THE REARVIEW MIRROR: NAVIGATING THE STEM (STEAM) IDENTITY OF MIDDLE GRADES BLACK GIRLS THROUGH ONLINE EXTRACURRICULAR COUNTERSPACE

by

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ABSTRACT

W. KEITH BURGESS: The Rearview mirror: Navigating the STEM (STEAM) Identity of Middle Grades Black Girls Through Online Extracurricular Counterspaces. (Under the direction of DR. GREG WIGGAN)

U.S. school achievement has been the subject of much discussion. In the case of science, technology, engineering, arts, and mathematics (STEAM), the national underperformance across the country, as well as the underrepresentation of minorities are key issues (Anderson et al., 2023; Handelsman & Smith, 2016; National Research Council, 2015; The White House, 2017). Particularly, there is a small, but growing body of research on the low numbers of Black women in STEAM, and the Black girl's STEAM pipeline. Extracurricular STEAM programs have shown some success in increasing minority STEAM participation. As such, this dissertation seeks to investigate the following research questions: RQ1: How do online extracurricular STEAM programs created for Black girls serve as a potential space to increase STEAM identity? RQ2: Are there identifiable features that exist in online extracurricular STEAM programs that are important for creating a counterspace for adolescent Black girls? Through a qualitative case study, this dissertation explored Black girls' participation in online STEAM programs. The findings of the study reveal that the extracurricular STEAM programs helped to foster STEAM identities in young Black girls. The programs also help students build a sense of community and create a safe space for Black girls. The study provides implications and recommendations for educators and policymakers who are interested in increasing minority STEAM participation.

Keywords: Black girls, STEAM, Minority STEAM participation, Urban education, STEM

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working with you both to create new memories and having a broader impact on historically disadvantaged communities.

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DEDICATION

I wish I could name all of the people who I would like to dedicate this dissertation to. Unfortunately, that is not possible because this section would quickly turn into an encyclopedia. However, I would be remiss if I didn't mention my parents, Wally and Marie Burgess with whom without, none of this would be possible. You have truly been my number one supporters since birth and my values, ethics, temperament, gifts, and intuition all come from you. Thank you Ma and Dad for all of your tireless efforts to get your first born to this point in my life journey. I also want to shout out my brothers Evan and Steven, two thirds of the famous trio, Hurricane, Thunder and Lightning. I love you both and appreciate your brotherly love and friendship throughout our lives.

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TABLE OF CONTENTS

LIST OF FIGURES xi

LIST OF TABLES xii

CHAPTER ONE: INTRODUCTION 1

STEM Origins 2

History of STEM in the US 3

Science Achievement in the US 6

Role of STEM Exposure in Influencing career 8

Implementation of STEM in K-12 10

Problem Statement 13

Focus on Middle Grades 15

Implications for Shortage of STEM 17

Purpose Statement 18

Research Questions 19

Significance of the Study 20

Define Terms 21

Delimitations 28

Limitations 28

Chapter Summary 29

CHAPTER TWO: LITERATURE REVIEW 31

Critical Race Feminism (CRF) 32

Counterspaces 34

The Need for Black Girl Counterspaces 36
Counterspace as a Framework For Analysis 37
Importance of STEAM exposure in middle grades 40
History of Black Women in STEM 41
Possible Causation of STEAM Disproportionality 43
Perception of Scientist 43
Adolescent Black Girls in STEAM 44
Black Girls and STEM Identity 44
How Do Middle School Black girls Develop STEM Identity 45
Inspiring Girls in STEAM 46
Representation and Role Models 46
Education Initiatives and Programs 47
Establishing Support Networks for Black Girls 48
Extracurricular STEAM Programs 49
CHAPTER THREE: METHODOLOGY 54
Methodology Overview 54
The Purpose 54
Research Design 56
Sample Description 58
Data Collection 59
Data Sources 60
Analytical Procedures 63
Content Analysis 64

Coding Procedures 64
Analyzing Cases 67
Researcher Positionality 67
Methods Limitations 68
Chapter Conclusion 69
CHAPTER FOUR: FINDINGS 70
Overview of Findings 70
Participant Description Data 72
The Hidden Figures 73
STEAM Program Our Girl Coders (OGC) 78
STEAM Program BLack Girls STEAM (BGSTEAM) 79
Cracking The Code 80
Study Themes 80
Chapter Conclusion 97
CHAPTER FIVE: DISCUSSION 98
Findings and Discussion 98
CRF and Counterspace Experience 99
Research Questions and Themes 100
Implication 111
Limitations 113
Recommendations 113
Summary 115
REFERENCES 117

APPENDIX A: INTERVIEW PROTOCOL 133

APPENDIX B: RECRUITMENT PHONE SCRIPT 135

APPENDIX C: ASSENT FOR CHILDREN 12-17 138

APPENDIX D: PARENT OR GUARDIAN CONSENT 140

LIST OF FIGURES

FIGURE 1: Stages of human evolution defined by their ability to manipulate 3

FIGURE 2: CRF framework 33

FIGURE 3: Counterspace Framework 38

FIGURE 4: Coding procedure 65

FIGURE 5: Comparison of online STEAM programs 80

FIGURE 6: BGSTEAM storytelling image 88

FIGURE 7: OGC program for building relationships 91

FIGURE 8: BGSTEAM relationship curriculum 92

FIGURE 9: BGSTEAM self identification 93

FIGURE 10: BGSTEAM creating a safe space statement 96

FIGURE 11: OGC Commitment to safe space 96

FIGURE 12: BGSTEAM curriculum for safe space 97

FIGURE 13: Emergent themes and research questions 100

LIST OF TABLES

TABLE 1: Singapore vs US science scores 11

TABLE 2: Processes in counterspace 39

TABLE 3 Research design chart 57

TABLE 4: Data collection chart 61

TABLE 5: In Vivo coding process 66

TABLE 6: Description, similarities and differences of participants 75

CHAPTER 1: INTRODUCTION

Advancing the economic outlook for the middle grades science students that I teach has long been the driving force behind why I entered the field of education. Graduating from my undergraduate institution with a Bachelor of Science Degree in biology provided me with the essential skill set that would be necessary to provide science, technology, engineering, arts and mathematics (STEAM) instruction for the urban scholars that I teach. There is an extensive amount of literature that has been published communicating the need for an increase in the number of individuals that are trained and qualified to work in STEM careers (Anderson et al., 2023; Business Roundtable, 2017; Handelsman & Smith, 2016; National Research Council, 2015; Scherer & Leshner, 2018). For example, there are presently over 16 million technical positions demanding at least an associate degree or equivalent qualifications, and the demand for jobs necessitating significant STEAM proficiency has increased by nearly 34% in the last decade (Boggs et al, 2022). Additionally, the skills that employers are requesting from their ideal employee candidates for STEAM occupations are scarce relative to the demand (Rothwell, 2014). With the plausible possibility of a vacuum being created in STEAM related jobs, an opportunity exists for science teachers like myself to groom students for preparedness in these highly skilled and technical professions. To meet these challenges, it is essential for educational institutions, policymakers, and industry leaders to collaborate and invest in STEAM education at all levels, from primary and secondary education through higher education (Kendricks et al., 2019). This includes providing support for students, teachers, and researchers, as well as creating inclusive and diverse STEAM communities that reflect the broader population.

Over the last nine years I have had the opportunity to teach middle grades science at a Title 1 school in a Southeastern county in the United States. In providing full disclosure of the demographics of the students that I teach, it can be said that the overwhelming majority of them come from homes of low socioeconomic status. In communities like the ones I have taught in, the issue of low socioeconomic status (SES) is a problem that has evaded solutions and is well documented in academic literature (Aaronson & Mazumder, 2008; Chetty et al., 2014; Davidai, 2018; Davidai & Gilovich, 2018). While some believe there is a solution for every problem, perhaps the fix to mitigating poverty may lie in the form of STEAM exposure for students who have been historically underrepresented in these fields. Over time, particularly during years of adolescence, STEAM skills can be developed and nurtured putting students in optimal positions for entry into STEM careers.

STEM Origins

The beginning of science can be traced back to ancient African civilizations. According to work done by Archibold et al. (2019) our African ancestors were performing science through the use of fire manipulation after lightning strikes. Their work dates the use of fire as a tool back more than one million years ago and further traces the manipulation of fire without lightning as a necessity, back almost 300 thousand years. Further, many writings contributed by the Ancient Greek philosophers credit Egyptians as the developers of mathematics, science, religion, philosophy, and astronomy (Asante, 1990; Watson-Vandiver & Wiggan, 2018). Additionally, the ancient Egyptian Imhotep, who lived between 2650 and 2600 BCE, was recognized as a multi-genius due to his philosophical, scientific and medical prowess. It should be noted that

Imhotep was not only recognized for his medical skills and thus was coined the father of medicine, but Egypt was also recognized for their knowledge of medicine 1000 years before Hippocrates was born (Serageldin, 2013; Watson-Vandiver & Wiggan, 2018).

