEM spaces who persist?

The Sub-questions are:

S.Q.1 How do Black girls engage in and respond to informal STEM learning experiences?

S.Q.2 How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM?

S.Q. 3 What pedagogical practices effectively engage Black girls in STEM?

The research process included interviewing Black girls who attended informal STEM education programs. To understand each program's process and climate, participants described their experiences through questionnaires, interviews, and a written prompt response that were triangulated to connect Black girls' informal STEM education experiences to participation and STEM identity. Therefore, the research questions focused on gaining a comprehensive understanding of Black girls' experiences during informal STEM education programs. This study aimed to investigate the experiences of Black girls who participated in informal STEM education programs who persist using research questions and data to capture the overall focus of this study.

Operational Definitions

The following definition are significant to this study and require an in-depth understanding: Black, Informal education, Intersectionality, STEM, STEM efficacy, STEM fields, and STEM identity.

Black

Black is a signifier for people or persons who self-identify as Black or African American and are descendants of Africans (a part of the African Diaspora). This word to refer to people with origins in any of the Black racial groups of Africa or persons with ethnic origins in the Black racial groups of the Caribbean, Central America, South America, and other world regions.

Science, Technology, Engineering, and Mathematics (STEM)

In this research, STEM is an acronym for Science, Technology, Engineering, and Mathematics that describes units of study and academic disciplines. STEM enhances subject-specific learning and foster thinking, reasoning, and collaborative skills (Dori et al., 2018). When taught in school or informal spaces, STEM education can use an interdisciplinary, hands-on approach to real-world applications.

Additionally, STEM can also be taught in informal spaces by the various disciplines in science, technology, engineering, and mathematics. These disciplines include: mathematics, statistics, computer/information science, computer programming, electrical, chemical, mechanical, civil, or other engineering, engineering technology, electronics, natural resources, forestry, biological science (including zoology), biophysics, geography, interdisciplinary studies including biopsychology, environmental studies, physical sciences including chemistry, and physics (Anderson et al.,2006).

Informal Education

Informal education refers to education outside of formal or traditional schooling (Dierking et al., 2003). Informal education is the process of learning that takes place outside of the regular school day. Informal education is often used interchangeably with informal learning; this field mainly involves programs that offer enrichment activities such as out-of-school time (OST) activity (after school or mentoring programs, summer camps, internships, science expositions, etc.)

Intersectionality

Kimberlé Crenshaw coined the term intersectionality, which describes the multidimensional interconnected lens of social identities that overlap with racist and oppressive encounters (Delgado & Stefancic, 2017). For Black women and girls, constructs such as race, gender, class, and other social categories overlap and contribute to systemic oppression and discrimination (Crenshaw, 2019).

STEM Efficacy

In this study, STEM efficacy is defined as an individual's belief in their natural ability to achieve goals in STEM. (Bandura, 2016).

STEM Identity

In this study, STEM identity is defined as a strong association with STEM exhibited by competence, efficacy, and confidence in STEM content and procedures; and confirmed by an individuals' STEM performances and recognition of those performances from STEM professionals, in addition to the perception of resources and support in forming a STEM identity (Carlone & Johnson, 2007).

Significance of Study

There are several reasons why this study is significant. First, there is a substantial gender gap in STEM-related fields. Moreover, when race and gender are presented, gaps in STEM-related fields are even more exaggerated. The scarcity of Black women who persist in STEM is critically low. Black women hold 10% of STEM degrees, while only 2% work in the STEM field (National Science Foundation [NSF], 2019). The low percentage of Black women in STEM disciplines deserves special attention. Black women represent about 6.4% of the total population; however, they hold 2.4% of all science and engineering jobs. Black women obtain STEM jobs at a much lower rate compared to their overall participation in the job market (Charleston et al., 2014). Furthermore, according to research, Black women leave STEM at a higher rate than any other underrepresented group (Fouad & Santana, 2016). Therefore, Black women and girls should be a priority to close the gender-racial gap in STEM-related fields. According to Klobuchar (2014), over the next decade, the economy will need approximately one million more STEM professionals than the United States will be able to produce at the current rate. It is critical that the training of Black women be a priority to keep up with this demand. As women see some gains in STEM fields, Black women are still pushed to the margins as they combat racism and sexism in all aspects of the STEM pipeline (Charleston et al., 2014).

Additionally, more research should be dedicated to factors influencing STEM participation and STEM identity among adolescent Black girls. When less than 2% of Black women pursue STEM careers (NSF, 2019), there should be an expressed interest in creating engaging spaces in STEM education for Black girls who could enter the STEM pipeline and pursue STEM careers. Unfortunately, K-12 classrooms are often places where Black girls feel they do not belong nor have a STEM identity (Evans-Winters & Esposito, 2010; McGee &

Bentley, 2017). Relevant and engaging STEM education should be a priority for all children. Unfortunately, White men are the primary beneficiaries of these spaces, followed by White women, Asian men, Asian women, and Black men (NSF, 2019). Black women are among the bottom portion of those persisting in STEM. The disparities among Black women are alarming. The research and literature on adolescent Black girls who are successful in STEM disciplines are critical to shifting the narrative of Black women and girls' experiences in STEM and increasing participation in STEM.

Summary and Organization of Dissertation Chapters

The literature encompasses an overabundance of research pertaining to gender gaps in STEM and the need to increase participation among Black women and girls. However, few studies exist related to adolescent Black girls' STEM participation and STEM identity in informal STEM education programs. Participation in informal STEM education programs has been shown to help increase Black girls' achievement and support the development of a positive STEM disposition (Young et al., 2019). Thus, Black girls' access to and participation in informal STEM education programs is one way to increase their STEM participation and STEM identity (Young et al., 2019).

This chapter acknowledged the critical need for centering Black women and girls in STEM. Furthermore, this chapter posits the crucial need for increasing participation and building STEM identity among Black girls. It also identified the research problem and significance, research questions, operational definitions to the study, and organization of this dissertation.

The following chapter is a literature review of the topics associated with this study. The sole focus in Chapter Two is to provide context about the state of STEM and its connection to Black girls. Moreover, Chapter Two also highlights the contributions of Black women in STEM

throughout history. This is especially important because it situates Black women in a familiar place in STEM and not as an outlier or a new phenomenon. Finally, Chapter Two discloses the gap in research that states more research is needed in order to investigate how informal STEM spaces can be used as a resource to increase STEM participation among Black girls and STEM identity, which is significant to this study when given the low performance of Black girls in STEM education and their underrepresentation in STEM fields.

Chapter Three outlines the research method used in this specific research study. Since the research sought to gain an in-depth understanding of factors that influence STEM participation and STEM identity in informal STEM education, it was vital to examine the process and climate of informal STEM programs. Thus, a collective case study was the best approach to investigate the experiences of adolescent Black girls who have attended informal STEM programs in the attempt to unearth factors that influenced STEM participation and STEM identity within informal STEM education programs within the collective case study setting.

Chapter Four will present the significant findings and themes that emerged from the study. This study's qualitative research design dictates examining questionnaires, interviews, and written prompt responses from the participants based on themes that emerged from the study.

Lastly, Chapter Five will present a discussion on each of the themes related to the research questions and previous research. Critical race feminism and Black feminist thought guided the analysis for this chapter. Chapter Five concludes with implications, limitations and recommendations for further research.

CHAPTER TWO: REVIEW OF LITERATURE

Chapter One acknowledged the critical need for centering Black women and girls in STEM. Additionally, Chapter One justified the crucial need for increasing participation and building STEM identity among Black girls. It also identified the research problem and significance, research questions, operational definitions to the study, and organization of this dissertation. This chapter provides an investigation of the literature presenting the main concepts of this study. This chapter begins with the often unheard-of contributions of STEM by Africans and African Americans. The second part of this chapter reviews the STEM education in the United States related to the STEM workforce. The third portion of this literature reviews minorities and Black women in STEM. Lastly, this literature review highlights the formation of STEM identity and the utility of informal STEM education.

This research study aimed to investigate the experiences of Black girls within informal STEM education who persist. And more specifically, this study sought to answer the following research questions: How do Black girls engage in and respond to informal STEM learning experiences? How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM? And what pedagogical practices effectively engage Black girls in STEM? There is a gap in the research exploring informal STEM education programs as a standard for STEM access and engagement among adolescent Black girls. This study aims to enhance the existing knowledge about the utility of informal STEM education programs and their role in STEM identity and STEM participation among adolescent Black girls to enrich the STEM pipeline. According to Hernandez et al. (2013), the underrepresentation of minorities and women in STEM fields is a national concern.

There are countless opportunities for STEM success in today's society within formal and informal education, and one might assume that these opportunities are accessible and afforded to all individuals. However, the history of STEM education for marginalized communities and, more specifically, Black girls is riddled with twists and turns that often make it challenging to access STEM opportunities and cultivate a STEM identity. Building STEM identity in school spaces often lacks "intersectional and socio-cultural relevance" for Black girls (Charleston et al., 2014). In other words, though STEM resources are extensively available, these opportunities are often disconnected from Black girls cultural, and gendered lives. The narrative for Black girls is dichotomous. Black girls are presented with the notion of success; however, the opportunities include an overwhelming number of challenges that interfere and create a legacy of unequal privileges and inherited stressors (Brown, 2019; Evans-Winters, 2007; Joseph, 2020). STEM education is often not accessible to Black girls as a whole. Lack of accessibility could suggest layered oppression such as issues of racism, sexism, and generational poverty, which keep Black “girls pushed out” of learning experiences (Morris, 2013). The stereotyping of Black girls often happens before they enter the school building. (Evans-Winters, 2007; Evans-Winters & Esposito, 2010; George, 2015). These negative narratives impact their self-esteem and self-perceptions (Smith-Evans et al., 2014). Black girls are frequently confronted with culturally insensitive school norms that are often not natural to their culture. Therefore, they are forced to assimilate to White middle-class ideas of how girls should be or consequently risk discipline for resisting those standards (Parsons, 2008; Smith-Evans et al., 2014). When Black girls show up as their authentic selves, they often are confronted with dire consequences.

Moreover, Black girls' discourse of belongingness in STEM spaces often identify White middle-class students as the pinnacle of talent, which is frequently enacted by teachers,

administrators, and peers (King & Pringle, 2018). As a result, the construction of the STEM identity for Black girls is often jeopardized due to negative stereotypes, mismatched cultural norms, and harmful school experiences. Black girls often face toxic educational environments, psychological stressors, and negative messages about who they are. Negatively framing Black girls can ultimately lead their identity trajectory away from positive STEM experiences in formal school settings and eventually STEM careers (Joseph et al., 2017). Therefore, in many cases, parents, educators, and other advocates have found it is necessary to combat the negative school experiences of Black girls by inserting culturally informed informal STEM learning experiences (King & Pringle, 2018). To understand the need for informal spaces, it is essential to illustrate the progression of STEM education in schools and the nuances of race and gender in this context. It is also important to note that diversifying the STEM field has been an essential part of many platforms; however, Black women have been excluded from the narrative. This information is vital in connecting Black girlhood and the need for informal STEM spaces to increase the participation of Black women in the STEM profession.

Hidden Contributions in STEM

It is important to note that the contributions of Black people in STEM are not new. Historically the contributions made by Black people, and Black women in particular, have remained hidden. There are innumerable examples of Black peoples' STEM endeavors throughout history. Unfortunately, these contributions have been excluded from the history of STEM. Much of what we know and learn about STEM has centered a White, Eurocentric male viewpoint (Murfin,1994). The contributions of Africans, African Americans, and women have been excluded from the history of STEM. Hypathia is an example of a missing African female figure. She is cited for her science and mathematical contributions in ancient Egypt during 350 -

415 A.D. (Lumpkin, 1988). North Africans also credit her for inventing an apparatus to distill water and measure liquid levels (Lumpkin, 1988).

Furthermore, it is noted that Egyptians invented many of the mathematical concepts and techniques such as algebra (Pappademos, 1984). African American women have made a significant impact in STEM such as Mary Elliot (1931) who was an organic and analytical chemist, Katherine Johnson (1953), a NASA mathematician (Shetterly, 2020), Patricia Cowings (1971), a NASA psychophysiologist (Cowings & Toscano,1982; Graves 1984), and more recently, Dr. Shirly Jackson, a theoretical physicist and the 18th president of Rensselaer Polytechnic Institute (RPI). Jackson is the first African American woman to receive a doctorate from the Massachusetts Institute of Technology. She was awarded the National Medal of Science (2016), the highest honor to individuals who made contributions to scientific fields (Schaffer, 2017). These are just a few examples of the many contributions of Africans, African Americans, and women to STEM. So though Black people's contributions in STEM have not been recognized in U.S. education, their contributions are significant to the foundation of STEM.

STEM Education

According to the South Regional STEM network (SRSN),

> STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections between school, community, work, and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy. (p. 3)

Despite the immense potential of the STEM industry, the country still has a long way to go in nurturing a culture of STEM education that is both inspiring and challenging (Allen et al., 2019).

In the United States, improving and expanding STEM education and developing innovative thinkers is considered a top priority (Allen et al., 2019). However, research shows that there is a challenge to increase the STEM workforce, which indicates students are not prepared, as well as declining STEM attitudes and performance (OECD, 2016). Overall, the United States has unique inconsistencies in cultivating a skilled and motivated workforce in the STEM industry. For example, research has found that the most challenging jobs to fill are in science, technology, and mathematics, and according to a recent analysis, these positions can take more than twice the time to fill as jobs in other fields (Rothwell, 2014). Furthermore, in STEM fields, there is a significant underrepresentation of minority groups. For instance, Black people and women are less likely to be hired in these fields than Whites (Hynes et al., 2012).

Minorities in STEM

The national STEM platform posits the importance of increasing STEM education in the United States However, the progress is slow, and large disproportionalities continue to persist among marginalized groups (National Science Foundation, 2017). Though the STEM pipeline is increasing, it does not accurately mirror the nation's diverse demographics, especially when comparing genders and races (Casto & Williams, 2020). Many barriers to STEM education for minoritized students (e.g., African American, Latinx, Native American, and female students) have been identified in the literature, which includes a lack of physical access to quality STEM programs (Archer et al., 2015; Casto & Williams, 2020; Grossman & Porche, 2013). A review of the literature indicates that adequate preparation for college-level work in STEM subjects is critical to students' success in this field (Charleston et al., 2014). The courses taken in secondary school before high school graduation also play a significant role in students' success in this field (Charleston et al., 2014). Adelman (2006) notes the academic intensity of a high school's

curriculum is a stronger predictor of a student's chances of earning a bachelor's degree than other factors. One contributing factor to the under-preparedness of minority and ethnic students within the STEM pipeline is the difference in funding each school receives (Adelman, 2006). This issue is especially prevalent in high-poverty schools.

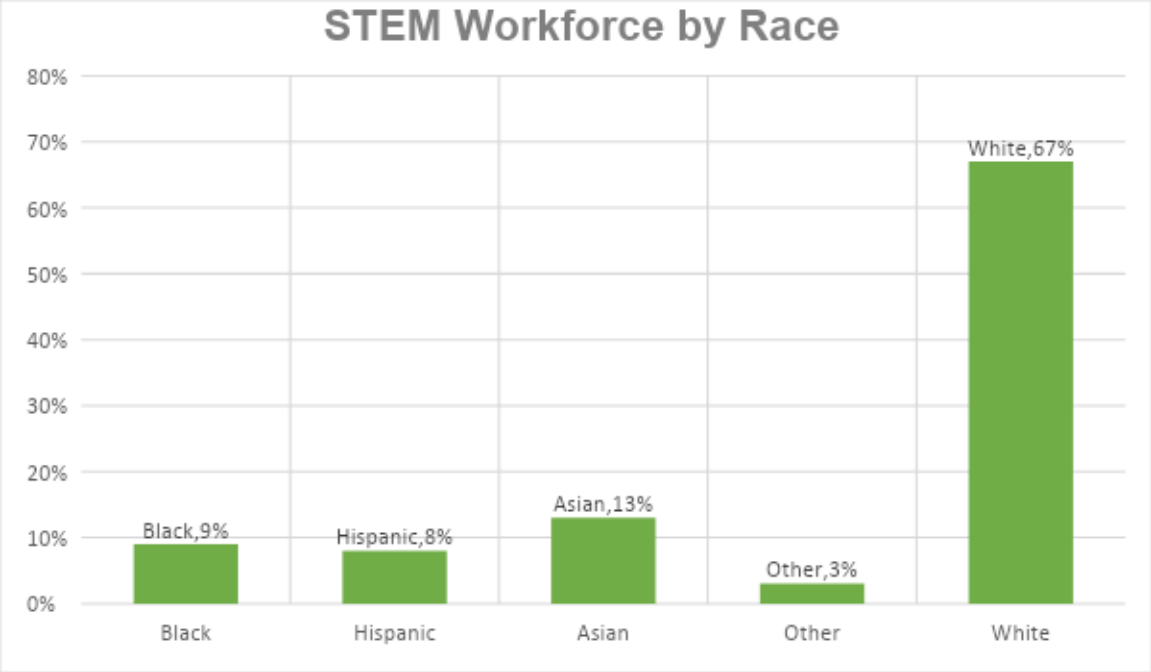
In many cases schools that are in wealthy neighborhoods receive more funding than those in low-income neighborhoods (Museus et al., 2011). The tracking system promotes ethnic and racial inequality in STEM because it places high-achieving students in more complex academic tracks. According to the latest data, Blacks and Latino/as are more likely to be in low-ability or remedial programs than their White peers. Surprisingly this tracking system occurs regardless of the higher scores received (Museus et al., 2011). Despite the overrepresentation of minority students in remedial courses, they are underrepresented in the number of Advanced Placement courses offered by high schools (Museus et al., 2011). For instance, Adelman (2006) found that Lantino/a students are less likely to take A.P. courses in mathematics and science than their White counterparts. Furthermore, Ladson-Billings (1997) clarified that educational institutions that serve a majority of Black students are inclined to possess "less demanding mathematics programs and offer fewer opportunities for college preparation and to take such gatekeeper courses as algebra and calculus that lead to increased opportunities at the college level and beyond" (p. 701).

The underrepresentation of qualified ethnic and racial minorities in the teaching profession is a contributing factor to the gap of academic preparedness is STEM. Research indicates that marginalized students are more likely than White students to be taught by inexperienced teachers (Darling-Hammond, 2000; Ladson Billings, 1997). Boyce (2017) noted that minorities are under-utilized in terms of resources in STEM. He also pointed out that STEM

program evaluation needs to be focused on issues of diversity and culture. A study piloted by Olszewski-Kubilius et al. (2017) indicates that the probability of obtaining a degree in science, technology, engineering, and mathematics (STEM) is not solely determined by one's abilities or achievements but rather their race and STEM identity.

Table 4

Percentage of the STEM Workforce by Race.