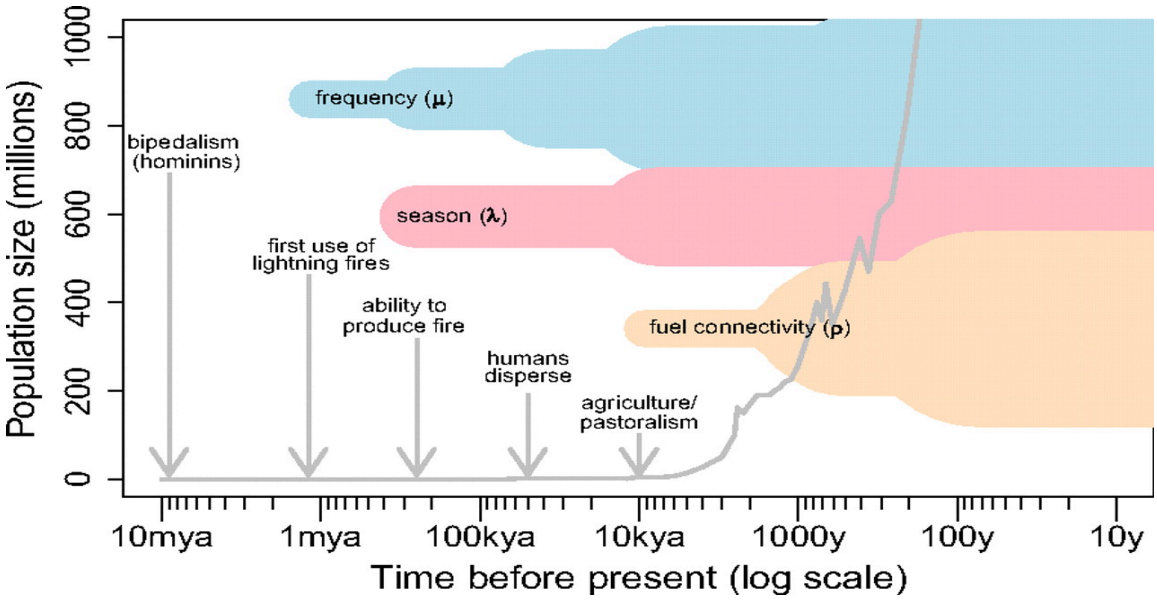

Figure 1
Stages of human evolution defined by their ability to manipulate.
Note: Adapted from 2012 Evolution of human-driven fire regimes in Africa. https://www.pnas.org/doi/epdf/10.1073/pnas.1118648109

History of STEM in the U.S.

Navigating through a historical overview of STEM education in this country would be incomplete without addressing the genesis of the term "STEM". The acronym STEM has become ubiquitous throughout the daily interactivity of our society. However, STEM is a relatively new term which was coined in 2001 by Judith Ramaley in her role as the assistant director of the Education and Human Resources Directorate at the National Science Foundation (NSF) (Breiner, et al., 2012; Zollman, 2012). Prior to STEM, the NSF used the acronym SMET

for science, mathematics, engineering and technology. Ramaley believed the acronym SMET was closely similar to a vulgar term and thus re-coined the acronym to STEM (Sanders, 2009; Breiner, et al., 2012). The acronym STEM has since become a term that has been embedded in the lexicon of numerous programs at national, state, and local levels, as well as within scientific communities as it is a critical focus for educational reform and renewed global competitiveness for the U. S (Breiner, et al., 2012).

Throughout various times in American history a premium has been placed on the importance of STEM in our society. Although sporadic, this sentiment can be traced back to rhetoric of our nation's founding fathers. According to Gonzales and Kuenzi (2012), albeit he did not call it STEM, in his first State of the Union address, president George Washington called upon congress to advance scientific knowledge for the purpose of the republic stating:

> nor am I less persuaded that you will agree with me in opinion that there is nothing which can better deserve your patronage than the promotion of science and literature. Knowledge is in every country the surest basis of public happiness. In one in which the measures of government receive their impressions so immediately from the sense of the community as in ours it is proportionably [sic] essential. (p. 1)

During more recent times, an increase in STEM awareness in this country can be traced to the "cold war" space race that took place during the middle of the 20th century. October 4th, 1957 unquestionably changed the landscape of science on a global scale as the Soviet Union launched Sputnik 1 (Gonzales & Kuenzi, 2012; Koehler et al., 2015; Stevenson, 2014). Sputnik 1

was a small, silver satellite and the first man-made non-celestial body to successfully orbit the Earth (NASA, 2014). During its 92 day mission before re-entering the Earth's atmosphere Sputnik 1 orbited our planet approximately 1,400 times (NASA, 2014; Koehler et al., 2015). This scientific feat prompted the U. S. to immediately begin the funding of curriculum projects such as the Physical Science Study Committee (PSSC), Earth Science Curriculum Project (ESCP), and Biological Science Curriculum Study (BSCS) through initiatives developed by the National Science Foundation (NSF) (Koehler et al., 2015; Thomas & Williams, 2008).

Additionally, in response to the space race that was transpiring between the U. S. and the Soviet Union, the creation of specialized schools were established to enhance STEM education (Stephens, 1999; Thomas, 2008). The intention of these specialized STEM schools were to address the concerns pertaining to American economic competitiveness along with a predicted shortage of talent in these fields (Thomas, 2008). Thus many state legislatures along with educational communities instituted:

> new public high schools with an emphasis on mathematics, science, and technology, such as Thomas Jefferson High School for Science and Mathematics in northern Virginia, The North Carolina School for Science and Mathematics in Durham, The Illinois Mathematics and Science Academy in Aurora, and the Eleanor Roosevelt High School in Greenbelt. (Atkinson, Hugo, Lundgren, Shapiro, & Thomas, 2007, p. 16)

Further, recognizing the need for gifted students living in rural and low socio-economic communities to gain access to STEM education, several states implemented statewide,

residential, secondary STEM schools (Thomas & Williams, 2009; Lederman, 1992; Stanley, 1987). These specialized, residential schools can be found housed on college campuses while others are stand-alone residential campuses which offer an advanced STEM curriculum (Thomas & Williams, 2009).

Science Achievement in the United States

In the U.S., congress is responsible for creating the legislation that provides federal funding for reforms such as STEM initiatives. This can be concerning to stakeholders tasked with the implementation of STEM curricula because of the uncertainty as to the level of understanding many political leaders possess. As noted in a survey of the 111th Congress a total of 74 members (14%) held a degree in a traditional STEM field, and only 19 members (3.5%) had a background in education (Breiner et al., 2012; NSF, 2010). This limitation of STEM conceptualization is not exclusive to our political bodies. In a 2010 poll conducted by the Entertainment Industries Council, 5,000 participants were asked if they understood the term "STEM education." Of those surveyed, 86% were unaware of the reference, with some of them associating it with STEM cells, flowers, as well as broccoli stems (Angier, 2010; Breiner, et al., 2012). Additionally, recent studies have reported that when the "arts" are infused into STEM to create STEAM, teachers have insufficient or limited understanding of the significance of the arts, creating challenges for providing STEAM activities (Chia-Yu, L., 2023; Herro & Quigley, 2017).

This incomprehension of STEM as well as STEAM across a diverse segment of the American population demonstrates that a gap exists between policy makers, universities, K-12 school districts, and the general public. Notwithstanding, this disconnection is again apparent

when it comes to the parents' understanding of the need for STEM education. For example, in a 2007 report conducted by the Kaufman Foundation it was revealed that only 25% of guardians surveyed in Kansas and Missouri believed their kids required more science and math instruction (Kadlec et al., 2007). Further, this study also revealed that 64% of the guardians surveyed do not believe that science and math is a serious issue. Likewise, in a 2010 national report entitled, Are We Beginning to See the light? (Johnson et al., 2010), it revealed that just over half of the parents believed that the mathematics and science their children received was fine as it is. There is however, recent evidence that shows families play a central role in inspiring students to pursue STEM, and the findings of this research hold significance for middle school educators who serve as key influencers in students' motivation and engagement in STEM (Morales-Chicas et al., 2023).

The previous findings were concluded despite the intentional efforts by the US government to promote efforts to buttress science instruction and curriculum throughout the country. For example, the 1983 report by the National Commission on Excellence and Education (NCEE), entitled A Nation at Risk, exposed an unflattering picture of the education system in the U. S. (Koehler et al. 2014; NCEE, 1983). This monumental report indicated that (a) U.S. students were inferior to their counterparts from other developed nations with regards to science and mathematics, (b) a copious number of students failed to possess "higher order" thinking skills, and (c) on average the achievement of high school students appeared to decline even lower than when Sputnik was launched. One suggested recommendation from this report was the development of national standards of learning (Koehler et al. 2014; NCEE, 1983).

Subsequently, the Nation at Risk report put into motion a number of programs that led to the development of a variety of national science initiatives. One such initiative was Project 2061: Science for All Americans, which delivered a framework for K-12 education and established an objective that all Americans must be literate in science, technology, and mathematics by 2061, the year Halley's Comet returns (American Association for the Advancement of Science, 1990). This seminal work provides a conceptual framework as to the importance of science literacy in our society. Further, it provides stakeholders with recommendations for providing citizens with a better understanding of how to become science and technology literate. Despite the innumerable studies and resources that have been directed towards the advancement of STEM in our society, American students are still underperforming nationally in science and math compared to their international counterparts in these same fields.

The role of STEM exposure in influencing career opportunities

An outcome of enhanced STEM exposure across society is the development of a workforce positioned to enhance national economies and maintain leadership in an ever-evolving and expanding globalized economy (Kelly & Knowles, 2016). Increased worry about nurturing future American scientists, technologists, engineers, and mathematicians to retain competitiveness in the international economy has revitalized focus on STEM education (Wang et al., 2011). Elevating students' performance in STEM subjects is crucial to sustain competitiveness in the expanding global economy. While the concept of STEM access emerged in the 1990s, few educators appeared capable of implementing it effectively in the subsequent decades (Kelley & Knowles, 2016). Hence, to address the desire for skilled individuals,

businesses and tech professionals can collaborate with K-12 institutions, higher education, and various training providers (Ainslee & Huffman, 2019). These partnerships aim to expose and equip students and adult workers with sought-after STEM skills, paving the way for diverse STEM career opportunities.