Note. Data adapted from Pew Research Center (2019)

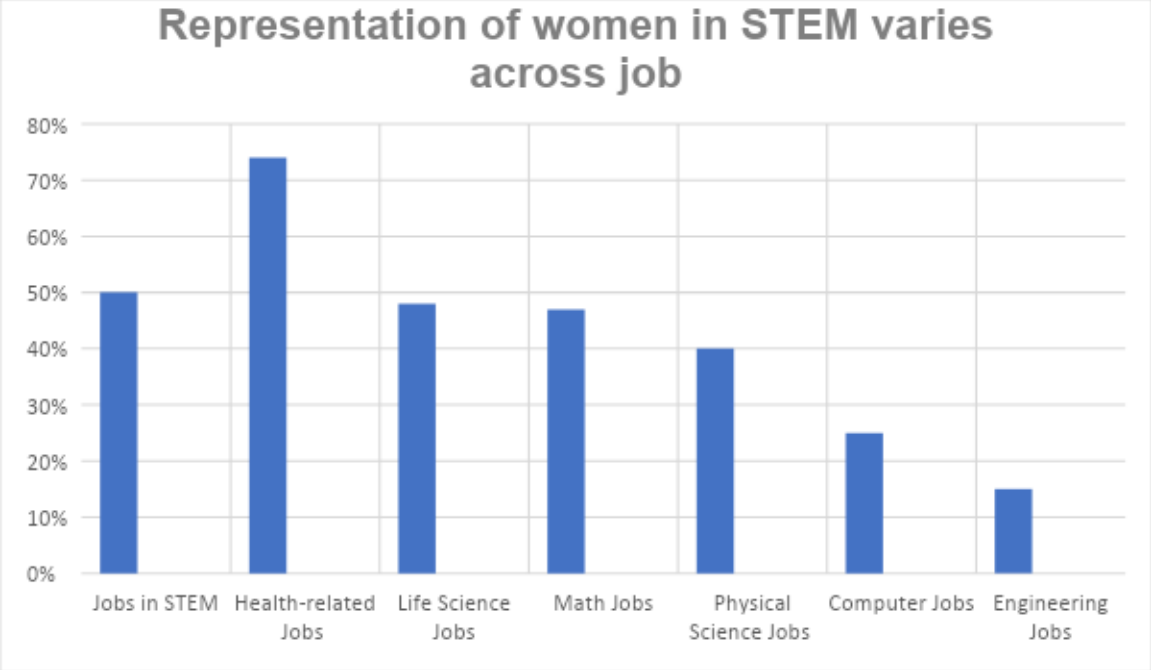
Women in STEM

Despite the steady increase in the percentage of women obtaining bachelor's degrees in the United States, they are still underrepresented in those earning bachelor's degrees in some STEM disciplines, which subsequently is the cause of the exacerbated gender gap in some fields of science, technology, and engineering (Casade et al., 2018; Legewie & DiPrete, 2012). According to the Pew Research Foundation (2011), women have made gains in particular fields

in STEM, such as health-related, life science, and mathematics jobs. However, significant disparities remain in engineering and computer jobs (Pew Research).

Table 5

Percentage of Various Jobs in STEM Held by Women.



Note. Data adapted from Pew Research Center (2019)

These disparities could be due to gender stereotypes shaping educational practices before high school (Chapman et al., 2019). Therefore, it is imperative when thinking about post-secondary education; consideration must be given to how schools prepare females to make career decisions during high school, as this is a critical time for career choices in the STEM industry. According to research, females leave the STEM pipeline faster than males, so interventions must begin before high school (Chapman et al., 2019). These critical decisions are persuaded in part by peers and teachers, proximity to STEM fields, and their school STEM experiences (Chapman et al., 2019). Research conducted by Ripley et al. (2005) observed the differences between men's and women's brains found no difference, similar to the research expressed by Byars-Winston

(2013) that STEM interest is neither bounded by gender nor color. A study conducted by Chezky and Goldstein (2016) queried high school girls about increasing STEM education and boosting the STEM workforce found that students' responses encouraged STEM programs that introduce girls to various careers in the STEM field and partner with universities. Some STEM fields do not show gender disparities (National Science Foundation (NSF, 2019). The differences in gender representation could be attributed to the women's perceived acceptance and safety in these environments (Casad et al., 2018).

Furthermore, with the number of women students in the post-secondary STEM field, there remain disparities in female professors (Rosenthal et al., 2013). While women have been noted to perform better in their STEM courses than their male counterparts, they leave at higher rates (Beasley & Fischer, 2012). Consequently, it is possible that the males and professors in STEM fields could have damaging outcomes on women's self-confidence and trajectory in the STEM profession. A study conducted by Carlone & Johnson (2007) suggested that cultures characterized by White masculine values and behavior push some women out of the STEM field. In addition, women reported that sexist treatment from male faculty and colleagues impacted their retention (Beasley & Fischer, 2012). Finally, Felder et al. (2002) concluded that an absence of female role models and mentors impacts women negatively. These negative experiences in secondary education may explain the underrepresentation of women in STEM. Women who do not feel a sense of protection or community have difficulty committing and persisting in the STEM field.

Black Women and Girls in STEM

Momentum for diversifying the STEM field and affording opportunities for women and girls has been of national importance for some time (McGee & Bentley, 2017). However, despite

this momentum, there has been a noticeable void of Black women and girls in STEM (Collins et al., 2019; Ford et al., 2018). According to the National Science Foundation (2015), only 2% of scientists and engineers are Black women. Their underrepresentation has led to a growing body of research examining their absence and ways to address this disparity. Research has revealed that the underrepresentation of Black girls in STEM starts early in the educational pipeline and continues to grow through college and career (McGee & Bentley, 2017). The low participation of Black women in college STEM courses is partially due to the lack of STEM course offerings in low-income secondary schools they disproportionately attend (Ong et al., 2011).

Additionally, studies show that Black girls are often steered away from challenging STEM courses in favor of social work and sociology courses (McGee & Bentley, 2017). Navigating Black girls away from rigorous mathematics and science courses in high school often limits collegiate STEM opportunities (Joseph, n.d.; 2020; Joseph et al., 2017; McGee & Bentley, 2017). Furthermore, race, gender, and class intersectionality place Black girls in a precarious position that increases the inequities to STEM access (Collins et al., 2019; Joseph, 2020). Mentioned in literature as the "double bind," which suggest that Black women experience racism and sexism throughout the STEM pipeline (Ong et al., 2011). Black girls have a troubled history of stressors and challenges that distract from their successful entry into and exit from the STEM pipeline. Historically, Black girls have faced barriers that differ from White females due to their race and gender, which has impacted their educational and social outcomes (Collins et al., 2019; Ford et al., 2018; Joseph, 2020). Attention given to diversifying the STEM field has homogenized girls' experiences in STEM. Hence, much of what we know about girls in STEM has normalized the experiences of White girls to be representatives for all girls. This blanket representation is problematic because it renders Black girls invisible when they are lumped with

the whole Black community or White females (Collins et al., 2019; Joseph, 2020). This invisibility leaves room for deficit notions about Black girls' ways of being compared to White girls. Black girls are thus expected to conform to a normalized White standard as the exemplar because their own culturally appropriate ways have been disregarded. Therefore, White girls are privileged to experience STEM in ways that Back girls cannot access. White women have increased their participation in STEM throughout the years, while Black females continue to be disproportionately represented in achieving STEM degrees (Ford et al., 2018).

Moreover, Black women who decided to enter the STEM field encounter various forms of racial microaggressions, learn in environments where they are frequently the "other," frequently in the absence of Black faculty (Malone & Barabino, 2009; McGee & Bentley, 2017). Furthermore, Black women often face the challenge of maintaining their racial identity while attempting to cultivate a STEM identity in spaces that are primarily White and male (Jackson, 2013). Not enough importance has been placed on the nuanced experiences and pathways to STEM for Black women and girls.

STEM Identity Formation

A STEM identity is an individual's ability to see themselves as the kind of person who could justifiably participate in STEM through their interests, abilities, race, gender, and culture (Ong et al., 2017). As with all students, Black girls' identities come from what they think of themselves and partly from how their parents, teachers, and counselors view them (Joseph et al., 2017). Identity plays a role in STEM learning, success, and interest in careers. Typically, education is thought to be a "process of identity formation" (Brickhouse & Potter, 2001; Lave & Wenger, 1991). Moreover, as students decide what career path or how they may situate

themselves in the world, they begin to acquire what is needed for participation in relevant communities of practice.

Competence then is acquired through participation and the help of mediators; students can acquire the necessary skills and knowledge to excel in various STEM and academic fields. (Brickhouse & Potter, 2001; Wenger, 1998). Identity, then, is how one understands themselves in relation to their past, present, and future. STEM identity involves a transference and acceptance of interpretation. Brickhouse and Potter (2001) asserted:

> We understand identity to refer to one's understanding of herself concerning her past and potential future. Identity refers to how one participates in the world and how others interpret that participation. Identities are maintained in performances in which one makes a claim on identity and then judges the viability of that identity against the reactions of others. (p. 29)

Therefore, students have some control over identgl classroom and other educational settings correlates with career choice (Young et al., 2019). Therefore, increasing Black girls' engagement in STEM and diversifying the STEM workforce will require an expressed commitment to consistently building strong STEM identities among Black girls early on in their educational journey. Being that schools, are often institutions that pass on racist and dehumanizing policies and practices (Patton et al., 2016), it is unlikely that Black girls will find them to be the place that builds their identity for STEM. One such place is the mathematics classroom which is often constructed as an exclusionary space dominated by White male norms and values (Joseph et al., 2019). In some cases, mathematics instruction has been shown to reproduce oppressive systems, such as racism, sexism, classism, and xenophobia (Joseph et al., 2019). Sadly, such classrooms create a problematic space for Black girls to understand themselves as STEM learners and

develop healthy STEM identities. According to Dou et al. (2019), identifying with a STEM culture and career can be challenging for youth due to their perceived lack of knowledge and experience in STEM disciplines. Specifically speaking, the research asserts that a healthy STEM identity begins early in a student's trajectory and incorporates positive experiences and access to resources. Similarly, Hoffer (2016) suggested that identity can be formed through early experiences and education. Additionally, students' belief in their abilities could influence their development as STEM-oriented students (Hoffer, 2016). The theory of science identity is explored in the literature as a framework to examine the various facets of a person's STEM identity. Carlone and Johnsons (2007) presented their findings and found that competence, performance, and recognition yielded a strong science identity among women in science majors. It was noted that these three categories in science identity could be affected by race, gender, and ethnicity (Carlone & Johnson, 2007a). Herrera et al. (2012) re-interpreted Carlone and Johnson's (2007) science identity framework to reflect the complexity of the experiences of underrepresented minority students. Herrera et al. (2012) found that social identities affected a sense of self and recommended the use of intersectionality as a lens to investigate the experiences of marginalized students in STEM.

Informal Education

Despite the obstacles that face the underperformance of Black girls in STEM education and the underrepresentation of Black women in STEM fields, hope still prevails to overcome these barriers. There has been noted success from participants of informal educational programs to help combat these disparities. The development and expansion of informal educational programs have thrived in urban communities (McComb et al., 2011), making it possible for minoritized students to access STEM curriculum when they may not have in other situations.

Informal education programs are described as safe and structured programs that provide adult-supervised activities for kindergarten through high school students to promote learning and development outside of formal or traditional school parameters (Beckett et al., 2009). Since the underrepresentation of Black women in STEM fields is a long-standing issue (Adams et al., 2014), interventions such as informal educational experiences are frequently used to increase learning opportunities. Informal education experiences are often a significant part of STEM engagement for many marginalized groups of students who attend schools with inadequate science resources (Adams et al., 2014; Rahm, 2007). And while past efforts have focused on improving in-school K-12 STEM learning experiences, there is a growing awareness of the potential role of informal education programs in promoting STEM (Bell et al., 2009; National Research Council, 2009). According to the National Research Council (2009), structured informal educational opportunities are significant as they are vital in supporting STEM engagement, learning, and developing children's commitments to school STEM and career pathways (Bevan et al., 2013; Fadigan & Hammrich, 2004). In addition, informal STEM education spaces can help mitigate the gaps in STEM seen in K-12 education as well as the STEM gender gap. The Lang science program is one such program that created opportunities for youth to participate in the culture of science and learn (Adams et al., 2014). Additionally, a study by Weinberg et al. (2007) reported that participation in a STEM summer camp improved girls' attitudes toward science and engineering careers. The results indicated that well designed informal STEM programs could effectively modify social and cultural beliefs and maybe particularly promising in encouraging girls to pursue STEM areas for study and careers (Weinberg et al., 2007).

Moreover, informal education has many fundamental features that provide opportunities for success, such as flexible uses of time, socially supportive adult-child relationships, positive peer groups, and role models (Bevan et al., 2013). These developmental features of informal education create intellectually safe spaces for students to engage and build a positive identity. Creating a safe space where learning and participation are essential fosters STEM identity where girls can see themselves as active participants within STEM (Adams et al., 2014; Gray, 2013; Hidi & Renninger, 2006). STEM identity is key to helping girls make career choices consistent with how they see themselves contributing to the STEM community. As Carlone and Johnson (2007) noted, being recognized as a scientist by others creates a powerful narrative of belonging.

A study released in 2016 by the Charles Stewart Mott Foundation revealed that STEM afterschool programs are effective. They can help kids succeed in mathematics and science by building a positive attitude about STEM, increasing their STEM career knowledge, and building a positive STEM identity. It is important to note that informal educational programs are also signified as out-of-school time (OST) programs such as afterschool and summer camps (Eshach, 2007). Thus, according to the Harvard Family Research Project's findings, informal education programs are becoming more prevalent due to various reasons, such as additional learning supports, and more time in an effort to increase the achievement of lower-performing students (Rhea, 2013). There is also evidence that participating in well-designed informal STEM education programs can improve the participants' chances of pursuing a degree or career in STEM (Afterschool Alliance, 2012; Laursen et al., 2013). Informal education is often seen as an extension of formal teaching practices and has become an integral part of STEM education. (King & Pringle, 2018; Pleasants & Olson, 2019).

This literature review provided the untold significant contribution of Africans and African Americans in STEM history, the history of STEM in the United States, and its disjointed relationship with minoritized groups, especially, Black women and girls. It also established that Black women and girls are still disproportionate within the STEM careers and courses despite the efforts made in the United States to make STEM education a top priority. This review indicated that Black girls show an acute interest in STEM early in their school career; however, they are often confronted with many obstacles rooted in racism that turn them away from STEM, such as a White male-centered curriculum. This research also illustrated the need to construct STEM identity early among Black girls and in what ways informal STEM spaces show promise in increasing their STEM engagement. Chapter Three will provide an overview of the methodology used in this study.

CHAPTER THREE: RESEARCH METHOD

Chapter Two provided an examination of the literature presenting the key concepts of this study. This chapter began with the hidden STEM contributions by Africans and African Americans. The second part of the chapter reviewed STEM education in the United States. Next chapter Two reviewed literature pertaining to minorities and Black women in STEM. Lastly, chapter Two reviewed the literature about the formation of STEM identity and the utility of informal STEM education. This chapter will provide a synopsis of the research design and methods for data collection and analysis. Chapter three will also detail the use of thematic analysis, ethical considerations, the researcher's positionality, and assumptions.

The purpose of this study was to investigate the experiences of adolescent Black girls in informal STEM education programs who persist. Specifically, this study examined aspects of informal STEM education programs that influence STEM participation and STEM identity among adolescent Black girls. The study used a qualitative case study design. According to Ravitch and Carl (2020),

> Qualitative research uses interpretive research methods to understand individuals, groups, and phenomena in contextualized ways that reflect how people make meaning of and interpret their own experiences, themselves, each other, and the social world. (p. 2)

For this study, the use of a qualitative approach was essential for several reasons. A qualitative research method allowed for an in-depth investigation of the experiences of Black girls who have participated in informal STEM education programs (Creswell, 2003; Mertens, 2015). Moreover, qualitative research explores a problem or issues that need to be explored (Creswell, 2003). The disproportionate number of Black women in the STEM field, as well as the disengagement of Black girls in STEM education, is a significant issue that is worthy of exploration. Finally, this

qualitative research validated the voice of Black girls in being experts in narrating their own stories. Chapter Three is structured using the following sections: (a) research questions, (b) researcher's positionality, (c) theoretical framework, (d) research design overview, (e) participant selection, (f) data collection method, (h) data analysis and (i) ethical considerations.

Research Questions

The human experience is dynamic, and so should be our analyses in telling/writing about it. (Evans-Winters, 2019, p. 283)

The guiding research questions for this collective case study design were:

R.Q.1 What are the experiences of Black girls in informal STEM spaces who persist?

The Sub-questions are:

S.Q.1 How do Black girls engage in and respond to informal STEM learning experiences?

S.Q.2 How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM?

S.Q. 3 What pedagogical practices effectively engage Black girls in STEM?

Researcher Positionality

As an educator and researcher, I was highly conscious of my positionality and political interest throughout this study. As a result, I used numerous data sources and member checking throughout this study to ensure that the research is be presented accurately and objectively. It is also important to articulate how my personal history as an educator and a Black woman has influenced the purpose of this research and the methodology used. The researcher is a doctoral student, a former public-school educator, and a former out-of-school-time paraprofessional. As a practitioner, the researcher worked in primary school and middle school levels in an extensive

metropolitan public school system in North Carolina. During the first eleven years of the practitioner's career, the researcher taught primary grades, of which her focus was literacy skills and proficiency.

Additionally, the latter eight years of the practitioner's career were spent teaching middle school students' mathematics and science. While teaching middle school, the researcher noticed that many Black girls simultaneously had interest in mathematics and science while lacking confidence in these subjects. The researcher also noticed the students' lack of engagement through the scripted mathematics and science curriculum. The middle school offered a science club for girls, of which the practitioner was a volunteer, and the practitioner observed the increased levels of confidence and engagement the girls displayed during this time. The practitioner incorporated many of the strategies used in the science club in her middle school classroom. Through this experience, the researcher began to question current STEM pedagogical practices in elementary and middle school that disengaged Black girls. There were several reasons for conducting this research. One goal was to discover the utility of informal STEM education programs for adolescent Black girls. The second goal of this study was to identify factors that influence STEM participation and STEM identity in informal education programs. The researcher's former experience helped shape this research to understand better ways to instruct Black girls in STEM.

Theoretical Framework: Critical Race Feminism and Black feminist Thought

Critical Race Feminism

Furthering the scholarship on Black girls requires scholars to integrate existing theories that provide an appropriate lens to accurately identify, name, interpret, and write about this group's experience (Few et al., 2003). A qualitative study is suitable for research when the aim is

to explain a phenomenon relying on the voiced experiences of participants (Stake, 2010). This qualitative study used Critical race feminism (CRF) as a guide to analyze the data.

"Black women and Black girls deserve a theoretical framework that combats racial and gender oppression from multiple standpoints. Critical race feminism in education may provide legal and academic stratagem for studying and eradicating race, class, and gender oppression in educational institutions." (Evans-Winter & Esposito, 2010).

CRF is a branch of Critical Race Theory (CRT), which seeks to transform the relationship between race, racism, and power (Delgado & Stefancic, 2017). According to Delgado and Stefancic (2017), the basic tenets of CRT are:

1. The idea that racism is ordinary.
2. The idea of interest convergence.
3. The idea that race is a social construct.
4. The idea of storytelling and counter-storytelling.
5. The notion that Whites have been recipients of the privileges afforded by civil rights legislation.

Although these tenants align racially with the needs of Black women and girls, they neglect the intersectionality of Black women's existence. Additionally, feminist legal theorists highlighted the viewpoints of White and upper-class women but assumed that the gendered experiences of White women and women of color were identical. It should be noted that CRF theorists separate themselves from CRT by rebuffing essentialization of all minorities (Wing, 1997). Moreover, CRF acknowledges anti-essentialism by recognizing the multiple identities of women (DeReus et al., 2012; Wing, 1997).

Critical Race Feminism in Education

According to Evans-Winters & Esposito (2010), Critical Race Feminism in education is beneficial to investigation and theory building around educational issues impacting Black girls in the following ways:

- CRF as a theoretical lens and movement purports that women of color's experiences, thus perspectives, are different from the experiences of men of color and those of White women;
- CRF focuses on the lives of women of color who face multiple forms of discrimination due to the intersections of race, class, and gender within a system of White male patriarchy and racist oppression;
- CRF asserts the multiple identities and consciousness of women of color (i.e., anti-essentialist);
- CRF is multidisciplinary in scope and breadth; and
- CRF calls for theories and practices that simultaneously study and combat gender and racial oppression.

Evans-Winters and Esposito (2010) suggested that Black women experience education differently from males of color and young White women. "Therefore, using a CRF lens in the examination of the educational experiences of Black students allows for the avoidance of gender and racial essentialism" (Evans-Winters & Esposito, 2010, p. 21). The lived experiences of Black girls are diverse, and those experiences are often not represented in ways that recognize the totality of their humanity. CRF rejects essentialism which excludes or misrepresents the lived experiences of Black girls and thus is harmful to theorizing and advocating for them. Ultimately, CRF acknowledges and asserts the notion of multiple consciousnesses (Evans-Winters & Esposito, 2010). They stated:

> Women of color are required to hold on to their own beliefs and values while also being aware and conscious of the state of mind of the oppressor. Many young Black women are able to survive in schools also because of this multiple consciousness. For many Black girls, their identities shift between their personalized identities (shaped by their socialization in their immediate families and neighborhoods) and the perspectives of White male or female middle-class school administrators and teachers. (Evan-Winters & Esposito, 2010).

For the purpose of this study, it was necessary to use a theoretical framework that "offered multiple possibilities for the enrichment of Black girls' education and quality of life" (Evans-Winters & Esposito, 2010).

Black Feminist Thought

Black Feminist Thought (BFT) (Collins, 1986, 1989, 1990, 1997, 2009) is a social construction that posits the experiences of Black women and their significance from the viewpoint of Black women in the diaspora (Collins, 1986, 1989, 2009). BFT situates academic knowledge and everyday experiences within the context of racial, gender, and class oppression (Collins, 2000). The aforementioned oppressive forces intersect to shape the collective and individual worldviews, actions, and outcomes of Black girls (Lindsay-Dennis, 2015). At its core, BFT seeks to ground everyday acts of resistance of Black women (Collins, 2000). The fact that Black women and girls are existing and persisting in STEM is an act of resistance and solidifies their status as "outsiders within" (Collins1986). BFT focuses on the lived experiences of Black women as a principle of meaning.

Collins (1986) articulated there are three themes of Black Feminist Thought.

Theme one is self-definition and self-valuation. BFT frames the experiences of Black women as key to its core values. This framing challenges the status quo of Black womanhood defined by a White male-centered lens (Collins, 1986). BFT provides a space for Black women to share their perceptions and experience, which creates their lived realities. This research centers on the experiences of adolescent Black girls in informal STEM education programs. It shines a light on how they engage and respond in those environments to persist in STEM. Ultimately, the participants in this study position themselves in STEM and provide self-value and self-definition for the experiences they create as a means of survival.

Theme two is interlocking nature of oppression or what is termed intersectionality. Intersectionality encourages us to examine the unique identity and position of Black women. BFT honors the connected nature of Black women's experiences but understands that Black women's experiences are also distinct and unique. BFT thought urges us to examine the everyday experiences while also acknowledging the diversity of the other identities of Black women such as class, religion, and age (Collins 1986).

Theme three importance of Black women's culture. "BFT involves efforts to redefine and explain the importance of Black women's culture." Therefore, the third theme of the study explores the complex experiences of Black girls in STEM as a way of redefinition and passing on this culture. Doing so allows the researchers and participants to explore how they can contribute to the academic success of women and girls in STEM.

Some of the tenants of Black Feminist Thought also rely on dialogue, assessing knowledge claims, and the ethics of caring and personal accountability (Collins, 2000). Each of these tenants offers significance to Black girls' lived experiences and allows for an analysis of

Black girls as STEM learners. Most significantly, Black Feminist Thought positions, Black women and girls as critical experts and narrators of their histories and future in STEM education.

A Rationale for Using Critical Race Feminism and Black Feminist Thought as Theoretical Frameworks For This Study

This study aimed to amplify the lived experiences of Black adolescent girls who have participated in informal STEM education programs. Choosing a qualitative study aligned with Critical Race Feminism (CRF) and Black Feminist Thought (BFT) center the experiences and authentic voices of marginalized girls (Evans-Winters & Esposito, 2010; Wing, 1997).

Specifically, BFT is a culturally-based perspective that considers the contextual and interactive effects of "herstory" culture, race, class, gender, and other forms of oppression. BFT situates both the participants and researcher as conveyers of knowledge through their shared experiences as Black women in STEM. Furthermore, BFT centers Black girls' experiences in informal STEM education and empowers them to interpret their reality and define their experiences (Taylor, 1998). Using BFT allowed the researcher to unpack her positionality around her power and privilege as a researcher to enact change for Black girls in STEM.

Using Critical Race Feminism (CRF) as a theoretical approach, the researcher’s goal was to explore and understand the lives of women of color who face multiple forms of discrimination based on race, gender, class, and how these factors interact within a system of White male patriarchy and racist oppression (Wing, 1997). Additionally, CRF uses a multidisciplinary approach that focuses on theory and praxis. Therefore, the researcher was able to analyze the intersection of race, gender, and informal STEM education.

CRF and BFT encourage the use of personal narratives and interviews to collect data and explore the experiences of Black girls using an intersectional lens (Few et al., 2003). Therefore,

this study aimed to glean from the often unheard and provide insight into adolescent Black girls' STEM participation and STEM identity. Using both CRF and BFT theories allowed the researcher to have greater explanatory power.

Research Design: Collective Case Study

When using qualitative research, the primary focus is the motivation to understand a phenomenon and to make improvements (Stake & Munson, 2008). Yin (2003) defined the case study research method as an empirical inquiry that focuses on a modern phenomenon within its real-life context. Moreover, it investigates the boundaries between its context and the phenomenon and uses multiple sources of evidence. This collective case study explored adolescent Black girls who participated in informal STEM education programs. Yin (2009) stipulated a typology to determine the appropriateness of a case study methodology: (a) the focus of the study is to answer "how" and "why" questions; (b) the behavior of individual in the study cannot be manipulated; (c) contextual conditions are relevant to the phenomenon under study; or (d) the boundaries between the phenomenon and context are not clear. The case study used for this research satisfied the aforementioned characteristics; therefore, a case study method was most appropriate. The selection of collective cases allowed the researcher to examine different aspects of informal STEM education programs that contributed to STEM identity and participation among adolescent Black girls within multiple bounded systems (Yin, 2009).

The goal of this collective case study was to investigate the experiences of adolescent Black girls in informal STEM education programs who persist. Specifically, this study examined aspects of informal STEM education programs that influence STEM participation and STEM identity. To attain this goal, it was imperative to capture the perspectives of adolescent Black girls who attended informal STEM education programs. Specifically, collective case studies are

those in which “multiple participants are purposefully selected to illustrate an issue or phenomenon, providing different perspectives on the issue” (Creswell, 2007). This collective case study was designed using data from three primary data sources in order to collect "rich data" (Creswell, 2003, p. 147) that examined the learning experiences of Black adolescent girls at informal STEM education programs. Yin (2003) stated that a fundamental strength of case studies is the opportunity to use many different data sources. "Interviews are the richest sources of data in a case study and usually the most important type of data to be collected" (deMarrais & Lepan, 2008, p. 228). The data sources included questionnaires, interview transcripts, student reflective journal responses. According to Mertens (2015), "a case study is an investigative approach used to thoroughly describe complex phenomena, such as programs in ways to unearth new and deeper understandings of these phenomena" (p. 245). First, the researcher gave each participant a questionnaire. Next, the researcher conducted the first semi-structured interviews. Next, the researcher collected written prompt responses regarding the girls' experiences in their respective informal STEM education programs. Finally, the researcher concluded the data collection process by conducting the second semi-structured interview. This data assisted the researcher in assessing the girls' perceptions about their informal STEM education experience. The use of multiple cases allowed the researcher to examine multiple perspectives about participation, STEM identity, and pedagogical practices within multiple bounded systems (Yin, 2009). In addition, bounding this case study among multiple sites allowed the researcher to examine the girls' experiences across three different locations to examine STEM participation and STEM identity.

Table 6

Research Study Plan

Month	Brainstorming	Revamp	IRB draft	IRB Submission and approval	Recruitment	Consent and Assent forms sent and returned	Data Collection	Member Checks	Data Analysis
July	X								
August	X								
September	X		X						
October		X	X	X	X	X			
November		X			X	X	X		
December							X		
January								X	X
February									X
March									X

Phase I: Planning

The first phase of research took place from August through November 2021. This phase included brainstorming and revamping. The plan for the original study was to design a single case study of one informal STEM program as the foundation for my research. Unfortunately, due to COVID, the program could not host an in-person STEM program. The program then had to design a plan to revamp its in-person program to an online program and possibly start in January of 2022 instead of the original September 2021 start date. This caused the researcher to revamp

the research design from a single case study to a collective case study. The researcher completed and submitted an IRB and all necessary consent and assent forms. The researcher posted a flyer on social media as well as found adolescent Black girls for this study through purposeful sampling using the researcher's community network and snowball method.

Phase II: Data Collection

Phase two of the research took place from November 2021 through January 2022. During this phase, the researcher collected data from each participant in many ways. Initially, the researcher distributed a questionnaire to each participant to collect background information and gauge the participants' general feelings about STEM. Next, the researcher met with each participant at a convenient time for the participants. After completing their interview, the researcher then sent each participant an electronic reflective STEM prompt. Finally, the participants scheduled a final interview at a convenient time after they finished their reflective STEM prompts. The researcher then analyzed and coded the data and looked for emerging themes.

Phase III: Follow-Up

The third phase of research took place from January through March 2022. During this phase, the researcher analyzed the data using a combination of inductive, descriptive and in vivo coding. The researcher used Delve qualitative software to complete coding and triangulation of the data. From the coding and analysis process, the researcher noticed themes. These themes were further developed, which helped the researcher understand the participants' experiences in informal STEM programs.

Recruitment Strategy

The target population for this study consisted of Black adolescent girls who participated in informal STEM programs whose ages ranged from 12-17 years old. Purposeful sampling strategies through direct recruitment and snowball methods were used to recruit participants. When conducting qualitative research, purposeful sampling is often used to select individuals and sites for study because they can purposefully inform an understanding of the study's research problem and central phenomenon (Creswell 2007). Mertins (2015) noted that when using purposeful sampling, the researcher selects their samples with the goal of identifying information-rich cases that will allow them to study the case in depth. Moreover, purposeful sampling is a technique used to secure particular qualities or characteristics; therefore, the selection of participants is deliberate (Gay et al., 2012). A snowball method was also used to gather additional participants. Snowball sampling utilizes a referrals system to gain participants who are knowledgeable about the program or community being researched (Merins 2015). Initially, recruitment for this study consisted of the researcher posting on Instagram and Facebook to recruit participants.

Participant Selection

This study focused on Black adolescent girls who participated in informal STEM programs. Seven individuals responded positively to the information posted on Facebook; five girls were sent information but never returned the consent and assent forms. Ultimately only one participant was gained through this strategy. After the researcher solidified the participant from social media, they were asked if they knew other Black girls who attended informal STEM education programs. One participant connected the researcher with two additional Black girls who participated in informal STEM education programs. The final participant was recruited from the researcher's former colleague whose daughter had attended an informal STEM program. Four

(4) participants ranging in age from 12-16 were selected for this research. This qualitative research study utilized a small sample size. Creswell (2007) noted when thinking about the sample size, the researcher should make sure that the data collected from a sample is extensive in detail about each site or individual. In other words, the sample size should not be the focus, but the sample should allow the researcher to elucidate the particular (Creswell 2007). The researcher focused on ensuring that "rich data" was collected (Creswell, 2007). The four (4) participants contributed their STEM participation, engagement, and STEM identity.

Data Collection Procedure

Upon Institutional Review Board (IRB) approval from the University of North Carolina at Charlotte (UNCC) and, obtaining parental consent and participants' assent forms, the researcher began data collection. The researcher gathered preliminary data from participants in the form of a brief questionnaire. The questionnaire included age, grade, their general feelings about themselves as a Black girl, and about STEM. Primary data collection for this research study included in-depth personal interviews, a questionnaire, and a written prompt response. "Qualitative interviews are used when researchers want to gain in-depth knowledge from participants about particular phenomena, experiences, or sets of experiences" (deMarrais & Lepan, 2008, p. 52).

Individual Interviews

Interviews are the cornerstone of qualitative data collection as they provide deep, rich, individualized, and contextualized data that are centrally important (Ravitch & Carl, 2020; Yin, 2003). Qualitative interviewing starts with the belief that there is meaning in the perspective of others (Patton, 2002). Thus, the goal is to understand what participants think, feel and experience rather than evaluate or judge them (Ravitch & Carl, 2020). deMarris & Lepan (2008) contended

that an interview is a procedure by which both the researcher and participant partake in a conversation focused on the questions that are presented about the research study. More specifically, interviews are vital to case study evidence because many case studies are about human matters or actions (Yin, 2003). Accordingly, this case study utilized interviews as the purpose was to unearth the experiences of adolescent Black girls in informal STEM education programs. Therefore, semi-structured interviews were used to organize and guide the research. Semi-structured interviews are the most used form of interviews in qualitative research (Ravitch & Carl, 2020). A semi-structured interview asks specific questions to all participants and tailors follow-up questions depending on individual participant responses (Ravitch & Carl, 2020).

Document Analysis (Written Prompt Responses)

Document analysis is one form of qualitative research that uses documents that are interpreted by the researcher "to give voice and meaning around an assessment topic" (Bowen, 2009, p. 246). The documents used the accounts of individuals in first-person which showcases their actions, experiences, and beliefs (Bowen, 2009). In this research study, the participants completed a written prompt (electronically) which used to elicit the participants' feelings about their informal STEM education program and the teachers at their programs. Bowden (2009) contended that document analysis can point to questions that need to be asked during an interview to ensure the research is critical and comprehensive.

Open-Ended Questionnaire

For this research, participants completed an open-ended questionnaire at the beginning of the study. The questions on the questionnaire helped gather background data concerning the participants and their general feelings about STEM and being a Black girl in STEM. The questions on the questionnaire were also used to understand participants' general feelings about

themselves and STEM. For example, a question asked the participant, "do you see yoursekf as a STEM person?" Responses from the questionnaire allowed the participants to think deeply about their experiences and general encounters with STEM before being asked impromptu questions during the interview.

Data Collection Phase

Data collection was conducted from November to December 2021. This gave the girls time to select suitable interview times that worked around their school calendar. Several girls were burned out due to end-of-semester examinations and the end-of-quarter projects. The researcher was sensitive to the participants' circumstances and needs. The participants were given a questionnaire before the interview, which allowed them an opportunity to provide background information as well as general information about themselves and STEM. Next, each participant signed up for a convenient time to interview virtually. The first interviews were semi-structured. Each participant was interviewed using an interview protocol. Each initial interview lasted about 30 to 45 minutes. After the interviews, the participants were sent a written prompt to reflect on their STEM informal program experience more deeply. The researcher believed this information was helpful and gave the participants time to think at their own pace. This written prompt response was useful when the researcher needed to follow up with clarifying questions during the final interview. After the written prompts were received, participants were asked to select another convenient time for a second interview. The second interview took place about two to three weeks after the initial interview; this time frame depended on the participants' availability and when they returned their written prompts. The second interview was also semi-structured and used to clarify any questions from the initial interview and written prompts as well as to specifically discuss with the participants' perceptions about being a Black girl in

STEM. The second interview lasted about 20-30 minutes. All interviews were recorded to provide transcription precision, and notes were taken throughout the interview to gauge the use of probing questions. It is important to note that because of the COVID-19 pandemic, many parents were concerned about contact. Therefore, the researcher felt it best not to conduct face-to-face interviews as initially planned and all research was conducted virtually.

Table 7

Data Collection Table

Data Collection			
Data Source			
Questionnaire	*Interview*		*Reflective Prompt*
Participants received the initial questionnaire before scheduling their first interview.	*Interview #1 Participants scheduled interview #1 after the initial questionnaire was received.*	*Interview #2 Participants scheduled interview # 2 after their journal prompt was received.*	*Participants received the reflective prompt at the completion of interview #1*
Collection site			
Google Form	*Zoom (Virtual Platform)*		*Google Form*
	Frequency		
Once	*Two Interviews were conducted*		*Once*
Purpose of the data			
To collect background information about each participant and general feelings about STEM.	*Interview #1* *To collect data concerning participants' experiences in STEM informal programs, relationships, ability, engagement.*	*Interview #2* *To collect data concerning participants' perspectives on being a Black girl in a STEM Informal program.*	*Participants were given a prompt to think more deeply about their experiences in their STEM informal programs; this allowed them to write about their experiences in STEM informal programs instead of being asked random questions.*
Confidentiality and Storage			
Pseudonyms were used for each participant, and the data was stored in a private google folder.			

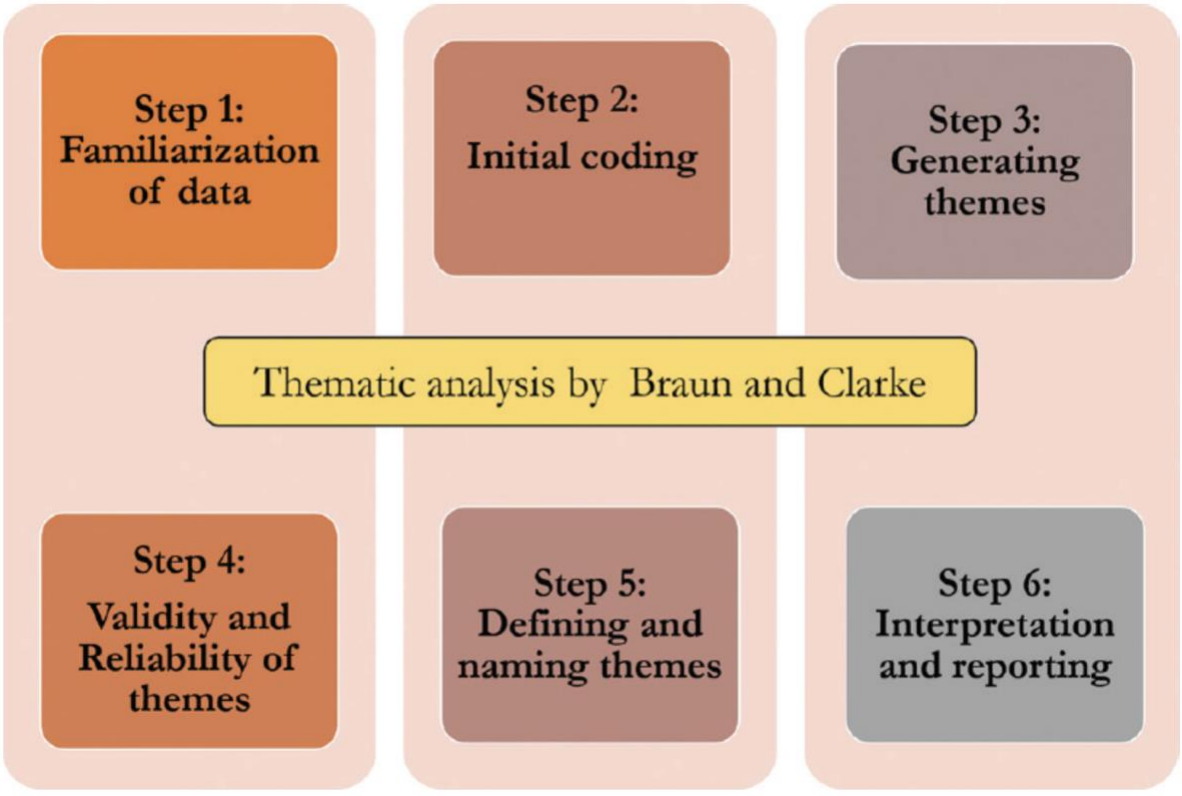
Data Analysis and Coding

The data analysis method that was used for this research was thematic analysis. Thematic analysis encompasses noticing relationships, similarities, and differences in the data (Ravitch & Carl, 2020, p. 239). Furthermore, thematic analysis has been noted as a "flexible" research tool that can provide "rich, detailed accounts" of the data (Braun & Clarke, 2006).