Concerns regarding America's potential lag in the global economy have prompted a significant shift towards emphasizing STEM education and careers (Friedman, 2005). However, stereotypes surrounding STEM fields often suggest that the work is solitary, self-focused, and lacks collaborative opportunities (Fuesting & Diekman, 2017). These perceptions might dissuade individuals who prioritize working with or assisting others, leading them to opt out of pursuing STEM paths. Communal opportunities in STEM can be an important lever in increasing STEM positivity and motivation (Diekman, Weisgram, & Belanger, 2015; Fuesting & Diekman, 2017). For example, individuals exhibited increased positivity and motivation for a career in science after reading about research that led to improved quality of life for brain injury patients relative to research that led to improved brain functioning (Brown et al., 2015). Similarly, motivational benefits occur from brief exposure to STEM exemplars who enact communal behaviors. Individuals who read about scientists collaborating with others, rather than working alone, developed stronger connections regarding the communal objectives within science (Clark, Fuesting, & Diekman, 2016). This, in turn, elevated their enthusiasm for pursuing a career in the field. Thus, Engaging with mentors or guides can provide chances for STEM students and professionals to pursue shared objectives along their educational and career paths (Fuesting et al., 2017).

It should also be noted that suppressed reporting of contributions made to the STEM field by Black scholars contributes to the lack of STEM exposure for Black and historically marginalized students (Johnon, 2007). For example, outside of the occasional mentioning of George Washington Carver and his advancements in agricultural science (specifically the peanut), recognition of the accomplishments made by Black scientists often go unmentioned in the K-12 science and math curriculum. Names of late 19th century and early 20th century scientist such as Edward Bouchet (first Black to receive a PhD in Physics), Ernest Just, Katherine Johnson, Alice Ball (discovered the first treatment for Leprosy) and Charles Drew are not as ubiquitous as those of White American scientist such as Thomas Edison, Alexander Graham Bell, Albert Einstein and Neil Armstrong. Thus, when individuals make vocational decisions, they seek alignment between their self-perception and their perception of individuals in a specific occupation (Carlton-Parsons, 1997; Super, 1953). Similarly, other authors have posited that the interests of occupations is influenced by an individual's self-identity and the images they hold of who they currently are or aspire to become (Gott-Fredson,(1985).

Implementation of STEM in K-12 education

The long-standing issue of Black students' academic underachievement has been a subject of national discourse for many decades (Boykin & Noguera, 2011; Ford, 2011; Ford et al., 2008; Ford & Moore, 2013; Ladson-Billings, 2006). Traditionally, the response to this concern has involved attempts to rectify the problem through the implementation of academic reforms and revamped curriculum. Despite the concerted efforts of educational stakeholders to alleviate these concerns, the problem still persists (Ford et al., 2008). At its core, the concept of

the achievement gap presupposes that one group excels while the other lags behind. Moreover, there is a prevalent perception that minority students, particularly Black students, are the primary underperforming groups in areas such as science, mathematics, and literacy. However, upon scrutinizing both international and national data related to science and mathematics, it becomes evident that the United States is falling short in providing adequate education and enhancing the performance of all students (Allen et al., 2019; NAEP, 2019; TIMSS, 2019).

Table1:
Singapore Students Vs US Students in Science and Math *(TIMSS scores)*

8th grade (Singapore)	bottom 10%	Average	top 90%	avg. diff.
Math	487	616	718	231
Science	485	608	708	223

8th grade (US)	bottom 10%	Average	top 90%	avg. diff.
Math	385	515	642	257
Science	388	522	642	254

Note. Date retrieved from the Trends in International Mathematics and Science Study (TIMSS, 2019)

An analysis of data from the 2019 National Assessment of Educational Progress (NAEP), often referred to as The Nation's Report Card, and the 2019 Trends in International Mathematics and Science Study (TIMSS) reveals discernible trends that shed light on the underperformance of 4th and 8th-grade students in mathematics and science. TIMSS data constitutes an international

comparative study assessing mathematics and science achievement trends among 4th and 8th-grade students and facilitating international comparisons (TIMSS, 2019). Scores are presented on a 0 to 1,000 scale in the TIMSS assessment, where the midpoint is 500, and the standard deviation is 100. Similarly, NAEP serves as a national assessment of educational outcomes, gauging achievements in reading, mathematics, and science while making comparisons across various states and urban districts within the United States (NAEP, 2019). The science scores observed in NAEP assessments range from a scale of 0 to 300. The NAEP achievement levels establish the expected knowledge and skills for students: NAEP Basic signifies a partial mastery of fundamental concepts, while NAEP Proficient denotes demonstrated competency in handling challenging subject matter.

When juxtaposed with other OECD nations the United States has not demonstrated a trajectory that trends towards science advancement. For example, as part of the most recent data reported on the TIMSS science exam the average score of U.S. 8th-graders in 2019 remained statistically unchanged from both 1995, the inaugural year of the TIMSS assessment, and 2015 (NCES, 2023). Within the 20 education systems participating in both 1995 and 2019, 10 witnessed increased average scores, with notable gains ranging from 15 to 70 points in countries like Japan, the Republic of Korea, and Australia to Lithuania. Despite these global advancements, the U.S. maintained consistent average scores of 513 in 1995 and 522 in 2019. Similarly, of the 37 systems partaking in both 2015 and 2019 assessments, 12 demonstrated improvements, with score increases spanning 8 to 35 points in countries such as Chile and Saudi

Arabia. Remarkably, the U.S. exhibited no significant deviation in its average science scores between 2015 (530) and 2019 (522).

During the administration of the last four NAEP science tests, the data has shown that an achievement gap exists between the various racial and ethnic groups that participated. For instance, the most recent data collected (2019) of 8th grade results revealed Asian/Pacific Islander (167) and White (165) students attained the highest average science scores, while Black students scored the lowest (133) (NCES, 2023). Intermediate scores included 159 for Two or more races, 144 for American Indian/Alaska Native students, and 141 for Hispanic students. Additionally, current published data for the 2019 results report, Asian students averaged 168, and Pacific Islander students scored 139. Notably, average scores in 2019 were higher compared to 2009 across all reported racial/ethnic groups, reflecting an overall improvement.

Problem Statement

The salient problem this study seeks to address is the underrepresentation of African American women in the United States that are employed in STEM professions. STEM careers are some of the highest paid and growing in the U.S.; within this sector of the labor force women are underrepresented (Eccles & Wang, 2016; Learper, 2015; NSF, 2015; Starr & Learper, 2019). This may be due in part to the fact the perception of middle grades students STEM professionals is dominated by a monolithic image of White, middle aged males. More specifically, in a study by Scherz and Oren on middle school students' perception of scientists they found "The common image was that of a scientist as a bespectacled male with unkempt hair in a white lab-coat" (2006, p. 977) when they drew their vision of what a scientist looks like. This general consensus

amongst middle grades students appears to perpetuate the misconception that STEM careers should be reserved for White males.

Beyond the common image that middle grades students conjure up when they visualize STEM professionals, there are additional factors that influence the low numbers of Black girls participating in STEM careers. These factors include limited perception of self-efficacy in scientific ability, internalized self-perception, lack of role models, the practices and perceptions of teachers, and institutional structures have all been recognized as fundamental causes for Black women underrepresentation in STEM careers (Davis 2020; Campbell 2012; Catsambis 1994; Oakes 1990; O'Brien et al. 2015).

In examinations concerning the academic performance of Black students, the primary focus tends to center on Black males (Ford et al., 2018). Undoubtedly, the experience of Black males is marked by oppression, missed opportunities, and pressing needs. However, addressing Black achievement shouldn't hinge on an either/or approach; it necessitates an inclusive both/and strategy to ensure equal opportunities for success. As postulated by Ford et al. (2018), in initiatives centered around race, the experiences of Black females hold equal significance. Thus, the challenging experiences of Black boys should not overshadow those of Black girls. Neglecting to address the unique needs of Black girls has made their issues unseen and exposed them to educational negligence. The convergence of race, class, and gender complicates the educational journey for Black girls, resulting in disparate and unfair encounters within the educational system (Davis, 2019; Edwards et al., 2016; Evans-Winters & Esposito, 2010; Joseph, 2019; Morris, 2013; Ricks, 2014).

Focus on Middle Grades

Middle school students continuously investigate the world around them, their passions, their principles, their capabilities, their limitations, other aspects of self and society (Arrington, 2000). Recognizing and addressing the distinctive developmental traits of these young adolescents, who fall within the 10- to 15-year-old age group, in culturally sensitive and responsive manners holds a central position among the principles of middle level education (Bishop & Harrison, 2021). This position was further advanced by a study done by American College Testing (ACT, 2008) in which eighth grade achievement scores were linked to college and career readiness (CCR) programs implemented in middle grades. Therefore, they recommended that CCR interventions that address career exploration opportunities be incorporated into middle grades instruction (ACT, 2008; Shaefer & Rivera, 2012).

Arrington (2000), also postulates that exploring careers offers middle grades students knowledge and opportunities that they can apply when initially formulating tentative objectives (Arrington, 2000). Further buttressing Arrington's statement Wheelock and Dorman (1988) concluded part of a comprehensive middle grades experience should emphasized career "guidance" as a crux for Middle grades instruction, stating that:

> Like curriculum, teaching approaches, organization and scheduling, guidance in middle grades should evolve from the normal developmental needs of students ages 10 to 14. Counseling in middle grades works best when it starts with an understanding that young adolescents are experiencing rapid cognitive, physical, and social-emotional changes and are

> engaged in the daily task of forming a firm self-identity. Guidance in middle grades is a means to meet the need for self-exploration that is common to all young adolescents rather than a tool to solve the extreme problems of some. (p. 26)

Numerous studies provide evidence that the attributes and characteristics of schools have an impact on the academic performance of students (Xie et. al, 2015,Hedges et al. 1994, Greenwald et al. 1996, Lauen & Gaddis 2013, Raudenbush & Bryk 1986).

Research consistently shows that neighborhood disadvantage, often assessed through factors like neighborhood-level poverty rates, has a profound impact on children's cognitive abilities, verbal skills, academic performance, and high school graduation rates (Brooks-Gunn et al. 1993, Sharkey & Elwert 2011). A growing concern is the substantial increase in residential segregation by family income over the past three decades, which places children residing in impoverished neighborhoods at a significant disadvantage in terms of academic achievement (Reardon & Bischoff 2011). In addition to socioeconomic segregation, Massey (2003) postulated racial segregation in the United States has been widely recognized for its detrimental effects on Black Americans, as it concentrates them in underprivileged and disadvantaged neighborhoods with failing schools, exacerbating educational disparities. By exploring opportunities for STEM outside of the classroom Black girls will have access to spaces that feature smaller class sizes, enabling educators to offer more personalized attention and tailored instruction to meet the diverse needs and interests of these students. Further, the informal and relaxed atmosphere of

after-school programs can foster a more relaxed and creative learning environment, encouraging students to explore STEM concepts in a less formal setting.

Implications for Shortage of STEM Qualified workers

American industry employers express concern regarding trailing their global counterparts, particularly China and India, across a broad spectrum of diverse STEM fields. For example these following factoids issued in a 2005 report presented by the Rising Above the Gathering Storm XCommittee, a bi-partisan group sponsored by U.S. legislators in both the Senate and the House of representatives found:

> (a) eight of the ten global companies with the largest research and development (R&D) budgets have established R&D facilities in China, India or both. (b) In a survey of global firms planning to build new R&D facilities, 77 percent say they will build in China or India (c) China has now replaced the United States as the world's number one "high technology" exporter (d) The World Economic forum ranks the United States 48th in quality of mathematics and science education (e) Sixty-nine percent of United States public school students in fifth through eighth grade are taught mathematics by a teacher without a degree or certificate in mathematics (f) Ninety-three percent of United States public school students in fifth -8th grade are taught the physical sciences by a teacher without a degree or certificate in the physical sciences. (Rising Above the Gathering Storm,2005, pp. 7-8)

The aforementioned realities present a bleak outlook for the immediate and distant future of American technology and innovation. Because globalization has brought about a significant increase in competition in STEM fields, as well as to perceived threats to national security, addressing STEM education is timely and appropriate (Business Roundtable, 2005; Bybee, 2013; Rising Above the Gathering Storm, 2010). Discourse between policy makers and educational leaders has recognized that the future of American prosperity is aligned with the improvement of STEM teaching and learning opportunities for children (Committee on Prospering in the Global Economy of the 21st Century, 2007; Moore et al., 2015). This critical juncture in which the U.S. finds itself comes at a time when 80 percent of the fastest-growing occupations are dependent on the skill set of those who master mathematics, engineering, technology, and science (Bureau of Labor Statistics, 2008; Moore et al., 2015). With the acquiring of the aforementioned skills comes positive benefits both academically and economically. For example, the mastery of STEM disciplines in K-12 schooling directly correlates to success in college, as well as economic growth and development, and global competitiveness (Committee on Science, Engineering, and Public Policy [CSEPP], 2007).

Purpose Statement

In order for the stakeholders responsible for creating K-12 curriculum to implement the necessary reforms that will make STEM exposure more inclusive for Black girls, a new comprehensive strategy must be developed. Thus, the purpose of this study is to seek an increase in awareness as to how extracurricular online STEM programs may be beneficial in the promotion of Black, middle grades girls, interests' in STEM careers. It is well documented that

careers in STEM fields will continue to increase in the future. This finding was supported by the work of Schaefer (2010), which found 65% of elementary school students' future jobs aren't a reality just yet, and many of them are STEM careers. In order to increase Black female participation in these future STEM career opportunities they must be placed on an academic path that will allow them to self identify with these fields. Ideally, middle grades is the juncture in which this can take place, and potentially close the disproportionality gap that exists for participation of Black women in STEM careers. Kang et al. (2018) have postulated that middle school years are a critical period for determining the career aspirations of students. This idea was further supported by the work of Karhaman (2022) who reported that individuals, regardless of gender, who perceive the practical value of science or mathematics in their lives are more likely to aspire to careers in these fields. Middle school grades are also the essential time in one's academic matriculation in which science and engineering interests as well as participation decrease significantly even if grades remain high (Kang et al, 2019; Christidou, 2011). Therefore, developing a better understanding of how to attract and retain Black girls that attend middle schools in urban communities, to STEM is essential to increasing their participation in these types of career fields.

Research Questions

RQ1: How do online extracurricular STE(A)M programs created for Black girls serve as a potential space that increases STEM identity?

RQ2: Are there identifiable features that exist in online extracurricular STE(A)M programs that are essential in creating a counterspace for adolescent Black girls?

Significance of the study

Although the cultural makeup of the United States continues to increase in diversity this trend is not reflected in the STEM workforce that has long been dominated by white males of European descent. In order to remain competitive on a national and global scale, diversity within organizations should be inclusive of the makeup of its members within its society (Del Carmen Triana & Garcia, 2019; Fuller, E. et al., 2019; Koster S. et al, 2020). In this regard, this study hopes to add to the current body of knowledge by assisting in determining what are best practices for increasing the pursuit of Black girls' interest in STEM careers. As our understanding becomes more acute as to the conditions that will increase the diversity in STEM fields, researchers and practitioners alike can forge together to create safe spaces for Black girls to participate in STEM programming. This study addresses a notable gap in research by focusing on the underexplored area of online Extracurricular online STEM programs for middle-grade Black girls. By doing so, it is poised to provide an original and unique contribution to the expanding body of knowledge that explores the intersection of Black girls, STEM education, the concept of counterspaces, and the diversity of self-identities. This research aims to shed light on the experiences and potential benefits of these young Black girls in STEM-focused, out-of-school settings, ultimately enhancing our understanding of how these factors interact and influence their educational and personal development.

Define Terms

In order to ensure that clarity and context throughout this manuscript is maintained, identification of key terminology is required. Thus, this section will define critical terms that coincide with the research questions, with the intention of providing an unambiguous interpretation of the study's focus.

Black Girls

The difficulty of defining Black girls has a two pronged challenge. The first is the complex interplay of cultural, historical, social, and biological factors. The term "Black" encompasses a diverse range of ethnicities, nationalities, and experiences, making it difficult to establish a singular, all-encompassing definition (Maylor, 2009). Defining the female gender presents a second challenge due to the intersectionality of identity, as gender experiences are influenced by factors such as race, class, and cultural context. Additionally, the subjective nature of gender identity means that individual experiences may vary widely, emphasizing the need for inclusivity and respect for diverse expressions of femininity (Collins,1986). Thus, in this research, the term "Black Girl" will encompass any individual who identifies themselves as both Black and female.

Counterspace

Individuals not belonging to the hegemony of a society may find themselves utilizing a combination of strategies to navigate life and find refuge in their communities. Counterspaces are a supportive tool used by historically marginalized groups to intentionally counter the systemic oppression, discrimination, and exclusion that marginalized groups often face in a

hegemonic society (Case & Hunter, 2012). By definition, they are “safe spaces” that are intentionally located outside the realm of mainstream educational spaces. They serve as refuges where these individuals can find comfort, understanding, and a sense of belonging, often away from the potentially challenging or exclusionary aspects of mainstream educational settings (Ong, M., & Smith, J., 2018; Solórzano, Ceja, & Yosso, 2000).

College and Career Readiness

College and career readiness denotes the readiness level required for a student to successfully enroll and progress in a credit-bearing course at a postsecondary institution offering a bachelor's degree, a program transfer, or in a high-quality certificate program facilitating career pathway entry and future potential growth (Conley, 2010). For purposes of clarity, definition requires further examination into the term successfully and *postsecondary institution*. For the purposes of this definition *successfully* entails mastering entry-level or core certificate courses to a degree of comprehension and skill, enabling the student to proceed to the subsequent course in the sequence or advance to the next level within the subject area or certificate program. Conley (2012) denotes that postsecondary refers to any formal setting in which an individual pursues additional instruction beyond high school. This might include two or four year degree programs, certificate or licensure programs, apprenticeships, or training programs in the military.

Extracurricular programs:

There are a variety of scholastic interpretations for extracurricular activities that underscores the range in which this idea takes. For example Valentine et al. (2002) limits their definition of programs to “school sponsored activities that occur within the context of the school

environment, the most common example of which includes athletics and academic or service clubs" (p. 246). A more broad definition was proposed by Stuart et al. (2011) stating "all activities beyond 'the classroom', such as involvement in university clubs and societies, paid and voluntary employment, family commitments, religious activity and internet activities." Additionally, extracurricular activities are those that are outside of normal school hours (including holidays), that take place either in school or out of school, with the aim of broadening a students' knowledge in regards to various subjects, channeling talent, and interests and completing the efforts to make a well rounded individual (Komalasari, 2014; Sehertian, 1985; Wahjosimidjo, 2008).

Hegemony

A term popularized by Antonio Gramsci's referring to the dominance of a ruling class's ideas, values, and cultural norms over society, extending beyond mere political control. Gramsci argued that this cultural hegemony is achieved through the manipulation of institutions and the shaping of popular consciousness, creating a consensus that reinforces the status quo. In essence, hegemony involves the ruling class' ability to maintain social order and control by influencing not only political structures but also the prevailing cultural and intellectual climate (Bates, 1975).