Saldana (2021) stated that a theme is an extended-phrase or sentence identifying what a unit of data is about and/or what it means. Moreover, a theme brings significance and identity to an experience as well as unifies the foundation of the experience (DeSantis & Ugarriza, 2000).

Figure 2

Description of Thematic Analysis.



Note. Adapted from "Using thematic analysis in psychology," by V. Braun and V, Clarke, 2006, Qualitative Research in Psychology, 3(2), 77-101.

The journal entries were collected initially from each participant. The participants' entries were read over for accuracy. The entries were then coded by looking for patterns that emerged. According to Creswell (2012), coding is the process of segmenting and labeling text to form descriptor and broad themes in the data. Next, the researcher conducted the virtual interviews at various times. The researcher transcribed and read over each interview for accuracy shortly after they were finished instead of doing this when all the interviews were completed. A semi-structured interview was used for both interviews with each participant. After data collection and transcription was completed, the researcher then coded each data semi-structured interview by looking for patterns that emerged (Saldana, 2013). For example, several of the girls shared similar experiences with their teacher, this resulted in the code, teacher engagement. I then open coded the data for each girl which resulted in specific codes, such as teacher, trying, success, perseverance, and accomplishment. Next, I looked across the transcribed interviews for patterns shared among their informal STEM programs. The researcher developed codes for patterns as it related to the coded categories. By doing this I was able to see the similarities and differences between the girls informal STEM program experiences. Lastly, I used axial coding to find emerging themes with the combined open coded data which I further analyzed. The use of thematic analysis provides the research with a highly flexible approach which provides a rich and detailed account of the data (Braun & Clark, 2006). Because this was a collective case study the use of thematic analysis was useful to examine the viewpoints of the research participants (Braun & Clarke, 2006; King 2004).

Table 8

Thematic analysis

Phases of Thematic Analysis	Means of Establishing Trustworthiness
Phase 1: Familiarizing yourself with your data	• Prolong engagement with data • Triangulate different data collection modes • Document theoretical and reflective thoughts • Document thoughts about potential codes/themes • Store raw data in well-organized archives • Keep records of all data field notes, transcripts, and reflexive journals
Phase 2: Generating initial codes	• Peer debriefing • Researcher triangulation • Reflexive journaling • Use of a coding framework • Audit trail of code generation • Documentation of all team meeting and peer debriefings
Phase 3: Searching for themes	• Researcher triangulation • Diagramming to make sense of theme connections • Keep detailed notes about development and hierarchies of concepts and themes
Phase 4: Reviewing themes	• Researcher triangulation • Themes and subthemes vetted by team members • Test for referential adequacy by returning to raw data
Phase 5: Defining and naming themes	• Researcher triangulation • Peer debriefing • Team consensus on themes • Documentation of team meetings regarding themes • Documentation of theme naming
Phase 6: Producing the report	• Member checking • Peer debriefing • Describing process of coding and analysis in sufficient details • Thick descriptions of context • Description of the audit trail • Report on reasons for theoretical, methodological, and analytical choices throughout the entire study

Note. Adapted from Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. International Journal of Qualitative Methods, 16(1)

Risks, Benefits, and Ethical Considerations

Research involving human participants and children, in particular, may present some challenges in terms of risk. This study, however, anticipated minimal risks. The parent and youth participants were both alerted that the possibility of this risk may ensue. Consent and assent forms for participants were required. During the interview process, youth participants were made aware of the voluntary nature of their participation. Great care was taken to provide a respectful and comfortable environment in which the research participants were contributors to the study and not research subjects. The study's participants' names were changed in the interview transcript and written report. Because the researcher may be familiar with the research participants and their backgrounds, a constant review of the data related to the research questions and the study's purpose was used.

This study will benefit the Black community, educators, and society by increasing our knowledge of Black girls' experiences in the educational landscape as it pertains to increasing their engagement in STEM. By understanding the experiences and perceptions of Black girls participating in informal STEM programming in contrast to the school environment, educators can better cater to the needs of this population and create more effective strategies to ensure their success in the formal school sector. It is crucial that we hear the voices of Black girls and consider their needs in contemporary STEM discourse. Classroom spaces and teaching practices must regularly include Black girls with cultural and gendered considerations when designing and implementing STEM curriculum. Critical Race Feminism reminds us that the work highlights Black girls' experiences while creating structures that lead to tangible forward movement in their favor (Gibbs Grey & Harrison, 2020).

Strategies for Quality

Ravitch (2020) noted that validity or trustworthiness in qualitative research denotes how researchers can support that their research findings are authentic to participants' experiences. Essentially, the research study is quality and rigorous; throughout this research process, bracketing was employed. Bracketing typically refers to" an investigator's identification of vested interests, personal experience, cultural factors, assumptions, and hunches that could influence how they view the study's data" (Fischer, 2009, p. 583). Secondly, journaling or memoing was used to reflect throughout this study and used as an audit (Treharne & Riggs, 2017). Lastly, member checking and peer debriefing with other researchers was employed. The findings from this research was presented to the interviewees to ensure that their authentic voices were being encapsulated. Member checking, also known as participant or respondent validation, is a technique for exploring the credibility of results. Data or results are returned or reiterated to participants to check for accuracy and resonance with their experiences (Birt et al., 2016).

Member Checks

This study utilized member checks to ensure that the researcher's personal bias was minimized. Mertens (2015) asserted that checking with participants in the research is a recommended practice. "Member checks involve the researcher seeking verification with the respondent about the construction that is developing as a result of data collected and analyzed" (Mertens, 2015). Member checks are one way to ensure that the research is credible. The researcher summarized what was said and asked if the notes precisely reflected the participant's view.

Validity

Validity refers to the quality and consistency of research (Ravitch & Carl, 2020). As a qualitative researcher, it is essential that the research is faithful to the participant's experiences. Patton (2002) asserted that along with reliability, validity should be of utmost importance while planning a study, analyzing results, and considering the quality of a study. As an Black female, I am aware of the biases I bring to this study; therefore, examining these biases was of great importance. Creswell (2013) stated that in qualitative research, validation is the researcher's attempt to judge the accuracy of the findings as best explained by the researcher and participants. This research attempted to ensure validity by employing member checks and triangulation. In addition, the researcher used Tracy's (2010) Eight Big Tent criteria listed in Figure 5 for qualitative research. The researcher made sure to acknowledge the threats of validity and made sure to apply the above strategies and these criteria to this research as an additional way to increase the validity.

Table 9

Qualitative quality: Eight “Big-Tent” Criteria for Excellent Qualitative Research

Criteria	How it will be achieved in this research
Worthy Topic	The topic of research is significant and relevant because it focuses on the persistent disparities of Black women in STEM, the correlation of Black girls' engagement in informal STEM spaces, and STEM identity formation.
Rich Rigor	The researcher uses a process for data collection and analysis in addition to theoretical constructs.
Sincerity	The researcher has acknowledged their positionality as an Black woman and a former STEM teacher. In addition, the researcher is transparent about how the research will be conducted.
Credibility	The researcher will use thick descriptions, member checks, and multiple data sources to ensure triangulation, such as multiple interviews and artifacts.
Resonance	The researcher will attempt to resonate with the reader by clearly articulating participants' experiences using direct quotes, showing not telling.
Significant contribution	This case study will provide a significant contribution for educators to learn about the ways in which Black girls engage in informal STEM spaces as well as how they develop their STEM identity in these informal spaces. It is our hope that stakeholders in education will have a more robust understanding of the benefits and challenges that Black girls experience with STEM identity formation and gain solutions for pedagogical practice. Stakeholders will then be able to assess how STEM can be incorporated into classroom practices as a learning tool to help educate and engage Black girls in an equitable and inclusive learning experience.
Ethical	The researcher will take precautions to ensure that procedures taken are ethical such as the IRB process.
Meaningful coherence	The topic is directly related to the researcher's research questions and current literature about the informal STEM education, disparities of Black women in STEM, and STEM engagement for Black girls.

Note. Tracey, S. J. (2010). Qualitative quality: Eight “big-tent” criteria for excellent qualitative research. Qualitative Inquiry, 16(10), 837–851.

Triangulation

Utilizing triangulation throughout this research, evaluation, and findings is another strategy to improve validity and reliability (Patton, 2002). Patton (2002) asserted that triangulation strengthens a research study by combining methods such as interviews,

observations, and artifacts. During this study, the researcher gathered data from three primary data sources to examine the experiences of adolescent Black girls in informal STEM education programs. The researcher facilitated multiple interviews with participants. Participants underwent an initial interview and a second interview. In addition to interviews, the researcher analyzed questionnaires and written prompt responses from participants as a second and third data source.

Assumptions

This study used counter storytelling as consistent with Critical Race Feminism. One of the main assumptions in this study was that participants were forthcoming. The researcher took all precautions to ensure confidentiality was preserved throughout the study. The participants were asked to convey their authentic experiences in order to make them feel comfortable. The interview environment was also created to make them feel at ease. The goal was to make sure that the participants were transparent about their experiences so that these findings would contribute to factors that influenced the adolescent Black girls' STEM participation and STEM identity in informal STEM education programs. Another assumption of this study is that it will provide an in-depth description of adolescent Black girls in informal STEM education programs using a qualitative method. Finally, it is assumed that the data in this study will inform STEM education policy, research, and practices to better support Black girls in STEM education.

Summary

This chapter provided a synopsis of the research design and methods for data collection and analysis. The researcher utilized a collective case study method to answer three critical questions about the experiences of Black girls in informal STEM programming. In addition, the researcher used an questionnaire, individual interviews and written prompt responses to address

the study's research questions. Chapter Three also detailed the use of thematic analysis, ethical considerations, the researcher's positionality, and assumptions. Chapter Four will outline the findings from the research study.

CHAPTER FOUR: FINDINGS

Chapter three described the collective case study approach used to investigate the experiences and perceptions of Black girls in informal STEM spaces who persist. This chapter presents the major findings from this study. This chapter is broken into two sections. Part I provides a narrative description about the study's cases. This section relies on the researchers notes from the questionnaire to describe the cases. Part I will also provide demographic information of each of the participants. As mentioned previously, four (4) participants were involved in this study. The researcher believes that it is important to present the research participants that are involved in this study in order to properly frame their responses.

When thinking about STEM the number of Black women who are persisting is disproportionate. Research indicates that it is important to listen to the voices of Black women and girls who engage in STEM spaces and who have experienced success. The voices of Black women and girls can be a critical key to unlocking how we can nurture the gifts and talents they bring to the STEM space and how educators can support this often-invisible population (Joseph, 2017).

The adolescent Black girls in this study participated in informal STEM education programs. Traditionally STEM spaces have not been designed with Black girls' needs in mind. This study discussed the experiences of adolescent Black girls in informal STEM education programs and focused on factors that influenced their STEM participation, and STEM identity through the following research question and sub-research questions:

R.Q.1 What are the experiences of Black girls in informal STEM spaces who persist?

The Sub-questions were:

S.Q.1 How do Black girls engage in and respond to informal STEM learning experiences?

S.Q.2 How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM?

S.Q. 3 What pedagogical practices effectively engage Black girls in STEM?

Part II of this chapter presents the five major themes that emerged from the data. The participants' experiences were analyzed through both Critical Race Feminism and Black Feminist Thought. These perspectives allowed the researcher to gain a more in-depth understanding of the significance of Black girls' lived experiences and positioned them as critical experts of their own histories. A Black Feminist thought lens was used to demonstrate the utility of Black girls being the narrator of their experiences in STEM where they are often left out of the conversation. Critical Race Feminism speaks to the Black girls' experiences from multiple standpoints, and demonstrates the intersection of race, gender, and class (Collins 1996; Wing 2003). Highlighting the experiences of Black girls persisting in informal STEM education allows for a better opportunity to understand the experiences of a population who is underrepresented in many STEM spaces because of race, gender and class. Data was organized based on the three research questions and categorized into major themes. The themes that emerged reflected the lived experiences of these four adolescent Black girls while participating in informal STEM education programs. This chapter provides an analysis of themes that were developed from data collection in the participants interviews, questionnaires, and written prompt responses. Five major themes emerged from the data collected in this study: affirming spaces, instructional strategies, support systems, racial representation, and racial microaggressions.

The findings in this chapter reflect the participants' revelations and interpretations of their experience in informal STEM education programs. The next section begins with a brief description of the participants followed by an overview of the themes and common ideas expressed in the interview transcripts. The chapter concludes with a summary of the findings and transitions to Chapter Five.

Part One: Meet the Participants

There were four participants in the sample of this study. Pseudonyms were chosen based on influential Black female authors that inspired the researcher throughout this study. Additionally, each participant was asked to use one word to describe themselves during their questionnaire. I felt that these words were significant because they clarified how these Black girls understood themselves and the attitude, they brought with them into the STEM environment.

Each participant had unique experiences and opinions about STEM and informal STEM spaces. However, there were many similarities in their journeys surrounding participation and STEM identity. During all the interviews, the participants were uneasy about articulating feelings and experiences that dealt with them navigating racism as Black girls in STEM.

Meet Audre

Audre is the twin sister of Zora. She is 16 years old and in the eleventh grade. Audre described herself as strong. As a Black girl, Audre described her Black girl magic as breaking the mold of what society says Black women should be and creating a version of yourself that, while always changing and growing, you are proud of. Some extracurricular activities she is involved in are Junior council representative, Right Moves For Youth (RMFY), Ambassadors program, and \ Chess Club. Audre likes cooking, art, and STEM projects. "My favorite thing about school

right now is my art class." Audre described herself as a STEM person because she has participated in STEM activities and camps for over six years. Another one of Audre's passions is science.

Even though she admitted that chemistry is challenging for her at present, she still enjoys it. Audre said:

I like chemistry, and we often have students versus teachers games. The teachers in chemistry are pretty understanding even though chemistry right now is hard. My STEM experience has been really amazing! I've been a part of robotics clubs and have gone to STEM-based schools since middle school, but my favorite STEM informal program I've ever been in was Girls Make maker-space in 7th- 8th grade. We would come in around four or so, and they would provide different snacks each time, then we'd get down to business. Whether we worked with a hammer and nails to create patterns for nail art or used various metals to solder motherboards into a working alarm, we'd tap into kinetic learning while learning to vibe well with others

Audre said she is confident in her ability in STEM because she feels focused and responsible with her time so she can succeed. According to Audre, her experiences in STEM have been great. "I would rate this program 10 out of 10 and would definitely recommend it to anyone interested in STEM but also to those who just need a break from their reality to tap into a new activity, and you can be sure it will change your life for the better." Audre said her future aspirations include: "Something intertwined with psychology, I want to use the science of human interactions and chemical changes that alter how we act to show others how to manage their emotions properly."

Meet Bell

Bell is twelve years old and is in the sixth grade. She described herself as a free thinker. Bell described Black girl magic as Black girls who have great qualities and abilities and have created success using those qualities and abilities. This year, she attends a virtual school due to the COVID-19 pandemic, and her favorite subjects are mathematics and science. She often struggles with ELA. She has enjoyed going to virtual school but misses the interaction with other students. She thinks she may want to try going to in-person school next year, pending how safe it is due to COVID-19. Bell is currently on a swim team and enjoys taking acting classes. Bell is not sure if she is a STEM person. She said STEM is of interest because she does an excellent job in mathematics and science. Bell does not want a career in STEM. Bell would like to be a screenwriter when she grows up.

"The particular informal STEM programs that I attended were a coding STEM program and an Engineering STEM program. Some of the experiences that I had when attending these STEM programs was being able to use coding to make music and in the other one creating my own website and presenting it to the camp. I did great!"

"I would tell others that STEM programs are really fun! You get to have a deeper dive into what STEM is really about. You get to do activities based on what you learned in STEM."

Meet Harriet

Harriett is fifteen years old and is in the tenth grade. She described herself as open-minded. Harriett described her Black girl magic as power, intelligence, and beauty being pursued by a Black girl. Harriett has a love of dancing. She dances with a production company and currently tap dances. She also enjoys working on STEM projects that include solving world problems. Harriett would describe herself as a STEM person because she believes that her interest in the field of science, technology, and engineering can take her far in life. Harriet has

attended several STEM informal programs and feels that they have improved her as a person. "STEM informal programs have had a large impact on my life at a young age providing a secure base for my love of science and interest in STEM."

"The first informal STEM program was an all-girls science camp. My second STEM program was a technology and coding camp that opened my eyes to technology by demonstrating coding, picture taking, making music, and creating digital buildings. The third STEM program that I have attended was Heath Sciences Camp which taught us about crime scenes and how to solve them using science. The last STEM program I am attending is a mentoring program which demonstrates STEM-oriented activities providing speakers as well as providing us with our STEM mentors." "I would definitely encourage someone to attend these STEM programs and all the possibilities waiting for them," Harriet said her future aspirations are to be to be a biochemist or a phlebotomist, possibly working in forensic science. She attributes her experiences with informal STEM programs to why she has chosen this career path.

Meet Zora

Zora is the twin sister of Audre. She is 16 and in the 11th grade. She described herself as amazing. Zora described Black girl magic as Black females having the power and the strength to do whatever they put their minds to for simply being themselves. Black girl magic can be in the form of beauty or anything put together by Black women/girls that empowers Black girls. She enjoys playing the trumpet. Zora also participates in Right Moves for Youth and Chess Club. Her favorite subject is mathematics. She said. "Math just comes naturally to me. I like how numbers work and social studies as well. I like to see how things have changed from the past and how we're, you know, advancing. And the subject that challenges me the most would be English." Her informal STEM experience was in middle school, where she attended a program just for girls.

"My informal STEM experience was a good one. I had the privilege of being a part of a STEM after-school program. In this program, I was able to let my creativity run wild as I created various projects that related to the components of STEM. Some of the projects included working with multiple power tools, Carvey, and a 3D printer. While at this program, I worked with other girls who wanted to explore the world of STEM." Zora said she identifies as a STEM person because she uses the skills she learned in STEM every day and appreciates all the STEM components. "I would tell people that the Girls in STEM program helped me develop my love for STEM. It also helped me to become more confident in my creative thoughts. The program was an amazing opportunity, and I wouldn't trade the experience for the world."

Zora's future career goals include being an entrepreneur and an activist for the Black community. She stated, "I think the STEM experience changed my mindset to learn how to overcome challenges and to develop problem-solving skills. So I think those things will be useful when pursuing my future career."

Table 10

Participant Snapshot

Participant	Age	Grade	Informal STEM program	Grade attended Informal STEM program
Audre	16	11th	Girls Maker Space	7th and 8th Grade
Harriet	15	10th	Scientist Club Geek Squad Health Sciences Camp	6th-Current
Bell	12	6th Grade	Coding Engineering	4th and 5th grade
Zora	16	11th	Girls Maker Space	7th and 8th Grade

Part Two: Themes

Five themes emerged from the data when investigating the experiences of Black girls in informal STEM spaces who persist:

Theme #1 Racial Microaggressions: “Outsider Within”

Theme #2 Supportive Systems: “You Got My Back?”