STEAM:

Used as an acronym to distinguish the five fields of: science, technology, engineering, arts, and mathematics. By incorporating the arts in STEM education opportunities for authentic learning is facilitated through real world context (Bertrand & Numakasa, 2020). By incorporating the arts in STEM education opportunities for authentic learning is facilitated through real world context. The

authentic tasks incorporate a multi-step approach to address problem through the use of the integration of arts to solve problems (Bertrand & Numakasa, 2020; Armory, 2014)

STEM

Is an acronym used to distinguish the following four fields: science, technology, engineering, and mathematics. These fields are inclusive of a wide range of disciplines that include not only recognizable categories such as mathematics, natural sciences, engineering, and computer and information sciences but also areas in social/behavioral sciences (such as psychology), economics, sociology, and political science (Chen, 2009; Green, 2007). In a report by Bybee (2013) he concedes that the meaning of STEM is not clear and distinct. He suggests that providing the context in which the term STEM is used aids in deriving a more conventional definition for this acronym. For example it may be four separate disciplines, as in "we need more individuals entering STEM careers," or a general category, such as "The teacher had STEM experience in industries this past summer." (Bybee, 2013, p. x).

STEM education

Although the distinction between each discipline in the acronym STEM is understood, there is in fact some ambiguity as to an exact definition of the term STEM education. According to Gonzalez and Kuenzi (2012), "STEM education" refers to "teaching and learning in the field of science, technology, engineering, and mathematics" (p. 1). These authors also went on to postulate that it generally encompasses educational activities across all grade levels from preschool through post-doctorate levels, in both formal (e.g., classroom) and informal (e.g., after school) environments. Additionally, Sanders (2009) describes STEM education as "approaches that explore teaching and learning between/among any two or more of the STEM subject areas,

and/or between a STEM subject and one or more other school subjects" (p. 21). Further, Moore et al. (2014) defines STEM education as "an effort to combine some or all of the four disciplines of science, technology, engineering, and mathematics into one class, unit, or lesson that is based on connections between the subjects and real-world problems" (p. 38). STEM education curriculum models can contain STEM related content with learning outcomes that are primarily focused on one discipline, however, contexts from other STEM subjects can also be incorporated (Kelley & Knowles, 2016; Moore et al., 2014). Finally, Kelley and Knowles (2016) defined STEM education as " the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning" (p. 11). There exists some stakeholders in the field that argue specific definitions such as the aforementioned ones are too static. They believe that a definition of STEM should focus on an assemblage of practices and processes that transcend disciplinary boundaries through which knowledge and learning of a particular kind materializes (Gonzalez & Kuezi, 2012; Moon & Singer, 2014).

STEM Identity

The concept suggests that individuals construct their identities through individual and collective interactions with community members who share distinct traits setting them apart from those outside the community (Calabrese Barton et al., 2013; Carlone & Johnson, 2007; Dou & Cian, 2021; Gee, 2000; Hazari et al., 2010; Moote et al., 2020). Because the term "STEM" carries an association with high socioeconomic status, whiteness and masculinity, which are

ingrained and rooted in the fabric of society, it is challenging for those outside this demographic to envision themselves in STEM careers (Dou & Cian, 2021).

Middle grades/school

Middle grades have typically been associated with the schooling of students in grades 6th-8th. These students in the "middle" are adolescents 10-15 years of age that are experiencing a distinct period of physical growth and development between childhood and adolescence (Caskey et al. 2016). The middle school is considered "the school which stands academically between elementary and high school, is housed separately, and offers at least three years of schooling beginning with either grade 5 or 6 (National Educational Association, 1965, p.5). According to the Encyclopedia of Middle Grades Education, "middle school" entered the lexicon in 1963 and grew at a rate in which the 5-3-4 pattern had become the dominant organizational plan in the U.S. (Mertens et al. 2016).

Urban

The term "urban" was defined in an editorial by Milner (2012) after he realized the need for a recognized set of characteristics for its use in the education field. Milner recognized three distinct forms of urban areas which include, urban intensive, urban emergent, and urban characteristics (Milner, 2012). In describing urban intensive Milner stated these would be regions that are situated in large, metropolitan cities such as New York, Chicago, and Charlotte. "What sets these cities apart from other cities is their size, the density of them" (Milner, 2012, p. 559). Milner further went on to postulate that "urban intensive speaks to the size and density of a particular local; the broader environments, outside of school factors such as housing, poverty,

and transportation are directly connected to what happens inside of the school" (Milner, 2012, p. 559). This definition is indicative of the community in which the participating students in this case study belong to.

Although this case study focuses on an urban intensive community as defined by Milner, a distinction should be made as to its differentiation from the other two classifications of urban. Urban Emergent describes the locals which are generally located in large cities but not as large as the major cities that are represented in the urban intensive category (Milner, 2012). "In these areas, there are fewer people per capita; the realities of the surrounding communities are not as complex as those in the intensive category. Examples of such cities are Austin, Texas; Columbus, Ohio" (Milner, 2015, p. 559). Finally, Urban Characteristic is a distinction that would be designated for regions not located in big or mid sized cities, however, they are starting to experience some of the negative conditions that are associated with urban intensive and urban emergent.

Globalization

When African American girls acquire high level STEM skills their influence in the field will allow them to impact business on a global scale via globalization. Globalization relates to the process of expedited interconnections that exist within a global economy and in social and political life pertaining to technological advancements and increased economic amalgamations (Giddens, 1994; Wiggan, 2012).

Title 1 Schools

Created with the intention of improving the academic achievement of the disadvantaged, these schools are governed by the No Child Left Behind Act (NCLB). Title 1 refers to the section of the federal Elementary and Secondary Education Act (ESEA) initially legislated in 1965 and revised as Improving The Academic Achievement Of The Disadvantaged in 2004 (MacMahon, 2011; U.S.Department of Education, 2004).

Delimitations

This research imposes the following delimitations: First, the study examines middle school Black girls who participated in an after school extracurricular STEM program, and addressed the underrepresentation of girls in STEM fields. Second, two online extracurricular STEM programs that included Black girls from across the country, served as cases in this study. Lastly, the study investigated the role of extracurricular STEM programs that were implemented over a year long time period.

Limitation

This study examined two cases of online programs that support middle grades African American girls bound to two STEAM programs, to determine the role these types of extracurricular activities can play in allowing girls to self identify in STEM careers (Creswell, 1998). Further, each program involved African American girls that attended Title 1 schools and had limited fiscal and transportation resources. Because these programs had an attendance mandate that involved virtual learning, the findings have the potential to be applicable to a broader range of participants. Despite the programs being implemented online (in some cases

hybrid), the limitations of this format does not impede the effectiveness of this study to address the research questions. On the contrary, by delivering this program remotely the sample size can be expanded in future studies. Furthermore, this format can serve as a template for later research that may involve logistic, and fiscal implications.

Summary and Chapter Organization of Dissertation Chapters

Since the founding of the United States, STEM has played a pivotal role in the nation's development. However, discussions on STEM contributions by Blacks have historically often been omitted despite their substantial contributions. With limited opportunities for Black students to self-identify in areas of STEM, it becomes apparent as to why their participation in STEM is proportionally lower than that of their White counterparts. This dissertation seeks to explore solutions that assist in expanding the participation of Black girls in STEM, thus leading to career opportunities in these fields. Included in the chapter is the discussion of the vital importance of prioritizing Black girls in STEM. Additionally, the chapter emphasizes the necessity to enhance involvement and foster STEM identity among Black girls. It also delineates the research problem's significance, research inquiries, and operational definitions.

Chapter two is designated as the literature review and provides a comprehensive overview of existing knowledge and research related to the dissertation topic. The chapter begins by examining how Black women have often been overlooked by historians in discussions regarding scientific achievement, and the rationale that identifies causations of these historic blind spots. The chapter then proceeds to shift into the relationship that exists between Black

girls and science with an emphasis placed on the middle grades. Concluding the chapter is a discussion on the use of counter spaces by Black girls.

Chapter three details the research methodology for the examination of how black girls in STEM extracurricular activities have the potential for increased engagement and identity formation. To comprehensively explore this, a case study method was chosen to delve into the opportunities for counterspaces to provide platforms for STEM participation. This method aims to showcase how counterspaces in STEM education can engage Black girls in the field and how these approaches can be adapted for formal educational settings.

Chapter four will highlight the major findings, as well as the themes and subthemes that surfaced during the study. Given the qualitative nature of this research, the analysis focuses on examining the websites, and transcripts of the study participants, with a specific emphasis on the emerging themes.

Chapter five will conclude with a comprehensive discussion that will be detail each of the themes related to the research questions and the underpinning theoretical framework, which draws from counterspace framework. The chapter will also culminate with a discussion of the implications and recommendations for further research, particularly concerning the impact of extracurricular STEM platforms and the pedagogical practices within these settings.

CHAPTER 2: LITERATURE REVIEW

This study seeks to examine the best practices for engaging, attracting and moving the interest of Black girls in the direction of STEM activities during adolescence. Pursuing an undertaking in this area of research is both critical and timely, as it presents ancillary implications for the career development for this often marginalized demographic. Developing a comprehensive understanding of this objective is a crucial step (Thiem & Dasgupta, 2022). It has the potential to lead to solutions that will narrow the margin of underrepresentation of Black women in STEM careers. Hence, this section of the paper will probe into the published literature to gain extemporaneous and historical insight into the state of Black middle grades girls in STEM, and the state of Black women in STEM careers today. The organization of this chapter is synthesized in a manner that focuses on five overarching themes: Critical race feminism as a framework, the history of Black women in STEM, adolescent/middle grades Black girls, STEM identity and lastly extracurricular STEM programs for Black girls. Completing a literature review without highlighting these critical categories limits the context of the challenges and the opportunities that Black girls experience from an overall academic standpoint. As will be discussed in this section, there are a number of contributing factors in society that surround the quotidian activity of middle grades Black girls. This cannot be done without first describing the framework that will be used to contextualize this study. Thus, the outset of this chapter will highlight literature that is relevant to interpreting the relationship of intersectionality and its application to Black middle school girls.

Critical Race Feminism

In the United States, Black girls in middle grades exhibit the lowest proficiency in science and math, as evidenced by the National Assessment of Educational Progress most recent data (NAEP, 2019). Alarmingly, they also face a disproportionately high rate of criminalization compared to their peers of the same gender (Nelson et al., 2017). Incorporating a colorblind pedagogical approach to education, as suggested by some scholars (Bell, 2017; Moore & Lewis, 2012), implies overlooking critical issues that adversely affect the academic success and well-being of Black children. Furthermore, an educational approach that neglects to acknowledge the intersections of race and gender is insufficient for liberating Black girls from the systemic oppression they face in the education system due to racism (Winter-Evans, 2005). Given these challenges, the application of Critical Race Feminism (CRF) with a focus on critical praxis is argued to be essential in addressing and rectifying these disparities in Science and math education (Childers-McKee & Hytten, 2015).

Critical Race Feminism (CRF) emerged with a foundation in intersectionality, as established by the influential work of Crenshaw (2001) and Collins (2000). The synergy between intersectionality and CRF introduces the notion of "multiplicative identity," positing that the layered multiple identities of Black women form a unique identity that serves as a lens for exploring instances of injustice (Patton & Ward, 2016). This study is guided by the four key tenets of CRF articulated by scholars such as Wing (1997), Evans-Winters and Esposito (2010), and Rodriguez and Boahene (2012):

1.CRF is Intersectional. underscores a distinct acknowledgment that the experiences of Black girls and women significantly differ from those of Black boys and men, as well as White women (Wing, 1997).

2. CRF is Multidisciplinary. Encompasses other aspects of CRF such as Black Feminist Thought (Evans-Winters & Esposito (2010).

3. CRF is Non-hegemonic. Practices that involve both gender and racial oppression are deconstructed (Wing, 1997).

4. CRF involves counter storytelling. The narratives of Black girls and women are brought to the forefront rather than being pushed to the margins of discourse (Rodriguez & Boahene, 2012).

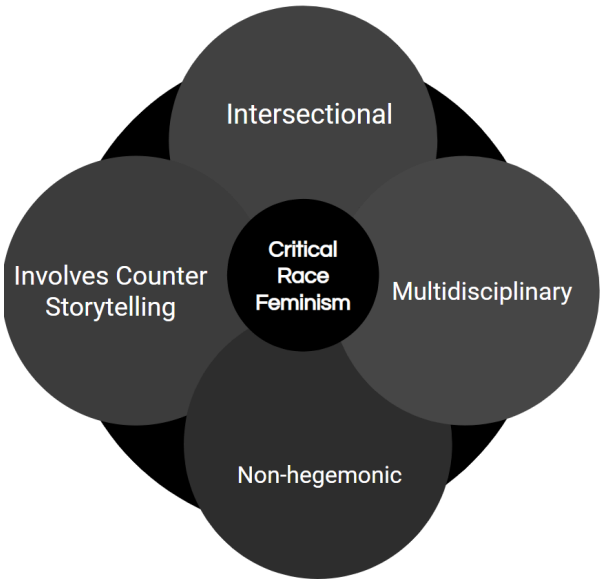

Figure 2
Tenets of critical race feminism
Note. Adapted from Wing (1997), *Critical race feminism: A reader*

Counterspaces

Counterspaces are environments created by individuals belonging to marginalized communities for the purposes of partaking in liberating activities free from dominant influences (Case & Hunter, 2012; Solórzano & Villalpando, 1998). These spaces provide sanctuary in both academic and social settings, providing underrepresented students the opportunity to validate their experiences as crucial knowledge, foster their own learning, express frustrations by sharing stories of isolation, microaggressions, and discrimination, and challenge negative stereotypes about people of color and other marginalized groups (Solórzano et al., 2000; Solórzano & Villalpando, 1998). Counterspaces are essential for establishing and maintaining a positive racial climate within environments that have historically been oppressive (Ong et al., 2018). These spaces have existed as part of African American culture since enslaved Africans arrived in the Americas and were relegated to a life of chattel slavery (National Humanities Center, 2009).

In order to be considered a counterspance, Case and Hunter (2012) postulated that two criteria should be met to fulfill this concept. The first being, counterspaces work as a tool for self enhancement through adaptive responding. In adaptive responding, historically marginalized individuals strive to preserve their psychological well-being in the midst of oppressive circumstances. This phenomenon of self enhancement is commonly described as coping, resilience, and resistance. The second criteria that informs counterspace is “setting”. A setting is characterized by the gathering of two or more individuals over time for a specific purpose (Case & Hunter, 2012; Sarason 1972). Settings encompass relationships, roles, social processes (interactions between individuals), activities, and resources (Tseng & Seidman 2007).

These same-race peer groups frequently congregate in designated physical spaces within a school setting (Carter, 2007). This phenomenon was elucidated by Tatum (1997) in her work "*Why Are All the Black Kids Sitting Together in the Cafeteria?*" Tatum posits that in racially desegregated school environments, Black adolescents contend not only with racism and self-reflection but also find their White peers, even if not personally responsible for racism, inadequately equipped to offer supportive responses. Consequently, Black students seek solace and support from each other, often manifesting as racial clustering in specific physical areas within the school, a scenario frequently observed in places like the cafeteria (Carter, 2007; Tatum,1997).

Counterspaces, whether formal or informal, academic or social, play crucial roles, particularly for Black students, as highlighted by Solorzano and Villalpando (1998). These social counterspaces offer a platform for Black students to openly discuss and vent their concerns and frustrations related to experiences with racism and discrimination outside the structured classroom setting. Additionally, these spaces foster bonding among Black students who share similar cultural backgrounds or experiences. Functioning as identity-affirming counterspaces, they enable Black students to validate the racial and ethnic dimensions of their identity, aspects often negatively portrayed or stereotyped by teachers and peers within the school environment (Carter, 2005). Particularly in predominantly White learning environments, where the classroom setting may lack positive representations of Blackness or Black identity, creating identity-affirming counter-spaces becomes a positive coping strategy for some students in response to perceived racism within the school setting (Carter, 2007).

The need for Black girl counterspaces

In a society consumed by racial hierarchy and oppression, Black youth navigating adolescence are confronted with the task of defining their identities and aspirations amidst the challenges posed by dehumanizing stereotypes that devalue and dismiss Black lives (Rogers & Butler-Barnes, 2022). Black females specifically, encounter persistent racist and sexist tropes, including labels such as "video vixen," "jezebel," "welfare queen," and the "angry matriarch" (Townsend, Neilands, Thomas, & Jackson, 2010). These challenges are further heightened at the intersections of various forms of oppression. Thus, the effects of these forms of intersectional oppression have been found to have a deleterious impact on the development of adolescent Black girls, impacting their health and safety, intellectual growth, and psychological well-being (Crenshaw, Ocen, & Nanda, 2015; Epstein, Blake, & González, 2017; Morris, 2016: Rogers & Butler-Barnes, 2021). Therefore, counterspaces introduce both a developmental and intersectional dimension to counterhegemonic communities. These spaces explicitly address the unique challenges of racial and gender oppression, emphasizing their importance for liberation during the critical adolescent years when Black girls are shaping their identities and exploring career possibilities (Rogers & Butler-Barnes, 2021).

Additionally, the significance of the adolescent developmental phase, along with their implications, cannot be overstated, as it establishes the groundwork for the future selves that young individuals will envision and actively pursue (Oyserman, Bybee, Terry, & Hart-Johnson, 2004; Spencer, 1995; Sumner, Burrow, & Hill, 2018). The implications are particularly visible in educational settings where adolescent Black girls face disproportionate and frequent disciplinary

measures, as well as instances of racial exclusion and sexual violence (Harris & Kruger, 2020; Morris, 2016). On a national scale, Black girls are six times more likely to experience suspension compared to their white counterparts, and in urban areas such as New York City, the rate of school expulsion for Black girls was 53 times higher than that for white girls (Crenshaw et al., 2015; Rogers & Butler-Barnes, 2021). By centering the attention on Black girls, it highlights the structural forms of oppression such as racism, sexism, and misogyny, that frequently contribute to rendering Black girls invisible (Patton et al., 2016). Focusing attention toward Black girls and the spaces they inhabit accentuates the intersectional realities specific to Black girls. It acknowledges that "Black girls and women's liberatory practices are grounded in the spaces we insist on, pursue, generate, and nurture" (Butler, 2018, p. 28).

Counterspace as a Framework for analysis

Self-enhancement, a crucial element in adaptive responding, occurs predominantly in the presence of others, as highlighted by Jones (2003). The relationship between self-enhancement and settings leads marginalized individuals to actively seek or create settings that support self-enhancement. Examining the interplay between individuals and settings becomes key to understanding adaptive responding, emphasizing the significance of analyzing settings for a comprehensive perspective (Linney, 2000). This framework, focusing on the role of settings in promoting well-being, particularly delves into self-enhancing social processes within settings that contribute to adaptive responding. However, not all settings facilitate adaptive responding. In this framework, settings that foster adaptive responding in marginalized individuals are referred to as counterspaces.