Theme #3 Affirming Spaces: “Good Vibes”

Theme #4 Racial Representation: “Where My Girls At?”

Theme #5 Instructional Strategies: “A Worthy Investment”

These five themes mirrored existing literature on the experiences of Black girls in STEM, reasons why some Black girls are persisting, and factors contributing to their underrepresentation in STEM programs and STEM courses. Affirming Spaces as a theme suggested that informal STEM educational programs contribute to Black girls' STEM engagement. Instructional Strategies as a theme indicated that when instructors implore effective instructional strategies that address the whole child, it contributes to developing STEM identity and engagement. Support Systems as a theme suggested that support was a critical factor in ensuring Black girls' continued engagement and STEM identity development. Racial Representation as a theme centered around findings in the data that suggested the presence of Black women and girls in informal STEM educational programs was paramount to the development of Black girls' STEM identity development and engagement. The final theme that emerged from the data was Racial Microaggression, as the participants reported structural inequities within informal STEM education.

Affirming Spaces: "Good Vibes"

"I really, I just, I really like what STEM does."

A central theme that emerged from the data was informal STEM education programs are affirming spaces and impact in the lives of each participant in a positive way. The data from this research indicated that all four participants felt that attending an informal STEM education program made a positive impact on their lives. Each participant was able to identify in what ways STEM added value to their lives. The lasting effects of the program were positive. Many of the participants could vividly recall their experience and smiled and giggled when they spoke of their experience in their respective STEM programs. For some, STEM provided a boost to their confidence as they worked with like-minded individuals who appreciated learning about STEM

and gained understanding of concepts such as engineering and coding. And then for others STEM provided a space for them to talk freely and not be judged. One participant stated that being a part of her STEM program allowed her to not overthink. Another participant felt that STEM changed their mindset and gave her the freedom to be creative. Each participant felt that STEM enriched their lives in some way. Bell stated that:

> STEM made me better because I got to do more stuff in that[STEM] specific area
>
> My STEM program positively influenced how I feel about engineering

While interviewing Bell, she explained that STEM was something that she decided to try because it was presented to her by her mother's friend. Like Bell, Zora felt like her STEM program made her a better person:

> STEM develops your mindset and opens your mind, like a mindset change. I liked that it opened my mind. It made me think outside of the box, sometimes they would like, they would allow us to create things by ourselves and like we could use recycled materials, like a project or something. And it made me think outside the box.

Zora often spoke about the STEM informal program she was a part of allowing her to tap into her creative side which she hardly ever got an opportunity to do in schools.

> In this program I was able to let my creativity run wild as I created various projects that related to the components of STEM.
>
> I really, I just, I really like what STEM does. It makes you think out, it makes you just think further on like how things work or like the science behind things. It just makes you think more. I like that aspect of STEM.

Audre spoke about STEM being a boost for her confidence. She described herself as an introvert, someone that is shy and quiet. She appreciated the fact that STEM was able to help her be more confident and outgoing:

> This program in particular for Black girls, I think helped boost my confidence because being a part of it, or being a part of the group, finding your click or whatever, finding something that made me happy and then going back and showing it to your parents was really nice.
>
> So in that program, I was able to be less of an introvert and talk freely without thinking that I was wrong or overthinking a certain topic.

Audre also mentioned that one of the positive impacts STEM had on her life was it gave her a chance to get a break from her reality. Audrea mentioned that at her middle school it was hard to find like-minded people who were interested in STEM:

> So, when I was in middle school, there weren't a lot of people who liked the same things that I like who were really interested in making sure they succeeded in life. They kinda just wanted to play around. So, seeing people really invested into the sciences, the robotics part, and we could have an actual conversation without there being an altercation. That was great.
>
> Anyone interested in STEM that just need a break from their reality-STEM gives you a chance to tap into a new activity which is sure to change your life for the better

Like Audrea, Harriet also felt that STEM affected her positively because she was around like-minded individuals that she could connect and collaborate with.

> Some of my experiences attending these STEM programs have been overall positive and very influential.
>
> I would say that being in STEM informal programs impacted me positively because a lot more Black girls were interested in STEM. So, I had more people who are like me and had the same opinions, views, like-minded people around me that I have with me that will want to help me and want me to grow.

Most of the participants in this study were not currently in STEM programs yet they were able to speak about the positive impact that their STEM experiences had on their life. Most participants shared commonly the idea that attending a STEM program gave them a chance to be with like-minded individuals. This central theme framed how many of the participants spoke about the other aspects of their STEM informal experience.

Instructional Strategies: "A Worthy Investment"

"They were encouraging, and they helped us"

The findings from this research indicated that the participants were able to define the type of instructional strategies their teachers used to effectively engage them in their STEM informal space. All participants were school age, so they experienced different types of teachers. For the purpose of this study the participants identified the instructors as teachers although they may not have been a teacher in the formal sense with K-12 academic credentials. Additionally, in this study instruction is defined as being able to encourage learning through discovery and acquired knowledge. It was evident from the research that the instructional strategies used increased the participants' STEM engagement. STEM engagement and instructional strategies were a focal point of this study. The participants were able to recognize specific strategies that helped them be more successful with the STEM content in their respective STEM informal programs. Many of

the participants commented that when teachers would break down the information or provide activities that they explained step by step that was helpful. Additionally, showing examples, essentially show not tell, allowed the participants to better understand many of the concepts taught. The data also spoke to teachers creating a fun and interactive environment in which to learn. One participant repeatedly spoke about her STEM informal program being fun which gave her a better appreciation for STEM. One of the participants noted that she appreciated her STEM teacher pushing her thinking and creativity which ultimately helped her engage in the STEM space. A sub theme throughout instructional strategies was "how" the teachers made participants feel when they gave instruction. All the participants spoke of the teachers caring about them and making connections.

> Typically, they have like little slideshows, not all of them, but typically some of them do and it breaks it down more. So, you're understanding and they're not like reading slideshow, word for word. They're kind of collecting all the main ideas a breakdown of each section from like the overall topic that we're talking about and it kinda just helps me understand a little bit more

Zora explained that it was showing her step by step that was significant and helped her engage in the STEM space stating:

> They did activities and lessons step by step. They showed us how to do it first. Like how to do the project, gave us like an example either showed us a video of how to do it or did it themselves. And then like, it was like step by step, but then they would allow us to do it by ourselves and if we needed help, we could actually come to them.

Audre also noted that the showing not telling made a difference in her STEM experience:

> So, one of my teachers like the robotics teacher. 100% my favorite class, even though I didn't understand parts of it, he would walk me through it and teach me how to do different things that I didn't know how to do before.

It's important to note that teaching is about connection with students just as much as it is about the content. Maya Angelo stated that people may forget what you said, what you did but they will never forget how you made them feel." Harriett noted that the instructor's ability to interact with students and make connections to their lives was significant. She stated:

> Something they used was, interacting a lot and it wasn't just like one speaker. It was all the speakers that interacted with us a lot even if sometimes, like we just didn't wanna talk, they would just try their best to encourage us to talk really. They would, instead of just like randomly calling on you they'd, ask one of the administrators to share, and that would make us feel a little bit more comfortable and we would wanna share as well. They always had something that would relate to us, like in our lives. So I feel like just being able to connect with us and interact a little bit more, kind of intrigues us a lot and why we really like to do it [STEM], and why we keep going to the meetings and we keep doing the projects.

Audre explained the connection between the instructor and herself as "good vibes" and noted how the STEM experience made her feel:

> The other two people, they worked at my STEM camp, it was their aura. Like every time I went in there, they made me feel so welcome.
>
> Although the teachers did a lot, like, for instance, I forget her name, but there was this one lady and she just like, listen to what I had to say first, when I came to like me being

> confused about a certain project and gave insight and then asked me more questions, not like in a disrespectful way, but to push me to think further.

Zora described the camp as an “absolutely amazing” experience. She recognized that the program taught her many new things, but she was also able to pinpoint that the overall environment was one that she felt welcomed her. Zora stated:

> I would say that they were absolutely amazing. They showed me so many new things and they pushed me to bring my creativity to the forefront when doing projects. The instructors made everyone feel comfortable to be in the environment. No one was undermined while in the program and the instructors kept good vibes throughout the STEM camp.

For Bell it was how the information was presented in a fun way but also that the instructors made her feel encouraged and supported throughout her STEM program. She noted that the presentation wasn’t always hands on but it was interactive.

> What I would tell someone about the teachers in this STEM program is that they are full of fun and help us when we need it because some of the stuff was confusing and most of it was new. They let us do fun activities based on the STEM subject that we were doing such as coding through music and creating our own designs through engineering.

Bell noted that the teachers broke down the information so that she could understand it.

> Well, it wasn't really like those hands-on activities. It was like to understand and like break it down, it was more like where we just started this and like they asked like, does anybody have experience in STEM? And then some of us didn't, some did, some that didn't they like broke it down.

Bell also pointed out that even though the information was confusing the teachers were encouraging and supportive:

> They were encouraging, and they helped us with stuff that we needed help with. Cause some stuff we were confused about. It wasn't always one on one, and they like did this thing where they taught us this stuff in like the beginning it's like beginner stuff. And then like after they ask like, does anyone eat more help or assistance? That's why I feel like I was being supported.

Support Systems: "You Got My Back?"

"There's just a lot of people that stand by you."

For most of the participants, STEM was a new experience when they enrolled in their respective informal STEM programs. The path that each of the participants took to get to STEM started with a support system. The research from this data indicated that family, peers and a caring adult were the catalysts for these girls' debut into STEM. Each of the girls' supportive systems encouraged them to engage in STEM. Many of the girls echoed that their support system made an emotional investment into who they were and not just STEM. For others their family encouraged them to try something new and take a chance on STEM. One participant spoke about their third-grade teacher investing time to make sure she was able to sign up for a STEM program when she was too busy. Each participant spoke about different situations where they felt that a caring adult or family member supported them in the STEM space. And for other participants the supportive adult helped them discover STEM as a viable option. Each participant could pinpoint who it was that supported them in STEM successfully. Harriett spoke about her third-grade teacher that introduced her to STEM:

> Like the only reason I'm in STEM is cuz I was grateful to have, she was actually my first Black teacher in third grade. We always had these little like [activity] folders that had all kinds of information or news or about what was going on. And I wouldn't stop talking to her about it or stop asking her about it. About how I didn't have a lot of time like time in my schedule to like to do an essay straight up [to get into the camp]. So, she actually called my mom, and told her like she really wanted me to do this, and we did end up signing up for it. And I did my essay over the phone to my mom because she was like, no, she's doing this essay. She's getting into this camp. So, there's not a lot of people like that in your corner. I'm very grateful to have my third-grade teacher in my corner.

Harriett also spoke about the adults in the STEM programs that she attended. She noted that they care about her as a person:

> Something that I would tell someone about the teachers in all of the programs that I have attended would be that when they say that they care or are concerned, that they actually are. Not only do they care about STEM as much as you do, they also care about you and wouldn't mind learning more about you and seeing where you would end up in life. An example would be one of the STEM programs, although I am well beyond the age requirement for the camp that they have every year they still kept in contact and introduced me to their mentor program.

Audre noted that the STEM camp did not always involve her instructors, teaching us but that they helped her in life. She stated:

> The staff there were always polite and looked forward to helping us excel in every way on projects, in life, and emotionally. Other times my robotics teacher, like sat with me

> and started to talk to me about his day, and about my day. And we built an overall better relationship. Like they actually cared about what I wanted [out of life].

Audre's dad encouraged her to participate in activities that related to STEM:

> I'm not sure if it's like the school that you go to, or if it's the atmosphere that you're around when you're at home. But for me, whenever I was given an opportunity, my dad told me to take it.

Harriette also noted that her family always encouraged her and they are very supportive to her and her endeavor. She said:

> So, I'm very grateful to have my mom in my corner. I'm very grateful for my brother and my father who are always like, "Oh yeah, that's something that's good. "If you don't like it, that's fine. Oh, there's something similar to something that you like, you might like a certain aspect of this, but not like the whole staying at your desk all day. Like I wanna be in a lab all day. I'm fine with that. So they're like, "Oh, there's this part, which you don't like so maybe we can look at something else." There's just a lot of people that stand by you [me].

Racial /Gender Representation: "Where Are My Girls At?"

"Staying in STEM might be difficult, simply because you might not see a whole lot of representation"

The findings from this research indicated that representation matters. Most of the participants spoke about the importance of models of Black women in STEM and its connection to their participation and engagement in STEM. Participants shared the impact of representation in several ways. One participant was able to recall vividly the number of Black women speakers

that spoke at her STEM mentoring program last year. She described how these four Black women made her realize that she could "do" STEM too. The ability to be able to "do" STEM was an overarching sub theme within representation. The participants were similar in their responses that seeing Black women in STEM allowed the participants to realize that being a part of the field of STEM was an attainable goal and that they could make a difference. All participants had instructors of different races and genders in the STEM informal programs however they communicated that having Black women role models and Black girls in the programs was important to how they viewed their place in STEM. Additionally, one participant noted that while STEM presented some opportunities for Black girls, staying in STEM might be hard because there is not a lot of representation for Black girls in STEM. Harriett had several speakers who were Black women in STEM:

> I think we've had like maybe three, four speakers out of all of our meetings who were Black and just, I don't know it just felt like STEM was something that I could do or be. Like, oh, hey, I could do this and that and such and such because she just proved that I can do that and more.

Zora, who had a similar sentiment as Harriet noted that seeing more Black women in higher positions in STEM made her want to be a part of STEM.

> Black girls are like, Black women [they] are developing to like higher positions. You can see a lot more examples of Black women being in higher places or making more of an impact [in STEM] which helps me want to be a part of STEM

Additionally, Zora felt that she would be successful in her informal STEM educational space because she noticed other Black girls in the program. Seeing same-race peers helped her be confident.

> I felt capable, sorta. I felt like I could do it. A lot of people there were, Black girls, so it didn't make me feel like an outcast or anything like that, it made me feel like I could do it though. It [The STEM program] made me feel empowered and it made me feel like, like I could do anything else [in STEM] that anybody else could do.

Audre noted that representation made her realize that STEM something she could do to make a difference the best way to engage with STEM if it is of interest is to make sure you, "learn about the people before your that were Black." She stated:

> If STEM is really important to you, learn about the people before you that are, Black, but especially Black women, who've already done what you've wanted to do. And if you want to talk to somebody who's already in the situation that you would wanna be in ask them to mentor you because you probably won't get told that information.
>
> Watching myself, my sister, the people around me, they were all people of color if they weren't Black. Even the teachers so to see them do great things made me think that I could do great things too. This experience showed me that women (especially women of color) can make a difference in the STEM field especially through science, [that I could make a difference in STEM].

Audre also recognized that it may be difficult to stay in STEM because of the lack of representation of Black women, stating:

> As of right now I think, like, Black girls have, like, a big chance of doing things in STEM, but staying in STEM might be difficult, simply because you might not see a whole lot of representation wherever you're at as a Black girl.

Like Audre, Harriet noted the lack of representation when promoting STEM programs and activities:

> It's [STEM] not publicized or pushed to Black girls to do STEM and then it's not shown, a lot of times when we see STEM being promoted in school, it's kind of mainly the White girls on the cover doing the little labs and doing all the work and making it seem like their work has paid off and our work isn't.

Harriett also spoke about the impact of the representation in one specific STEM program she attended that was mostly Black girls and Black women instructors.

> Probably out of all the programs I did, maybe one program had activities that related to me, it's just more diversity. And since it's mainly Black girls who were in [the] STEM [program], it's more connected. And then they kind of branch out from girls being in STEM, and it goes to your race and how one girl might feel about something else. And another girl might see it a different way. And you could relate to a Black person a little bit better. But, I would say out of all of them [STEM programs], probably that one has been to my benefit as a Black girl, I can relate the most to.

Because Bell was in a STEM program that she was the only Black girl, she noted that the environment made her feel uncomfortable because of a lack of representation:

> I mean, the teachers didn't make me feel comfortable because, like, they did treat us all the same, I think. but it just felt uncomfortable to me because I was the only Black

because I'm not gonna lie, some of the programs I did do had more White people than like me being Black.

Racial Microaggressions: "Outsider Within"

"Maybe they think we don't belong"

Another theme that emerged from data was microaggressions. The participants felt that STEM was a place that sometimes made them feel as if they did not belong as Black girls through messaging. The findings also indicated that the majority of the participants talked about being judged or thought of differently because of their race as compared to the other participants. One participant spoke about STEM programs only being offered to the "smart" Black girls. And yet another participant spoke about having to code switch when she was in the STEM environment. Conversely, while all participants enjoyed their STEM informal experiences, they were aware of the structural inequities in these environments as well. Harriet felt judged in one of her STEM programs that was majority with White girls:

> When I was in my virtual STEM program, I would probably say mainly people might see how I do things online versus in person, it's kind of difficult to tell race but then in person it's just like, oh, well, she might be so and so because of her race, she might be,lazier. She might be this, she might be that. So, in-person circumstances, I feel like it's difficult to do things and not be judged and you have to put in a little bit more work because of your race. But when you're with people like you that want you to be there and like you, then it's just an entirely different situation and it's just 10 times better.

Harriet further explained that oftentimes Black girls are stereotyped and scrutinized for not meeting the expectation of others. She also realized that in many cases the individuals do not know you a Black girl but make assumptions about who Black girls are. These assumptions lead to Black girls getting pushed aside because they may not think Black girls are smart enough. When asked about being in STEM informal programs with other race of girls Harriet said:

> They see me, a Black girl, as like being like lazy, maybe inconsistent, a procrastinator of some sort, maybe you are aren't as organized or you don't meet their expectations of organization or to how they would like them [assignments]. But, I would also say to add on, if you are with people who don't look at how you appear [your race], but mainly what's in your head, they want you to be there, but in some circumstances that doesn't work with a lot of people and they just see you based upon your race, and they'll just push you aside and go look for somebody else to be in their group who they think fits their idea of smart.

Audre was aware that there were other Black girls that did not get offered an opportunity to participate in the STEM informal program she attended because the staff didn't think they were capable. She was able to share that the administrative staff passes over these Black girls often because they may think they are troublemakers, or their grades are not where the school staff thinks they should be. Audre stated:

> So, if the girls that didn't have the greatest grades, like let's say they had like a 2.5 or whatever, and you're Black, that doesn't really go down. Well, especially in the school system that you're gonna call you or not call you, but they're gonna think that you're dumb or that you're doing something wrong before they even tell you.

Audre went on to say that the opportunities for STEM are not made available to Black girls because they assume that Black girls do not want to be in those spaces. She stated:

> Because if there are STEM opportunities they need to be sought out for us. They're not just on a poster in your school waiting for you to go ahead and take it [the opportunity] maybe they think that we don't belong.

Audre also indicated the ways in which she felt the preset expectations that are expected of Black girls and how she needed to change the ways in which she spoke because of these expectations.

> I think a lot of people have their own expectations of how Black girls speak or how Black people speak in general. So, I had to put my normal speaking, like when I'm talking to my mom or when I'm talking to my friends aside and speak very formally in front of people, um, at the group or whatever, because I didn't feel like having to explain myself.

Zora was also aware that being involved in STEM required more of her because she needed to search out the opportunity as they are not just readily presented to Black girls, stating:

> So I would say that being in those [STEM programs], getting that opportunity to be in that program, I had to look for and go search for it. You have to look for that for the opportunity. Because those opportunities are not [presented to us], you may not know about them or they might not be geared towards you [Black girls].