Solórzano et al. (2000) define counterspaces as sites where deficit notions about people of color are challenged, establishing a positive climate. Counterspaces actively challenge deficit-oriented cultural narratives, acting as "sites of radical possibility" (hooks 1990, p. 149) that resist reproducing societal patterns of oppression. Further, counterspaces offer a transformative approach by fostering supportive communities that validate diverse perspectives and experiences (Ong et al., 2018). These spaces challenge the hegemonic norms within STEM fields by providing a platform to confront issues like isolation and microaggressions. Unlike conventional interventions that focus solely on addressing perceived deficiencies in underrepresented groups, counterspaces actively work to dismantle systemic barriers by creating inclusive environments that empower individuals to thrive. The framework's unique contribution lies in its delineation of a specific mechanism that challenges deficit notions across various counterspaces, demonstrating how these settings provide self-enhancement and, consequently, adaptive responding.

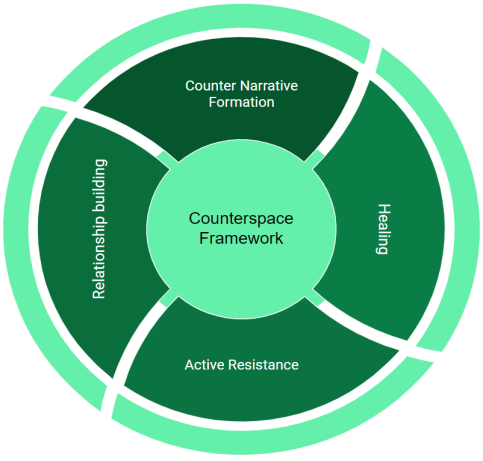

Figure 3
Counterspace Framework
Note. Adapted from Case and Hunter (2012), https://doi.org/10.1007/s10464-012-9497-7

The counterspace framework posits a common functional mechanism across all counterspaces, asserting that they uniformly challenge and confront negative representations and notions pertaining to one or more marginalized identities (Case & hunter, 2012). Hence, there exist distinct and universally recognizable domains of challenging processes within counterspaces. More notably, three overarching domains of challenging processes that are expected to be prevalent in counterspaces include narrative identity work, acts of resistance, and direct relational transactions (refer to Table 2).

Table 2

Challenging processes in counterspaces

Challenging processes	**Specific mechanisms**	**Effects**
Narrative identity work	**Creation/maintenance of:**	
	Oppression narratives	Affirm and privilege the individual's subjective experience of oppression
	Resistance narratives	Ready the individual to respond to oppression; embody the individual's right to respect and dignity; provide a vision of an alternative future, and instill a sense of hope concerning a better tomorrow; prevent internalized oppression
	Reimagined personal narratives	Re-craft individual identities which have been misrepresented and demeaned through dominant cultural narratives
Acts of resistance	Collective critique Engaging in non-normative behaviors	Act out and thus enhance resistance and reimagined personal narratives; act out and celebrate aspects of the individual's culture and identity that are devalued within the larger society
Direct relational transactions	Fostering empathy and security through a shared sense of community	Amelioration of current psychological distress and feelings of isolation and exclusion
	Transmission of adaptive cognitive and behavioral strategies for responding to oppression	Enhancement of self-protective mechanisms

Note. Table shows how counterspace is used to challenge hegemony. Adapted from Case & Hunter (2012).

Importance of STEAM exposure in middle grades

Globally, there exists significant variation among youth in terms of their knowledge about STEM careers, their interests in such careers, and their intentions to pursue them (Blotnicky et al., 2018). STEM career knowledge, referring to a student's familiarity with specific STEM professions, is notably influenced by the guidance provided by their school's STEM career programs. The authors went on to conclude that students' increasing knowledge of STEM career requirements in middle school grades is a positive influence on STEM career choice (2018). Thus, the level of STEM career knowledge directly impacts an individual's intentions to pursue a STEM career in the future, as highlighted in studies by Compeau (2016), Nugent et al. (2015), and Zhang and Barnett (2015). Insufficient knowledge increases the risk of students dismissing STEM-based career paths as viable options, leading to a decline in interest and negatively affecting their participation in activities aimed at enhancing STEM career awareness. Interventions have demonstrated that early exposure to STEM career knowledge enhances students' motivation to enroll in more science and mathematics courses during high school, as evidenced by research such as Harackiewicz et al. (2012).

Research indicates that students begin making career decisions as early as middle school (Tai, Liu, Maltese & Fan, 2006; Wyss et al., 2012). However, at this stage, students may lack exposure to the diverse career possibilities within the STEM fields, leading to decisions made without accurate information. Subramaniam (2008) studied 580 fifth and sixth-grade students in Singapore, revealing that 33% were uncertain about their preference for a science career. While the applicability of these findings to the United States is unclear, it underscores the possibility

that some students inclined towards STEM may lack sufficient knowledge to make informed choices about STEM classes and career paths (Wyss et al., 2012). According to Gottfredson (1981), during adolescence, aspirations become more realistic based on student interests, perceived abilities, and individual characteristics, as well as the opportunities available. Without accurate perceptions of STEM professions or a personal connection to them (Buldu, 2006; Osborne & Collins, 2001), these career options may be overlooked in the developmental process.

History of Black Women in STEM

The STEM related contributions of Black women throughout American history often goes unrecognized by historians and scholars of the antebellum south. This lack of recognition of Black women scientists can best be examined by frameworks from the field of social epistemology, such as epistemic injustice, epistemic oppression, and conceptual competence injustice (Prescod-Weinstein, 2020). Although initially formulated with a focus on the experiences of white women, epistemic injustice encompasses two distinct phenomena: testimonial injustice and hermeneutical injustice (Fricker, 2007; Prescod -Weinstein, 2020).Testimonial injustice involves the devaluation of a speaker's words based on biases against the speaker's identity group (Fricker, 2017). Hermeneutical injustice centers on the absence of resources, which can lead individuals with knowledge to doubt their own competence (Medina, 2012).

Epistemic oppression broadens and essentially restructures the concept of epistemic injustice by emphasizing minorities as active participants in epistemic processes, rather than solely as recipients of epistemically unjust behaviors (Dotson, 2012; Prescod-Weinstein, 2020).

Thus, epistemic oppression is “an unwarranted infringement on the epistemic agency of knowers” (Dotson 2014, p. 115). This concept is not found exclusively in social epistemology but also in critical race theory, as illustrated by Patricia Hill Collins's exploration into the suppression of Black feminist thought, which is characterized by low citations (Collins, 2015). Additionally, Anderson (2017) identifies conceptual competence injustice as a distinctive manifestation of epistemic oppression in which a knower is perceived as fundamentally deficient in the required conceptual or linguistic competence to be recognized as a knower.

Although there is much to be desired regarding the publication of works identifying the contributions of Black women to STEM during the 19th and early 20th century, their impact is nonetheless still significant. With very little to no formal education Black women became pillars within their communities in what can be considered nontraditional STEM fields (Evans, 2016). This included the frequent participation in matters of healthcare such as midwives and herbalists, environmental justice and agriculture. Not to mention the knowledge of astronomy that should be considered for a woman such as Harriet Tubman, who led the way on the Underground Railroad, a network comprising locations like churches, homes, and barns, was instrumental in facilitating the escape of countless slaves from the Southern United States (Selvanathan et al., 2023).

Covey (2007) presents two slave narratives that emphasize the importance of the medical knowledge some enslaved women had on the stability of a plantation:

> “An’ speakin’ of oures, white folks, us niggers had ‘em. My grandmammy was a midwife an’ she useta gib women cloves an’ whiskey to ease de pain. She also gib ‘em dried watermelon seeds to git rid of de grabel in de kidneys. For night sweats Grandmammy

would put an axe under de bed of de sick pusson wid de blade asittin' straight up. An iffin yo' is sick an' wants to keep the visitors away, jus' putt a fresh laid egg in front of de do' an' dey wont come in. If you anxious fo' up' sweetheart to come back fun a trip put a pin in de groun wide de point up an' den put a aig on de point. When all de insides runs outen de aig yo' sweetheart will return"

—Dellie Lewis, Alabama

However, Despite the significant societal and institutional barriers they faced, Black women have made invaluable contributions to their communities and paved the way for future generations in many key ways.

Possible Causation of STEM Disproportionality

Perception of scientist

In order to build racial and gender equity in STEM careers, it is essential that society begins to dispel the belief that males are more suited than females in this field (Kinskey, 2020). The picture that most students will depict when asked to draw an image of a scientist is the same for most students, which consists of the stereotypical image of: a white male, with off kept hair dressed in a white lab coat (Kinskey, 2020). This belief was also confirmed in an alternate study done by Aguilar, Rosas, Zavaleta, and Vazques (2016), in which students were asked to draw a mathematician, which yielded similar results: a male dressed in nice clothes and wearing glasses was the most perceived image. In a study done by Fralick, Kearn, Thompson, and Lyons (2009), they found that when students were asked to draw the image that comes to mind when they think about an engineer, 50% of the images were male while only 13% were female. The results of this

study re-emphasizes the idea that building and redefining prior conceptions are critical in teaching science at any grade level. Studies such as the aforementioned build upon our understanding of why there may be a disparity that exists between Whites and Blacks in the field of STEM.

According to Sparks (2017), female students of color who participate in STEM often face a number of racial and ethnic biases on a consistent basis, which could therefore be considered a system of oppression. This contributing factor is where the tie in for the use of intersectionality comes into play for this proposed research. In developing her framework Crenshaw was seeking to bring attention to the plight of women of color, who had been left out of the conversations relating to feminism and gender equality (Crenshaw, 1989).