Zora noted that there were times that she felt it was difficult for teachers to approach Black girls and teach them.

> As a Black girl they might not know how to go about, teaching you different things they might not know how to approach you like they might, to treat you a different way.

Zora also indicated that she would encourage other girls to keep an open mind even though there will be times when other people might not think that STEM is a place for Black girls.

> I would give advice to other Black girls who think that they can't do STEM or think that they won't be able to fit into STEM or maybe they [other people] don't think that you're capable of doing STEM, to keep an open mind, that's what I did.

Zora also noted that other STEM programs she has been a part of made her feel like she did not belong although that wasn't her experience in this program:

> I mean like a lot, a lot of times, programs can be made and like, you feel like you're not supposed to be there. Like, they think you're like, you're kind of hard [to deal with]. Or just how like they approach you the staff or from teachers, stuff like that. Like they might, treat you a different way. They might not know how to approach you, I guess as a Black girl.

Bell was in a STEM program where she was the only Black girl, and she noted that the environment made her feel uncomfortable.

Summary

This chapter provided the findings from the themes developed from data collection of the participants questionnaire, interviews, reflective prompt, and questionnaire. Five major themes — Affirming Spaces: Good vibes, Instructional strategies: Worthy investment, Support systems: You got my back, Racial Representation: Where my girls at, and Racial Microaggressions: Outsider within — emerged from the data collection of this study. Chapter Five will discuss and interpret the findings.

CHAPTER FIVE: DISSCUSSION

My mission in life is not to survive but to thrive and to do so with some passion, some compassion, some humor, and some style.

-Maya Angelou

Chapter Four presented the major findings from this study. The chapter was broken into two sections that provided a narrative description about the study's cases and demographic information of each of the participants. Chapter Five will discuss the themes that emerged from the data as they relate to STEM participation and STEM identity. Additionally, this chapter will conclude with implications, limitations, and recommendations for future research.

Research in the area of STEM has been a popular topic recently. Additionally, research conducted to investigate the disproportionate number of minorities in the STEM field has been of interest (NPSAS, 2008; Sharpe & Swinton, 2012; U.S. Department of Education, 2008). Specifically, the critical area of Black girls' underperformance in STEM education (Collins, 2018; Joseph, 2020) and the scarcity of Black women in STEM fields has received expressed attention. Data has shown that while the presence of minorities in STEM is low, the disparities of Black women and girls have the highest need (Jackson & Charleston, 2012; National Academy of Sciences, National Academy of Engineering, Institute of Medicine, & National Research Council, 2010). While there has been increased research conducted in this area, not many studies focus on the utilization of informal STEM education programs as a tool to increase engagement and build the STEM identity for adolescent Black girls. The findings in this study examine the experiences and perceptions of adolescent Black girls in informal STEM education programs and analyze their engagement and identity formation in these spaces. The themes that emerged from this study aimed to answer the research question from this study.

Critical Race Feminism and Black Feminist Thought provided the foundation for this study as four adolescent Black girls shared their experiences in informal STEM education programs. Critical Race Feminism speaks to the Black girls' experiences from multiple standpoints and demonstrates the intersection of race, gender, and class (Collins 1996; Wing 2003). Listening to the participants' responses collectively supported Critical Race Feminism and Black Feminist Thought in rearticulating the totality of their experiences as Black girls in informal STEM education programs. The findings revealed that participants utilized supportive systems, representation, and instructional strategies to increase their participation in STEM. The findings also revealed that racial stressors such as microaggressions were present in the participants' informal education space. Finally, the findings revealed that affirming STEM spaces increased STEM participation and significantly impacted participants' STEM identity and engagement. This research focused on the persistence of Black girls in informal STEM education programs. Because much of the research focused on STEM reform examines minorities in STEM from a deficit lens, this study exposed how Black girls persist in STEM education despite environments designed to push them out (Collins et al., 2019; Joseph, 2020; Ong et al., 2011). It is necessary to examine informal STEM education programs because they have been sites of engagement, joy, and liberation for Black girls where schools are not (Joseph, 2020; King & Pringle, 2018).

This qualitative study was designed to examine adolescent Black girls' engagement and identity formation in informal STEM education programs who persist. The data from this study indicated that the development of STEM identity and increasing participation resulted when participants were supported by an affirming environment, had effective instruction, were surrounded by Black women role models, same-race peers, and caring adults and family

members. These factors were integral to the participants' participation and STEM identity and were critical to their persistence in informal STEM education. The discussion of the findings will include a comparison of this study's findings to previous research in the field. Additionally, this chapter will discuss implications of the findings, limitations of the study, recommendations, and areas for future research.

Discussion of Findings

The research questions guided the themes that developed from the data analysis:

R.Q.1 What are the experiences of Black girls in informal STEM spaces who persist?

The Sub-questions were:

S.Q.1 How do Black girls engage in and respond to informal STEM learning experiences?

S.Q.2 How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM?

S.Q. 3 What pedagogical practices effectively engage Black girls in STEM?

Table 11

Research Questions and Themes

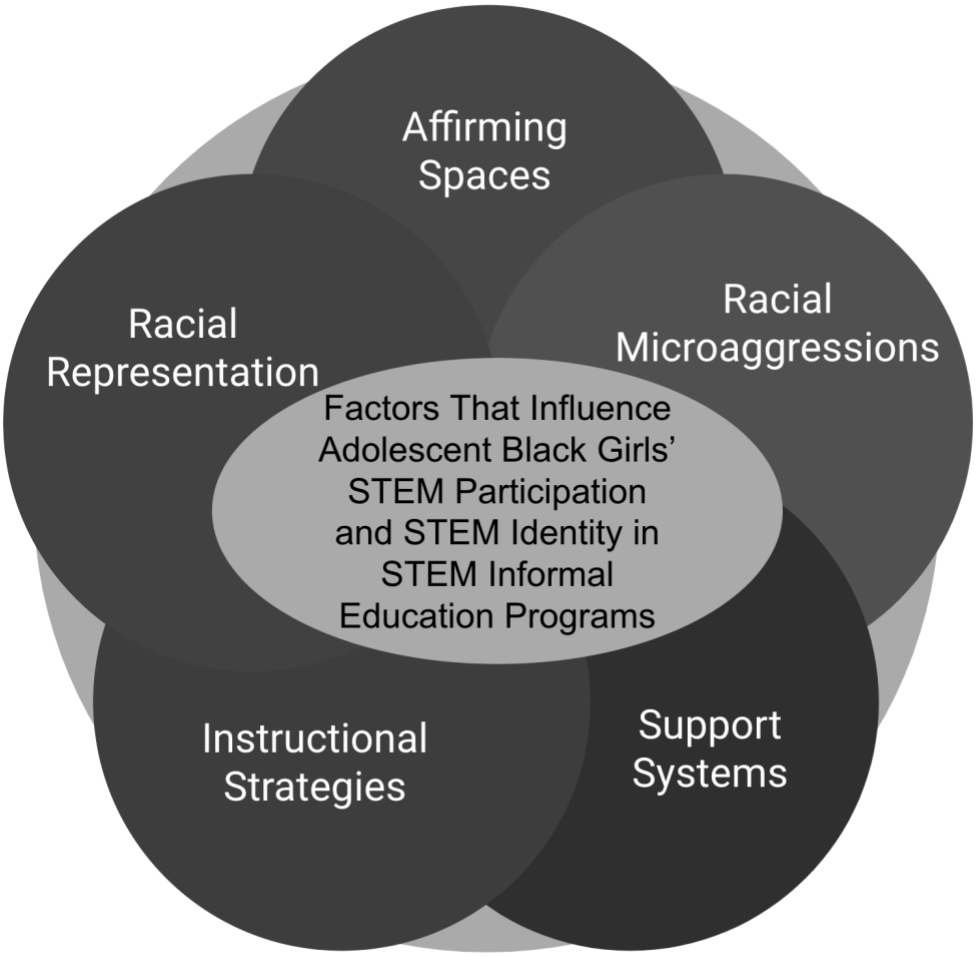
Research Question	Sub-Questions	Theme
RQ. 1. What are the experiences and perceptions of adolescent Black girls in informal STEM education programs who persist?	SQ.(a) How do Black girls engage in and respond to informal educational experiences?	Racial Microaggressions: "Outsider Within"
	SQ.(b)How can informal STEM educational experiences develop Black girls STEM identity and increase participation in STEM?	Supportive Systems: "You Got My Back?"
		Affirming Spaces: "Good Vibes"
		Racial Representation: "Where My Girls At?"
	SQ.(c)What pedagogical practices effectively engage Black girls in STEM?	Instructional Strategies: "A Worthy Investment"

The role of Critical Race Feminism (CRF) is to center the lives of women of color by examining and exposing processes by which racism and sexism intersect to shape Black women's experiences in educational environments (Wing, 1997). Additionally, CRF focuses on the lives of women of color who face multiple forms of discrimination due to the intersections of race, class, and gender within a system of White male patriarchy and racist oppression (Evan-Winters & Esposito,). Thus, CRF acknowledges that every Black girl in STEM brings a unique perspective and attitude to being successful in the discipline as an act of anti-essentialism. Because of the permanence of racism, affirming spaces in STEM are necessary for Black girls to persist. These spaces support many Black girls in controlling images and self-defining their identity at the intersection of STEM, race, and gender. The findings from this study show how Black girls claim a space in a discipline in which they have historically been left out. The Black girls in this study continue to affirm their space by utilizing instructional strategies and various systems of support. Some of those systems specified in the findings help Black women in STEM

challenge the matrixes of domination which can be oppressive for marginalized populations of students in education.

Figure 3

Factors That Influence Adolescent Black Girls' STEM Participation and STEM Identity in STEM Informal Education Programs



Research Question One: How do Black girls engage in and respond to informal STEM learning experiences? Within research question one, one theme emerged to explore how Black girls engaged and responded to informal STEM educational experiences. This was racial microaggressions.

Racial Microaggressions: Outsider Within

It was interesting that though participants acknowledged the positive STEM experiences, they were keenly aware of the racial stressors in their informal STEM education environments. CRF purports that racism is permanent. Thus, racialization is part of domination and subordination through the classification of physical appearance or skin color, which benefits the construction of the "other." Specifically, the racialized Black girls are deprived of opportunities, equal treatment, and excluded from participation in significant ways. The participants experienced racialization and their experiences are consistent with the literature about the treatment of Black girls in STEM environments which states that racial microaggression serves as a racial stressor and a product of racism (McGee & Bently, 2017). Microaggressions can influence Black girls' sense of belonging. Strayhorn (2012) defined a sense of belonging as several psychosocial dimensions that affect one's belongingness within a group or context. These dimensions include feeling a sense of connection to a group or context, perceiving that group members care about the well-being of others, and having value and importance to a group. Research reveals that Black girls are unfairly marginalized due to discourses that only positively recognize quiet, polite, passive, and fast workers (Wade-Jaimes & Schwartz, 2019). The data from this research suggest that there were shared challenges in terms of microaggressions directed toward the participants in a myriad of ways, such as microaggressions in the form of isolation, assumptions, exclusion, and stereotypes. For example, Bell experienced isolation in her informal STEM education program because she was the only Black girl there. Though she could not fully operationalize the situation, she understood it was an uncomfortable experience:

> I mean, the teachers did make me feel comfortable because like they did treat us all the same, I think, but it [STEM program] just felt uncomfortable to me because I was the

> only Black girl there, and I'm not gonna lie some of the programs I did do had more White people than like me being Black and it was uncomfortable.

Bell's comment suggested that she felt the isolation of an underrepresentation of Black girls in her STEM environment. In STEM, policies and culture reinforce isolation through the messages sent to other Black girls that they do not belong (Seymour & Hewitt, 1997). This could explain why no additional Black girls were a part of her STEM program. Harriet experienced microaggressions in the form of stereotypes and exclusion in one of the informal STEM programs, stating:

> They see me, a Black girl, as like being like lazy, maybe inconsistent, a procrastinator of some sort, maybe you aren't as organized, or you don't meet their expectations of organization or how they would like them [projects]. But, I would also say to add on, if you are with people who don't look at how you appear [your race], but mainly what's in your head, they want you to be there, but in some circumstances that don't work with a lot of people and they just see you based upon your race, and they'll just push you aside and go look for somebody else to be in their group who they think fits their idea of smart.

In Harriet's case, she experienced negative messaging in the form of stereotypes and exclusion. This stems from the notion that Black girls are not capable of being in STEM. The findings suggest that her peers believe damaging myths about Black people and therefore have determined that Harriet does not fit into their schema as capable of being a productive member of their group. Additionally, excluding Harriet from the group would suggest the use of Whiteness as property which is one of the ways Black girls are neglected from educational spaces (Harris, 1993). In other words, Whiteness as property in STEM would mean that Black girls are intentionally left out of spaces to safeguard STEM education for the most privileged (Wun,

2014). Racial microaggressions are one-way racial stereotypes are operationalized (McGee & Bentley, 2017). Stereotypes serve to dehumanize Black girls and ignore their brilliance. Audre noted:

> I think a lot of people have their own expectations of how Black girls speak or how Black people speak in general. So I had to use my normal speaking, like, when I'm talking to my mom or when I'm talking to my friends outside and speak very formally in front of people at the group or whatever, because I didn't feel like having to explain myself.

Audre's actions of "code-switching" were in an attempt to combat stereotypes by controlling the image of how her counterparts of all other backgrounds perceive Black people or Black women. Research suggests that microaggression can significantly influence Black women's sense of belonging in STEM (Dorch & Oarel, 2017). The findings from this study revealed the shared stories from the participants of the ways microaggressions have actualized in their informal STEM education programs. This aligns with the research that suggests Black girls experience imposed definitions of who they are and expectations of who they should be (Gibson & Espino, 2016). From this research, it does not appear that the microaggressions had a significant impact on the girls' outlook on STEM and their informal STEM experiences; however, we do not know the long-term effects of these instances. However, because they were expressed, it would suggest that the experiences did have an effect, even if minor. So, from a CRF and intersectionality perspective, we must recognize the potential harm that could be caused over time if Black girls internalize these negative messages..

Research Question Two: How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM? Within research question two, three themes emerged to examine how informal STEM education experiences developed Black girls'

STEM identity and increased their engagement. These themes were supportive systems, affirming spaces, and racial representation.

Supportive Systems: You Got My Back

The majority of the participants indicated that supportive systems were vital to their matriculation or persistence in STEM. For some of the participants having a support system positioned them as STEM learners. For others, it was the factor that introduced them to STEM. The findings from this study were consistent with the research that having a support system is a critical factor in Black girls' success in STEM education (Rice & Alfred, 2014; Tate & Linn, 2005). CRF supports practices that concurrently analyze and combat gender and racial oppression (Carter, 2012, p. 3). The findings from this study suggest that internal attitudes about STEM came from the participants' support systems. The support helped build the girls' confidence in their abilities to do STEM and served as an affirmation that STEM was achievable. The utilization of support systems encouraged the participants to persist in STEM even though the environment may not have welcomed them at times. Previous research on Black women and girls in STEM speaks to the critical need for a support system that can include family, teachers, and peers to ensure Black girls' interest and persistence in STEM (Gibson& Espino, 2016). Support in many cases can act as an anchor to ensure Black girls persist or a buffer against traditions that negatively affect their success in STEM (Erete et al., 2017; Young & Young, 2018).

The participants in this study express how their support systems were catalysts to and through informal STEM programs. For example, Harriet was sure that the only reason she was involved with STEM was that her third grade ELA (English Language Arts) teacher invested in her by recognizing that she was a "STEM "person even though at the time, Harriet did not

classify herself as someone who was a STEM person. Her third-grade teacher further invested in her by taking the time to help her fill out a STEM application to a summer camp. Harriet said:

> Like, the only reason I'm in STEM is cuz I was grateful to have, she was actually my first Black teacher in third grade. We always had these little folders that had all the information or news or what was going on. And she, I wouldn't stop talking to her about it, stop asking her about it. And how I didn't have a lot of time or like time in my schedule to like do an essay straight up. So, she actually called my mom because, and tell and told her like she really wants to do this and we did end up signing up for it. And I did my essay over the phone to my mom because she was like, no, she's doing this essay. She's getting into this camp. So, there's not a lot of people like that in your corner. I'm very grateful to have my third-grade teacher in my corner.

Harriet's teacher served as a support system because she took on the responsibility to invest in her beyond the classroom. It is possible that because Harriet's teacher was a Black woman, her support is rooted in her own experiences with racism and oppression, thus validating Harriet's brilliance as an act of solidarity and resistance against oppression. Additionally, Harriet has been able to persist in STEM because of the support of her family. They continued to encourage her ability in STEM.

> So, I'm very grateful to have my mom in my corner. I'm very grateful to my brother and my father who are always like, oh yeah, that's [STEM] something that's good, try it.

Harriet's response indicates she acknowledges the importance of her family's help to ensure she persists in STEM. Similarly, Audre acknowledged that her dad encourages her to try different presented opportunities. Stating,

> But, for me, whenever I was given an opportunity [STEM], my dad told me to take it.

Audre's response suggests that her father has been an integral part of her experiences in STEM. Because of the multiple layers of oppression that Black girls experience, it is essential that they have family support to reassure them it is acceptable to pursue STEM, as with the case of Audre and Harriet. Teachers in the formal and informal setting spend large amounts of time with students, and their support is vital to increase Black girls' STEM participation and identity. The data from this research suggests that supportive teachers or staff are essential to participants' engagement and STEM identity. Supportive adults can act as a fictive kinship. "Fictive kinship has been a component of Black American life since slavery. Due to separation from biological families, slaves largely depended on new kinships or extended community relationships as a means of survival and practical and socio-emotional support (Stack, 1974). Audre noted that staff helped her to excel in every way possible and "not just with STEM but in life, emotionally. She noted:

> The staff there were always polite and looked forward to helping us excel in every way on projects, in life, and emotionally. Other times my robotics teacher, like sat with me and started talking to me about his day, about my day. And we built an overall better relationship. Like they actually cared about what I wanted out of life.

Audre's comment "the staff actually cared" indicates that this type of interaction with her teachers is not a regular occurrence. The camp staff exhibiting care for her was an act that humanized the experiences and wholeness of Audre. Unfortunately, for Black girls, school is often a site of trauma where they are not validated or humanized. Audre's informal STEM experience suggests that Black girls need more STEM spaces where humanizing practices such as caring for the whole child are normalized. Program stakeholders can be critical components to

increasing participation and encouraging identity development in STEM for Black girls as they support their academic and social-emotional needs (Lane, 2016).

Affirming Spaces: Good Vibes

All the participants agreed that their STEM informal education program(s) positively impacted their lives. Many of the participants were several years removed from the program they were discussing. However, their memories were vivid, and their facial expressions showed the joy of participating in those programs. CRF provides a space for us to focus on the counternarratives of these girls to see them as inherently brilliant. The findings suggest that the positive experiences in informal STEM education programs were a factor in STEM participation and identity. The participants unanimously agreed that being a part of their informal STEM program added value to their lives. For example, Bell described how STEM influenced how she felt about engineering:

> My STEM program positively influenced how I feel about engineering. I mean, it did feel great because I thought I might not be that good at STEM [engineering] because honestly, it did seem a little bit confusing at first, but then as soon you like get to do it more, it started to feel more easier.

Bell's first thoughts about STEM was that it was hard and not for her. However, after participating in the STEM camp, she realized that she could be an engineer because she was able to do the work she thought she could not do. Bell increased her self-efficacy in STEM because she took a chance in her informal STEM program. Self-efficacy is one's perception of her ability to succeed at a task (Bandura, 1986). In other words, self-efficacy is how Bell perceived herself to be competent in engineering. Many of the participants did not know what to expect as they engaged in some of the STEM activities. Being a part of an unknown made them default to

feelings of inadequacy instead of an adventurous feeling of trying something new even though these spaces were non-punitive. These feelings of inadequacy suggest self-doubt, which stems from internalized oppression which can cause emotional distress such as anxiety. Black girls are susceptible to internalizing dominant stereotypes of their ability. However, they were all pleasantly surprised when they could accomplish the tasks presented to them in their STEM environment. These informal spaces provide empowering learning situations for students to realize that they can "do" STEM, thus defying negative messaging and increasing their STEM identity (Heard et al., 2000; Sasson, 2014). For example, Zora acknowledged that STEM developed her mindset. She was not sure of her ability in STEM or the program, but after completion, she recognized she had a renewed mindset: “STEM develops your mindset, and [you] have an open mind, like mindset changes. I liked that it opened my mind. It made me think outside of the box.” Zora's comment suggests that STEM allowed her to think differently and that the curricula challenged her to use her inherited intelligence and creativity. The act of Zora's acknowledging her intelligence in STEM was an act of resistance as the dominant narrative sees Black girls as positioned outside of STEM.

Positive experiences in informal STEM programs helped develop the participants' STEM identity. STEM development also led participants to have overall confidence in STEM, themselves, and their capabilities in other areas. STEM identity is how individuals view themselves based on confidence in their ability to utilize STEM skills and/or talents to become a STEM professional or innovator (Collins, 2018). Previous research suggests that informal STEM experiences increase female students' confidence in STEM (Jones et al., 2000). Moreover, informal spaces have provided marginalized students the opportunity to understand themselves inside and out of STEM (Rennie et al., 2003; Vincent-Ruz & Schunn, 2018). So while a healthy

STEM identity was being developed, these girls were simultaneously developing their self-perceptions of who they were outside of STEM. Thus, Black girls' existence in these informal STEM spaces is an act of resistance because they are persisting in environments that may not be designed for their success as STEM is a field that is dominated by White males. Their presence as Black females negates stereotypical images of should be positioned in STEM. The informal STEM education programs in this study are in stark contrast to the literature that states many of the elements that contribute to the negative culture of STEM education for Black girls manifest in academic contexts, namely the classroom setting. Black girls often report that STEM environments are unwelcoming, competitive, and discriminatory against students of color and women (Fries-Britt et al., 2013). Therefore, the informal STEM education programs that these participants served as counterspaces. Counterspaces are environments that facilitate psychological well-being among marginalized individuals (Case & Hunter, 2012). Being in an affirming STEM environment is extremely important to creating a healthy STEM identity for Black girls because of the compounded oppression and marginalization many Black girls likely face (Gholson & Wilkes, 2017; Joseph et al., 2017).

Racial /Gender Representation: Where My Girls At?

Every participant spoke about the impact of having the representation (or lack) of Black women and girls in STEM. The data from this research suggests that representation matters. Therefore, in light of CRF's view on the permanence of race and racism, it is essential for us to center how race and gender intersect within STEM. Racial representation can be a way to either marginalize or center Black girls. Research indicates that same-race and gender staff, teachers, or mentors resulted in girls exemplifying positive implicit attitudes, a deeper connection, and increased self-efficacy toward STEM. (Chen & Snolder, 2013; LeGrand, 2013; Sudler, 2009). It

was interesting that participants were in various types of informal STEM education programs. However, there were commonalities in their feelings about representation or lack thereof. CRF recognizes the multiple identities of Black girls and their unique experiences as different from White girls and both White boys and boys of color (Crenshaw, 1993; Wing, 2003). Therefore, it causes us to look at the ways representation has affected each participant in the STEM informal educational space. For example, Zora seeing Black women represented in her informal STEM education program increased her confidence and helped to assure her that she could be successful:

> I felt capable, sorta. I felt like I could do it [STEM] a lot of people there were, Black girls, so it didn't make me feel like an outcast or anything like that, it made me feel like I could do it, though. It [The STEM program] made me feel empowered and it made me feel like, like I could do anything else [in STEM] that anybody else could do.

Zora's statement "sorta" suggested that she questioned her ability but having a peer network gave her confidence in her ability to succeed in STEM. Consistent with previous research, Peer networks are also important factors that can affect the academic success of Black children. (Stout et al., 2011). Kunjufu (2011) stated that peer group interactions are positive interactions between friends in both academic and non-academic settings and are a salient influence. Zora's comment suggests that she may have encountered an environment where she felt isolated or an "outcast" because of her race. This comment also suggests that an environment with a lack of Black peers would have lessened her confidence in her ability to fit into the STEM environment. Bell stated that she was not sure if the teachers treated her differently in one of the informal STEM programs she attended. However, she was sure that she was uncomfortable being in an environment where she was the only Black girl. She could not communicate what that suggested,

but she was sure of how she felt. “It [informal STEM space] just felt uncomfortable to me because I was the only Black girl there.” Bell's feeling aligns with the research that speaks to many Black women and girls' isolation in the STEM spaces (Joseph, 2017; King, 2017). Research indicates that girls have solidarity with other Black girls to feel whole. In many cases, because of the multiple layers of oppression, Black girls face in STEM, this solidarity is a way they cope with devaluing narrative from peers and teachers in the STEM space. (Gholson et al., 2014; Joseph et al., 2017). An absence of same race and gender peer representation can be a painful experience and a disruptive practice that can affect the trajectory of Black girls in STEM. Same-race peers can act to counter the influence of race and racism in STEM environments and relationships in order to persist (Watkins & Mensah, 2019). This aligns with Harriet's experience with having four Black women speakers in her STEM program made on her life. I also want to note that Harriet attended a year-long STEM program that met once a week for nine months. So even with so few models of Black women in STEM, their presence made a significant difference in Harriet's STEM confidence.

> I think we've had like maybe three, four speakers out of all of our meetings who were Black women and just, I don't know, it just felt like STEM was something that I could do or be. Like, oh, hey, I could do this and that and such and such because she just proved that I could do that and more.

This aligns with the research that states that Black female role models matter in the lives of Black girls in STEM(Watkins & Mensah, 2019). The majority of the participants spoke about how seeing Black women as role models in STEM made them feel like STEM was a viable option. For example, Zora shared:

> Black girls or like, Black women are developing to like higher positions. you can see a lot more, a lot more examples of Black women and girls being in higher places or making more of an impact which helps me want to be a part of STEM.

Zora's comment suggests that because Black women are more visible in mainstream STEM disciplines, their example of excellence assures her that she can position herself in STEM. Ricks (2014) noted that role models can also help Black girls develop a deeper understanding of themselves and their communities. Additionally, role models can also provide them with the wisdom and experiences of their elders.

Research suggests that same-race/gender peers are essential to increasing participation in STEM, which builds confidence and commitment to STEM (Kunjufu,2011). When participation of Black women and girls is absent, it can have an adverse effect on Black girls' participation in STEM. Audre acknowledged that it may be hard for some girls to stay in STEM because of the lack of representation of Black girls in the programs.

> As of right now, I think like Black girls have like a big chance of doing things in STEM, but staying in STEM might be difficult, simply because you might not see a whole lot of representation wherever you're at of Black girls.

Audre's comment brings to light the dichotomous nature of STEM opportunities for Black girls; opportunities exist in STEM, but they are riddled with a number of situations that some Black girls may perceive as insurmountable challenges with racism, such as feelings of isolation, exclusion, and having to contend with negative stereotypes. As with Harriet's observation that STEM is not prompted to Black girls, "It's [STEM] not publicized or pushed to Black girls to do STEM and then it's not shown, a lot of times when we see STEM being promoted in school, it's kind of mainly the White girls on the cover doing the little labs and doing all the work and

making it seem like their work has paid off and our work isn't." Harriet's comment suggests that the culture of STEM excludes Black girls and sends negative messaging that STEM is not a place where they fit in. As we examine the culture of STEM, narratives of belonging are pervasive, and they do not position girls of color as STEM talent (Pringle et al. 2012), thus causing Black girls to question their belongingness in STEM learning spaces (Olitsy et al. 2010). For those Black girls who do pursue STEM, their presence is critical to how other Black girls situate themselves in STEM and persist. It is important to note that though participants mentioned the lack of racial representation in their informal STEM programs, they did not seem to interpret these racial experiences as particularly stressful or damaging to their experiences.

Research Question Three: What pedagogical practices effectively engage Black girls in STEM? Within research question three, one theme emerged to explore how Black girls engaged and responded to informal educational experiences. The fifth theme was instructional strategies.

Instructional Strategies: A Worthy Investment

How instruction is conveyed determines the capacity in which it will be received and utilized for knowledge or consumption. In informal STEM educational programs, instruction is often taught in nontraditional ways. However, the findings from this research suggest that in informal STEM education, the instructors used traditional methods to convey to teach lessons. As stated previously, each participant struggled with confidence in STEM and developing identity. CRF employs counternarratives as a point of resistance against the dominant narrative that encourages the racialization of women of color. Thus, listening to their experiences is key to understanding strategies that aided Black girls to persist and achieve success in informal STEM educational environments. Bell stated, "They encouraged us and helped us" Similarly, Audre noted on certain projects. “I would struggle. But there wouldn't be a part that I couldn't get back

up on or that I couldn't get help with. So, at the end, it would always work out." Bell and Audre's comments suggest the crucial element of encouragement for Black girls is in STEM as they develop a STEM identity. Their statements suggest a desire for support from their teachers. While this statement may be true of many girls in STEM, this statement is distinct because of the compounded oppression and marginalization many Black girls face in schools and, more specifically in STEM spaces (Joseph et al., 2017). The participants in this study acknowledged other supportive instructional strategies such as breaking down complex processes, teaching lessons step by step, or "walking us through" the problems. In other words, these STEM educators used scaffolding techniques to ensure that the participants understood assignments. Research indicates that many Black girls feel invisible in the classroom (Joseph, 2017), so when teachers take time to explain concepts, they acknowledge their vulnerability as adolescents. For example, Audre noted she could work on the assignment alone, stating:

> They did activities, and lessons step by step. They showed us how to do it first. Like how to do the project, gave us like an example either showed us a video of how to do it or did it themselves. And then like, it was like step by step, but then they would allow us to do it by ourselves, and if we needed help, we could actually come to them for help.

Audre's statement suggests that she enjoyed working independently and appreciated her teacher's trust to complete some projects independently. However, her independence did not overshadow her need to be reassured that she could come to her teacher for help if she needed it. Audre's statement also implies that she has had other classroom interactions where she could not always access her teacher for help. The approachability of staff is crucial because it demonstrates an environment where students are assured they will have the support they need to be successful, which builds a healthy STEM identity. As with Harriet's experience, her instructors interacted

and connected with her. She stated, "It makes us want to keep going." Teachers who relate to their students is an instructional strategy that builds a trusting learning community and humanizes Black girls, promoting positive social interaction (Tuitt, 2003). Teachers being approachable, interacting, and connecting with Black girls acknowledges their worth as learners and recognizes the value of positive interaction. When this strategy is applied consistently to their pedagogy, teachers can better transform how Black girls view themselves in STEM environments. Likewise, Bell talked about the teachers and activities being fun:

> What I would tell someone about the teachers in this STEM program is that they are full of fun and help us when we need it because some of the stuff was confusing, and most of it was new. They let us do fun activities based on the STEM subject that we were doing such as coding through music and creating our own designs through engineering.

Her comment suggests that being in a pleasant and enjoyable environment helped her engage with STEM. Her view of the informal STEM environment underscores the importance of incorporating learning activities that Black girls find enjoyable and want to be a part of. Black girls especially can benefit from this type of instructional style since they have historically been perceived as hard to teach (Evans-Winters & Esposito, 2010) or adultified (Joseph, 2017; Morris, 2013). Teachers who bring joy into the classroom restore the innocence that Black girls have not been afforded (McGee & Bentley, 2017). This research also established the importance of how teachers made participants feel in the STEM environment, encouraging them to engage in and be a part of the STEM community. These findings are consistent with the need for Black girls to be taught in environments where teachers engage in humanizing practices such as an ethic of care (Noddings, 2012). "When we care, we consider the other's point of view, their objective need, and what he expects of us" Noddings, 2013, (p.24). Additionally, Ladson-Billings (2009) stated

that caring for students entails personal expressiveness, emotions, and empathy as a part of the knowledge validation process. Caring validation is crucial to Black girls' participation in STEM because they are a part of a largely oppressed group. For example, Zora noted that there was always a "good vibe" in her informal STEM program. Audre stated that her teacher's "aura" made her feel welcome and included every time she was there. For several of the participants, their description of their informal space was freeing. These participants could engage deeply with the STEM content because they sensed an environment that cared for and welcomed them. Likewise, Audre spoke about her teacher,

> Like, for instance, I forget her name, but there was this one lady and she just like, listen to what I had to say first, when I came to like me being confused about a certain project and gave insight and then asked me more questions, not like in a disrespectful way, but to push me to think further.

Audre's comments suggest that she wants to be challenged and encouraged as a way to prove her intellect, however, there is a need for her to be treated with care. Her comment suggests that her teacher employed a caring disposition in that she listened to the needs of Audre. Audre makes a point to acknowledge that even though her teacher pushed her but not in a disrespectful way, this suggests that Audre has had instances where teachers may have been disrespectful when "pushing" her to think. Consistent with the literature that indicates Black girls are often in educational environments where their intellect is not valued nor are they cared for (Evans-Winters,2007; Morris, 2013). The findings from this research suggest that teachers that believe their students are worthy investments increase STEM participation and identity.

Though the Black girls from this study did not describe themselves as an "outsider" in their informal STEM education programs, their accounts suggest that they were. The various

experiences of being the "only one," stereotyped and excluded, implied that they were an "outsider ." This is consistent with research that states the likelihood of Black girls experiencing situations of being the only person of their racial and gender identity in STEM spaces is significant. There is also a greater chance that Black girls will experience racial and gender stereotypes and microaggressions in STEM environments. Most participants indicated that they experienced racial stereotypes or microaggression in their STEM environments. However, the findings do not support that participants experienced gender microaggressions or stereotypes. However, because of the intersectionality of CRF, we must look at how these interactions affected their emotional and psychological well-being at the intersection of race and gender. The informal STEM experiences of the Black girls in this study were acts of resistance. While oppressive spaces in STEM contribute to the disparities in Black girls' participation, these girls are defying the odds. Their stories of persistence in the face of sexism and racism in a male-dominated discipline are valuable to advancing the field of STEM.

Implications of the Study

Findings from this study suggest several possibilities for practice. This study suggests that creating welcoming, innovative spaces for inquiry and fun in STEM is critical to increasing Black girls' participation. Black girls want to learn in environments that value their brilliance and those that are learning spaces of joy; Black girls deserve joy. Black girls desire a sense of belonging and connection to STEM communities that welcome and accept their authentic selves. The data from this study directly supports the positive effects that STEM informal education programs possess. Several participants noted that participating in STEM informal programs enhanced their ability to think outside the box and be more open-minded. The informal STEM experiences and programming added value to the participants' lives. The participants noted that

these environments were welcoming. There is a need for this type of informal STEM education program structure, especially in the lives of Black girls. Historically, STEM has not been a place where Black women and girls have been centered. Ultimately Black girls want to be in environments where they matter. Historically, many STEM environments have marginalized Black girls' gifts and talents. Thus, Black girls have been conditioned to believe that they do not matter in these spaces when we examine the culture of STEM, such as the structure of the curriculum, the teachers in charge of the curriculum, and how STEM is taught. Black girls want to know that they belong in those spaces and their abilities will be recognized. Therefore, informal STEM educational spaces that center the representation and voice of Black women and girls are paramount to their increased participation and STEM identity. Role models and mentors are paramount to Black girls' healthy existence in STEM. The study suggests that representation of Black girls' same race and gender mattered in the matriculation through STEM education. As previously stated, the exposure of Black women in STEM is one strategy to increase STEM efficacy and identity.

Because of the disproportionate number of Black women and girls in STEM, Black girls must be exposed to resources and programs outside of school that provide opportunities for exploration and engagement in STEM. It was clear from this research that being exposed to these informal STEM education programs changed how the girls positioned themselves in STEM. Although all the participants did not articulate that their STEM program boosted their confidence, they all implied it differently, such as "I did great even when I thought I couldn't", or "STEM changed my life."

Additionally, the findings from this study also suggest that there is a need to attend to the psychological and emotional wellbeing of Black girls in informal STEM spaces by grounding

humanizing approaches to teaching STEM. These approaches should honor Black girls' background knowledge, culture, and life experiences. Thus, teaching STEM as a way that honors the multiple ways of "being" a Black girl is important. Historically, the culture of STEM has rooted negative stereotypes and messaging that do not position Black girls as STEM talent. These narratives can be particularly damaging to Black girls as they question their STEM belonging. Over time, these microaggressions could influence Black girls' sense of belonging in STEM. The participants overwhelmingly agreed that their informal STEM experiences positively affected them; however, they all mentioned racial microaggressions and the lack of racial representation within their programs. As previously mentioned, the participants did not seem to interpret these racial experiences as stressful or damaging to their STEM experience; however, they felt the need to share these experiences suggesting that they may have had some minor effects on their psychological or emotional wellbeing holistically. Therefore, there is a need for ongoing work to examine and propose solutions to inclusion, injustices, and inequities in STEM education.

Limitations

This study aimed to impact the interdisciplinary field of research regarding Black girls in STEM, and the findings revealed several significant factors that affect the participation of Black girls in STEM. However, as a researcher, I acknowledge that research has limitations due to human nature. Likewise, this dissertation has several limitations.

1. Limitations to this research would be not using observations as a data source. Though this study used interviews which are a source of rich data, it could be possible that the interview protocol could limit the participants' views. Observations would have allowed the researcher to

visually capture the “everyday” experiences of participants in their natural settings thus strengthening this study.

2. This study utilized a small sample size. From some researchers' point of view, this could be viewed as a limitation; however, having a small sample size allowed me to focus more intensely on all the girls in this study. In future research, I plan to expand my sample size and age ranges of participants to understand the experiences of various Black girls in grades such as primary and postsecondary education.

3. Another limitation is that while I am a researcher in this study, I am also a Black woman who works with Black girls in STEM. As a researcher, I brought my values and beliefs into this research study. I was keenly aware that I related to the participants' experiences and lives as a Black woman. I made sure that I used member checks to ensure the validity of this study. Therefore, the researcher used member checks to reduce possible biases.

4. A final limitation could be the participants' ages. There could have been instances where the participants may not have been able to communicate their thoughts and feelings in a manner that allowed the researcher to collect enough data for effective analysis. However, the researcher felt that establishing rapport with the participants allowed her to gather enough data from each participant to analyze for themes.

Recommendations and Areas for Future Research

Recommendations for Educators, Informal STEM Education Programs, and Policymakers

Despite efforts to increase and diversify STEM, there continue to be disparities in the STEM field and STEM education. Additionally, due to opportunity gaps, traditional education has come short when educating Black children in mathematics and science. There continues to be a need to understand factors that affect Black girls’ participation in STEM. Therefore, stakeholders must

be committed to cultivating Black girls' STEM engagement and identity. Thus, it is critical that we not only hear the voices of Black girls but utilize those voices when developing educational programs, curricula, policies, and mentoring practices.

Recommendation for Current and Future Educators:

Much of the work that needs to be done with STEM education begins with pre-service teacher education programs. These programs must focus on how teachers are trained to address science and mathematics. Additionally, race-based justice work must be ingrained in the curriculum in pre-service teacher programs. These programs are the critical first steps to equitable outcomes for Black girls in K-12 education. Work should be done to challenge deficit notions of Black girls, inequities in K-12 education, and White ideology, curriculum violence. This work will lay the foundation for nurturing the gifts and talents of Black girls who see themselves in the curriculum and ultimately positioned within the context of STEM.

Recommendations for Informal STEM Education Programs:

There is a need to expand opportunities for Black girls in STEM as well as address systemic structures that prevent access to these opportunities such as affordable programs, and transportation to these programs. Informal STEM education programs must ensure that programs do not replicate the racist structure in traditional schools that are barriers to Black girls' engagement in STEM such as lack of diverse role models and participants in STEM programs. Additionally, informal STEM education programs should emphasize Culturally relevant and gendered practices such as validation, developing the whole child and humanizing practices that emphasize joy.

Recommendations for Policymakers:

Policymakers should significantly increase funding for alternative programs to engage Black girls in STEM. Partnerships with Colleges and Universities are paramount to developing a strong STEM pipeline for Black girls. Additionally, partnerships with Historically Black colleges and universities would have a considerable impact for Black girls as these institutions have Black talent in STEM that can serve as role models and create a stronger sense of belonging for Black girls.

Areas for Future Research

The purpose of this study was to bring attention to the disproportionate number of Black women and girls who persist in STEM disciplines. Additionally, this study's goal was to serve as a catalyst to increase awareness and research related to informal STEM education programs to mitigate the disparities of Black girls' participation in STEM. Five themes influenced Black girls' STEM engagement and identity in informal STEM education programs. Findings from this study reveal the need for researchers, educators, and policymakers to consider informal STEM spaces as one intervention to encourage participation in STEM for Black girls. This study was conducted to fill a noticeable gap in the literature about Black girls in informal STEM education and the impact on their participation and STEM identity. Thus, few studies have been conducted that specifically target Black girls and informal STEM education programs. Previous studies have focused on Black girls in STEM education and Black girls in mathematics and science education. However, there is still insufficient literature on how informal STEM education can serve as effective tools to prime the STEM pipeline for Black girls. Future research should include the following:

- Examining pre-adolescent STEM identity development in informal STEM spaces as an intervention to prime the STEM pipeline. This research revealed that the participants

were not exposed to STEM until later in their adolescent years. Therefore, there were missed opportunities in elementary school for exposure to STEM. This early introduction to STEM could have mitigated confidence issues, STEM efficacy, and STEM identity gaps.

- Examining the school counselor's role in mentoring and educating Black girls at the school level to encourage STEM identity and self-efficacy development. The data from this research suggested that STEM identity and self-efficacy work was needed with the participants.
- Examining informal STEM education programs that specifically focus on culturally relevant practices for Black girls. The data from this research focused on the participants' experiences. The data from this research suggest the need for culturally sensitive STEM programs for Black girls.
- Examining informal STEM education as an extension of traditional education. The data from this study focused on informal STEM education for Black girls; however, there was no direct connection to traditional schools. Current research indicates that Black girls are underserved in schools. This study's analysis revealed that STEM engagement in informal education was effective. There is worth examining how formal and informal education can come together to increase Black girls' participation in STEM disciplines.

Conclusion

STEM as a place of mattering (Love, 2020) for Black girls is imperative. Love (2019 described mattering as a quest for humanity, an internal desire for freedom, joy, and restorative justice. Until there are spaces consistently dedicated to practices that promote academic success, sociopolitical consciousness, and joy (Price-Dennis & Muhammad, 2021), change in STEM for

Black women and girls will be slow. This study's intention was to convey the stories of adolescent Black girls who persist in STEM spaces. These participants' stories are their truths and communicating them is consistent with the tenets of Critical Race Feminism and Black Feminist Thought, which seek to provide affirming spaces within a racist and sexist society where Black women and girls face intersecting forms of oppression (Collins, 2000). Collins (1990) urged us to closely examine bodies of work that speaks for Black women and girls without their input and thus the need for Black feminist though.

> Crenshaw (1989), states intersectionality describes the multiple ways in which oppression is experienced: Consider an analogy to traffic in an intersection, coming and going in all four directions. Discrimination, like traffic through an intersection, may flow in one direction, and it may flow in another. If an accident happens in an intersection, it can be caused by cars traveling from any number of directions and, sometimes, from all of them. Similarly, if a Black woman is harmed because she is in an intersection, her injury could result from sex discrimination or race discrimination. . . . But it is not always easy to reconstruct an accident: Sometimes the skid marks and the injuries simply indicate that they occurred simultaneously, frustrating efforts to determine which driver caused the harm. (p. 149)

Therefore, this research aims to utilize the narratives of Black girls to re-imagine STEM education with the expressed intent to notice, validate, and humanize Black girls (King, 2021). This research provides a point of noticing. Mason (2002) explained that noticing is how we fight the tendency to forget or not notice. Therefore, noticing causes us to be keenly aware of the realities of Black girls face and calls us to unremittingly challenge injustices to construct more

inclusive and welcoming STEM learning spaces. This research also calls us to validate Black girls as “enough,” complete individuals with multi-dimensional identities that must be affirmed. Validation is defined as an affirmation that a person or their feelings or opinions are worthwhile (Merriam, n.d.). Validating the voices and experiences of Black girls as experts and countering dominant mainstream narratives is necessary. Black girls must be free to thrive without the onus of adapting to preexistent standards of whiteness. While some informal STEM education programs validate Black girls and create safe spaces, there is still work to be done. Finally, this research calls for us to humanize Black girls in the context of STEM and beyond. Engaging in humanizing practices is pivotal for Black girls because they are a part of a largely oppressed group that dominant U.S. society regards as broken (McGee & Bentley, 2017). However, there is hope in informal STEM education spaces, as seen by the narratives of the participants who shared stories of humanizing experiences in their STEM informal spaces. Therefore, safeguarding spaces where Black girls' gifts and talents will be nurtured "in and out "of education is imperative for their increased STEM participation.

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APPENDIX A: QUESTIONNAIRE

IN AND OUT: A CASE STUDY EXAMINING ADOLESCENT BLACK GIRLS' STEM ENGAGEMENT AND STEM IDENTITY IN INFORMAL STEM EDUCATION PROGRAMS

1. How old are you?
2. What grade are you in?
3. What is one word to describe yourself?
4. Would you say that you were a STEM person?
    a. Why or Why not?
5. How do you feel about your ability in STEM?
6. What activities or sports do you participate in?
7. Does anyone in your family have a STEM career?
    a. If so, what career?
8. What you hear Black girl magic what does it mean to you?
9. What informal STEM programs have you attended?
10. What made you enroll in the informal STEM program?
11. What career do you want to pursue when you grow up?
    a. If it is related to STEM, do you believe your informal STEM experience influenced your decision?

APPENDIX B: INFORMAL STEM LEARNING INTERVIEW PROTOCOL

IN AND OUT: A CASE STUDY EXAMINING ADOLESCENT BLACK GIRLS' STEM ENGAGEMENT AND STEM IDENTITY IN INFORMAL STEM EDUCATION PROGRAMS

Good morning (afternoon). My name is Deneen. I am a doctoral candidate at the University of North Carolina at Charlotte (UNCC). Thank you for taking the time to talk with me today. I am conducting this interview to learn about the experiences of adolescent Black girls' participation in informal STEM education programs. In this interview I will ask you about your experiences in an informal STEM education program. There are no right or wrong or desirable or undesirable answers. I would like you to feel comfortable with saying what you really think and how you really feel. If it is okay with you, I will be recording our conversation. The purpose of this is so that I can get all the details but at the same time be able to carry on an attentive conversation with you. I assure you that all your comments will remain confidential, meaning that only I will be aware of your answers. I will be compiling a report which will contain all students' comments without any reference to individuals. The interview should last about 30 minutes.

Establishing Rapport-Warm-Up Questions

Q 1. Tell me a little bit about yourself?

Probe:

- How old are you?
- What grade have you completed?
- How do you feel about school?
- What is your favorite subject?
- What are some subjects that are challenging?
- Do you enjoy school?

R.Q.1 What are the experiences of Black girls in informal STEM spaces who persist?

Informal STEM Education Program

I would like to learn about your experiences during your informal STEM education program.

- **1(a). How do Black girls engage in and respond to informal STEM learning experiences?**

Q 2. Can you tell me about your experiences during your STEM program?

Probe:

- What program did you attend?
- When did you attend the program?
- What type of STEM program was it?
- Did it combine all these subjects?

Informal STEM Participation/Engagement

- What activities did you do?
- What was your favorite activity?
- What did you enjoy about the program?
- How was your relationship with teachers?

- How was your relationship with peers?
- What were some challenges?
- What were some things you wish you could change?
- Do you think the STEM program will help you be more successful in school?
- How do you think this program has benefited you as a Black girl?

- **1(b) How can informal STEM learning experiences develop Black girls' STEM identity and increase participation in STEM?**

STEM Identity

Q 3. What were your feelings about your ability to be successful in this STEM program?

Probe:

- Do you feel this was a program for Black girls?
- I'd like to learn about your STEM lessons.
- What was your favorite STEM lesson and what made it that way?
- What are your thoughts about your ability in STEM?
- Who or what influences your ideas about STEM, in other words, how do your ideas and feelings about STEM form?

- **1(c) What pedagogical practices effectively engage Black girls in STEM?**

Q 4. What are some of your teacher's instructional practices that helped you engage in STEM?

Probe:

- What classroom activities did your teacher use that helped you understand STEM?
- What did your teacher do to help you learn different concepts?

Youth Participant Cooling Off:

Q 5. What are your ideas about you becoming involved in STEM in college or when you grow up?

Probe:

- *Do you want to go to college?*
- *What do you want to go to college for?*
- *Do you want to choose STEM as a career choice like being a scientist, engineer, mathematician, computer scientist, etc.*

Q 6. Is there anything else you would share with me about your thoughts and feelings about STEM or your informal STEM program?

APPENDIX C: REFLECTIVE PROMPT

IN AND OUT: A CASE STUDY EXAMINING ADOLESCENT BLACK GIRLS' STEM ENGAGEMENT AND STEM IDENTITY IN INFORMAL STEM EDUCATION PROGRAMS

Goal of the Study	**Reflective Prompt** Directions: Please take this time to think about the specific STEM programs you attended. Use the questions to help guide you as you write about your experiences.
The purpose of this study was to investigate the experiences of adolescent Black girls in informal STEM education programs who persist. Specifically, this study examines aspects of informal STEM education programs that influence STEM participation and STEM identity.	What particular STEM programs did you attend? What have been some of your experiences attending these STEM programs? (What did you do? What did you observe? How did you feel?) Describe ways in which these STEM programs positively or negatively influenced how you feel about STEM? What would you tell someone about the teachers at this STEM program? What would you tell someone about the STEM program(s)?

Reflective STEM Prompt-Bell

Please take this time to think about the specific STEM program(s) you attended.
Use the questions below to help guide you as you write about your experiences and feelings.
Please note that this is a reflective journal prompt. Please describe as much as you can. There are no right or wrong answers. Thank You.

What particular STEM programs did you attend?
What have been some of your experiences attending these STEM programs?
(What did you do?What did you observe?How did you feel?)
Describe ways in which these STEM programs positively or negatively influenced how you feel about STEM?
What would you tell someone about the teachers at this STEM program?
What would you tell someone about the STEM program(s)?

1.The particular STEM programs that I attended was a Coding STEM program, and an Engineering STEM program.

2. Some of the experiences that I had when attending these STEM programs was being able to use coding to make music, and in the other one we created our own object on a website of our choice and presented it to the camp. I did great! But, I was a little bit nervous because I was the youngest one in my engineering program and I was afraid that I wouldn't do so great.

3. Ways that the STEM programs positively influenced how I feel about STEM is that in the Engineering STEM program I did we used a website based on engineering where we came up with our own ideas and built them through the engineering website. And this positivity influenced how I feel about engineering and STEM. It's an interesting yet fun subject to do and learn about and I thought engineering was something difficult but it turns out to be fun.

4. What I would tell someone about the teachers in this STEM program is that they are full of fun and help us when we need it because some of the stuff was confusing and most of it was new. They let us do fun activities based on the STEM subject that we were doing in the STEM such as Coding through music and Creating our own designs through Engineering.

5. What I will tell someone about STEM programs is that they are really fun! You get to have a deeper dive in what STEM is really about. You get to do activities based on what you learned in STEM and what STEM subject you learned about such as Science, Technology, Engineering, and Mathematics. And you present what project you did to your program teachers and others in the program.

STEM REFLECTIVE PROMPT-Audre

Goal: Reflect on informal STEM experience: My stem experience has been really amazing. I've been a part of robotics clubs and have gone to stem based schools since	*Please take this time to think about the specific STEM programs you attended.*

middle school but my favorite stem program I've ever been in was Girls Make makerspace in 7th- 8th grade. We would come in around 5 or so and they would provide different foods each time then we'd get down to business. Whether we worked with a hammer and nails to create patterns for nail art or used various metals to solder motherboards into a working alarm, we'd tap into kinetic learning while learning to vibe well with others. This experience showed me that women (especially women of color) can make a difference in the stem field especially through science. The teachers and administration staff there were always polite and looked forward to helping us excel in every way on projects, in life, and emotionally. 10/10 would definitely recommend to anyone interested in stem but also to those who just need a break from their reality to tap in to a new activity sure to change your life for the better.	*Use the questions to help guide you as you write about your experiences and feelings.* *You do not have to answer the question verbatim, they are just a guide.* *There is no length requirement. I just ask that you write complete thoughts.*
Purpose: To understand the ways in which Black girls feel their informal STEM program was beneficial and developed their STEM identity.	● What particular STEM programs did you attend? ● What have been some of your experiences attending these STEM programs? *(What did you do?What did you observe?How did you feel?)* ● Describe ways in which these STEM programs positively or negatively influenced how you feel about STEM? ● What would you tell someone about the teachers at this STEM program? ● What would you tell someone about the STEM program(s)?

STEM REFLECTIVE PROMPT-Zora

Goal: Reflect on informal STEM experience: https://youtu.be/QkDCCPq7zzM My informal STEM experience was a good one. I had the privilege of being a part of an	*Please take this time to think about the specific STEM programs you attended.*

after-school program called Girls In STEM with the Discovery Place. In this program I was able to let my creativity run wild as I created various projects that related to the components of STEM.Some of the projects included working with multiple power tools,Carvey, and the 3D printer.While at this program I was working with other girls who wanted to explore the world of STEM. We all learned from two instructors who worked to teach us how to do the projects and use a variety of tools. This program positively shaped my view of STEM by showing me ways to think outside of the box. While using the knowledge from STEM I was able to complete the projects assigned.This experience led me to further my interest in STEM which eventually caused me to participate in the Discovery Place as a volunteer during a few weeks in the summer of 2018. If I could I would tell someone about the instructors at the STEM program I would say that they were absolutely amazing. They showed me so many new things and they pushed me to bring my creativity to the forefront when doing projects. The instructors made everyone feel comfortable to be in the environment. No one was undermined while in the program and the instructors kept good vibes throughout the Maker Space. I would tell people that the Girls in STEM program helped me develop my love for STEM. It also helped me to come more confident in my creative thoughts. The program was an amazing opportunity that I got to be a part of and I wouldn't trade the experience for the world.	*Use the questions to help guide you as you write about your experiences and feelings.* *You do not have to answer the question verbatim, they are just a guide.* *There is no length requirement. I just ask that you write complete thoughts.*

Purpose: To understand the ways in which Black girls feel their informal STEM program was beneficial and developed their STEM identity.	● What particular STEM programs did you attend? ● What have been some of your experiences attending these STEM programs? *(What did you do?What did you observe?How did you feel?)* ● Describe ways in which these STEM programs positively or negatively influenced how you feel about STEM? ● What would you tell someone about the teachers at this STEM program? ● What would you tell someone about the STEM program(s)?

STEM REFLECTIVE PROMPT-Harriet

Goal: Reflect on informal STEM experience:	*Please take this time to think about the specific STEM programs you attended.* *Use the questions to help guide you as you write about your experiences and feelings.* *You do not have to answer the question verbatim, they are just a guide.* *There is no length requirement. I just ask that you write complete thoughts.*
Purpose: To understand the ways in which Black girls feel their informal STEM program was beneficial and developed their STEM identity.	● What particular STEM programs did you attend? ● What have been some of your experiences attending these STEM programs? *(What did you do?What did you observe?How did you feel?)* ● Describe ways in which these STEM programs positively or negatively influenced how you feel about STEM? ● What would you tell someone about the teachers at this STEM program? ● What would you tell someone about the STEM program(s)?

STEM began to display a large impact on my life at a young age providing a secure base for my love of science and interesting me in multiple STEM programs. The first STEM program was Project Scientist, an all-girls Science camp that provided a female interest concerning STEM. My second STEM program was a Geek Squad camp that opened my eyes more to technology by demonstrating coding, picture taking, making music, and creating digital buildings. The third STEM program that I have completed my first year with is a Health Sciences camp diving deeper biologically as well as giving us a crime scene example to solve. The last STEM program I am attending is a mentoring program built by Project Scientist demonstrating STEM-oriented activities providing speakers as well as our own mentors.

Some of my experiences attending these STEM programs have been overall positive and very influential. Each camp and program that I have been in has made me feel welcome right off the bat and didn't hesitate to help or to demonstrate STEM scenarios. I observed how to properly deal with a STEM-related issue, may it be a code inaccurately reading data, a picture being blurry, or how DNA is structured.

Different ways that these STEM programs have positively influenced how I feel about STEM is using inclusion as well as real-life instances that would prove valuable. The majority of the programs that attend include problems that have been displayed in my life or in someone's life that I know. As well as relatable and understandable situations that could also be portrayed in someone's everyday life including your own. Regarding all of the STEM programs that I attend they have incorporated real-life situations that would most likely be seen in the workplace or just roaming as an adult. It could be in connection to your groceries, housing, or even your future job. All of these ways collectively provide an even platform to display my knowledge, having a positive influence on my life.

Something that I would tell someone about the teachers in all of the programs that I have attended would be that when they say that they care or are concerned that they actually are. Not only do they care about STEM as much as you do, they also care about you and wouldn't mind learning more about you and seeing where you would end up in life. An example would be project scientists, although I am well beyond the age requirement for the camp that they have every year they still kept in contact and introduced me to their mentor program. I would definitely tell someone about these STEM programs and what is waiting for them.

APPENDIX D: INTERVIEW PROTOCOL #2

IN AND OUT: A CASE STUDY EXAMINING ADOLESCENT BLACK GIRLS' STEM ENGAGEMENT AND STEM IDENTITY IN INFORMAL STEM EDUCATION PROGRAMS

Hello. And thank you for agreeing to participate in a second interview. The last time we met we talked about your informal STEM education program experiences. The purpose of this interview is to talk about your experiences in STEM as Black girl. So let's get started….

R.Q.1 What are the experiences of Black girls in informal STEM education programs who persist?

- ★ How do you believe being a Black girl influences (impacts, influences) your opportunities to participate and be successful in STEM?
- ★ Based on your experiences in the STEM programs you attended do you believe the activities related to you as a Black girl?
- ★ Do you think the activities in your STEM program were designed (intended, planned) for Black girls?
- ★ What barriers (difficulties) did you face in the program?
- ★ What are some barriers (difficulties) that prevent Black girls from participating in STEM?
- ★ What barriers (difficulties) did you face in the program?
- ★ What do you think it means to be a Black girl in STEM today?

Thank you again for your help with my research project. This will be our last time speaking about my research project. I wish you much success in your future endeavors.