Adolescent Black Girls in STEM

Black Girls and STEM identity

For girls, aspirations towards STEM careers are in part based on her identities; which is to say who she feels she is and who she wants to be (Kang et al., 2019). In a quantitative study done by Kang et al. (2019), they made note that one's identity mirrors their interactions amongst people regarding structured activities such as science clubs (Holland et al, 1998; Kang et al., 2019). As an adolescent female begins to experience science over time and in various spaces, she will gradually come to identify, be identified, and be positioned as an individual associated with science (Calabrese-Barton, Tan, & Rivet; Carlone, 2004; Kang et al., 2019; Polman & Miller, 2010). These dynamics are not static, but are constantly evolving throughout the academic experience of adolescents. Thus, Black girls require direction and guidance to assist in

re-affirming students' beliefs that STEM careers are accessible for them. Self identifying in STEM requires a continuous and intentional plan to counter narratives set forth in society vis-a-vi political-economic and cultural-historical conjunctures that have led to an underrepresentation of African American girls being interested in these fields (Holland & Lave, 2009; Kang et al., 2019).

Research done by Calabrese-Barton et al. supports findings that show all students, including girls reflect on their identity while engaging in science, whether consciously or unconsciously (2013). Although the identities of girls in STEM are created contemporaneously, there is a historical aspect that provided a background of both institutional and personal struggles (Tan et al., 2013). For example Tan et al. (2013) reported "African American girls' struggle in forming a scientific identity in an inequitable playing field where prejudice and stereotyping of their identities in other figured worlds were leveled against them" (p. 1146).

How do middle school girls of color develop STEM identity

One method teachers can use to clear the misconceptions that students have regarding the identity of what a person in the STEM fields looks like is to show them images and discuss the stories of women who have been successful in these areas (Kinskey, 2020). Kinskey's study concluded that the images students see are an authentic method of communicating with them. Furthermore, the images that students see should be displayed in an intentional manner that compliments their learning goals (Kinksey, 2020). In fact, according to Kinskey, learning goals should connect with students on a personal level so that students can identify with scientists of their identified gender. These strategies align with the research of scholars such as Gloria

Ladson-Billings who have provided seminal works on culturally relevant pedagogy. Culturally relevant pedagogy allows teachers to utilize the background, knowledge, and experiences of their students to provide them with lessons that would be enriching to their identities (Ladson-Billings, 1995).

Inspiring girls in STEAM

In her summation of the importance of Black girls in STEM, Johnon (2023) expressed how inclusion is vital because observing individuals who resemble you in a specific field can instill the belief that you, too, have a place there. She further postulated that the absence of Black women in STEM sends a message to younger generations that these careers may be perceived as unattainable for them. Previous studies have established a connection between identity development and students' interest, competence beliefs, and expectancy for success in STEM education (Perez et al., 2014). Ireland (2018) observed consistent patterns of STEM interest, confidence, and expectations for success in the literature concerning Black women and girls. Additionally, Varma and Hahn (2008) identified a trend of growing interest in science among Black girls in computing majors from middle to high school. This sentiment is further reinforced by the work of King et al. (2019) and Meador (2018) who postulate that the inclusion of a diverse range of individuals within STEM has the potential to bring forth fresh perspectives, insights, and interpretations, thereby advancing and enriching these fields.

Representation and Role Models

Socializing agents, acting as interpersonal influencers, play a pivotal role in guiding and structuring the development of STEM identity, confidence, and achievement. These agents,

including family, teachers, peers, and minority networks, are crucial for the success and identity formation of Black women and girls in STEM education (Rice & Alfred, 2014; Tate & Linn, 2005). Research underscores the positive impact of institutional support, particularly through graduate-level mentoring, on Black women in STEM education (Borum & Walker, 2012). Additionally, the characteristics of science role models are significant in STEM identity development, with Black girls expressing a preference for role models who are people of color (Buck, Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Ireland et al, 2018). Moreover, Stearns et al. (2016) recognized that the gender composition of math and science teachers in schools did not influence whether Black girls declared a STEM major in college or graduated from a STEM program. They noted the higher percentage of White math and science teachers compared to Black teachers as a potential explanation for this trend.

Educational Initiatives and Programs

There is an increasing necessity to enhance the accessibility of science learning for a broader spectrum of students, creating a secure space for them to explore STEM interests within safespace settings (King & Pringle, 2018). Federal policies emphasizing mathematics and literacy have led to a reduction in instructional time for science in schools (King & Pringle, 2018). Thus to address this limitation, studies suggest that engaging Black girls in informal science learning can be effective, as they often experience greater academic success in these extracurricular settings (Barton, 2007; King & Pringle, 2018; Ladson-Billings & Tate IV, 1995; Shujaa, 1994). Thus, extracurricular activities such afterschool and summer science programs are

key in cultivating students' sustained interest in science (Basu & Barton, 2007; Burgess & Anderson, 2020).

It should be noted upon entering college, comparable percentages of African American, Hispanic, and White students express interest in STEM careers (Herrera & Hurtado, 2011; Means et al., 2017; National Science Board, 2016). However, a smaller proportion of the first two groups ultimately completes majors in STEM fields (National Science Board, 2016). Research examining the factors contributing to the lower completion rates among African Americans, LatinX, and women in STEM degree programs points to disparities in preparation and attitudes, originating in the middle grades and high school. In attempts to retain White students and enhance racial balance, many large districts establish magnet schools or programs offering additional educational resources (Metz, 2003). STEM-focused schools, a popular magnet type, often aim to serve "gifted students" or provide special facilities to retain White students in public school systems serving increasing proportions of students of color. Although selective STEM schools aspire to recruit students from underrepresented subgroups, admissions based on examination scores often result in underrepresentation of African American and Hispanic students (Kaser, 2006).

Establishing Support Networks for Black Girls

The role of creating supportive networks for Black girls to engage in STEM is also an invaluable tool for encouraging them to self-identify in STEM careers. In a study by Rice and Alfred (2014) on Black women engineers experiences in STEM, participants recounted support, encouragement, and connections with teachers both within and beyond the K-12 classroom, with

limited instances extending into college. The participants highlighted their teacher's involvement in both their academic and personal lives, showcasing genuine care that extended beyond the classroom. This genuine concern for success was mirrored by counselors, reinforcing the supportive environment. Goodman et al.'s (2002) study affirms the influential role of secondary education teachers in motivating women to pursue engineering. The consensus among participants was that these positive interactions significantly contributed to sustaining young African American women, empowering them to navigate the demanding engineering environment and persist on their path toward becoming engineers.

It should also be noted that Rice and Alfred delineated the importance of the supportive role family and friends play in supporting Black women in their STEM endeavors (2014). They conclude, the encouragement and grounding offered by family, friends, and significant others played a pivotal and enduring role in the lives of the participants, spanning from early childhood experiences through college and into their professional journeys. Additionally, they found that whether the support system showcased tough love or unconditional backing, the consistent outpouring of encouragement served as the foundational strength and resilience the women needed.

Extracurricular STEAM programs

Extracurricular activities play a critical role in enhancing student problem-solving, analytical and critical thinking skills through collaborative activities and hands-on experiences (Chan, 2016). By participating in extracurricular activities students have the opportunity to increase their sense of security at schools, develop interpersonal skills, and positive social norms

(Chan, 2016: Eccls et al., 2003; Stuart et al., 2011). The results from these experiences should yield an outcome that enhances mental health, school engagement and academic performance (Chan, 2016). Recognizing that extracurricular activities can be applicable to a learning approach, a concept for measuring such learning should be considered.

The use of the Presage-Process-Product (3P) model is applicable for evaluating the effectiveness of extracurricular activities that students participate in. The 3P model developed by Biggs (1993) proposes three sets of variables:

> (1) presage – before the learning takes place such as the learning environment and student characteristics; (2) process – while learning is taking place, that is, students' learning approach; and (3) product – the learning outcomes after learning has taken place are interrelated. Personal and situational factors (presage) may affect a student to adopt a particular learning approach (process) which influences the learning outcomes (product). (Chan, 2016,p. 224)

Subsequently, the product factors are dependent on the learning process and determine the learning outcome. With the 3P model each variable affects every other variable (Chan, 2016). The use of the 3P model is advantageous because it allows product factors to be described quantitatively (how much is learned), qualitatively (how well it is learned), and institutionally (grade point average) (Chan, 2016).

Participating in extracurricular activities is recognized as a form of the individual difference in presage variable of the 3P model. As such, extracurricular activities are immersed throughout schools and communities and are affected by families and peers. By taking part in these

activities students are provided with the opportunity to earn social capital, build coaching relationships, and develop a personal bond with schools (Chan, 2016; Feldman & Matjasko, 2005). School-based extracurricular activities have the ability to provide a means to generate social and human capital and a challenging environment outside of academics. Participation in extracurricular activities provides an environment outside of academics. This helps students increase the understanding of themselves by observing and interpreting their own behavior while they are participating in these activities and strengthens mutual trust with their peers (Valentine et al., 2002). Therefore, the negative narratives that are associated with students from underserved communities can be influenced in a positive manner.

With academic experiences consisting of classroom learning along with out-of-class activities, the model placed forth by Astin (1999) suggests that there is a positive correlation between students' involvement in extracurricular activities and students' learning and personal advancement in higher education. It is suggested that involvement in extracurricular activities enhances intrinsic motivation in learning (Zhang, 2000). Students who are more engaged in extracurricular activities are more likely to enjoy an increased sense of accomplishment, competence and self-esteem. It is hypothesized that a student with a high level of extracurricular activities is often associated with the DA. High academic achievers participate more in extracurricular activities because their credentials can be enriched through practical exposures and hands-on experiences (Hunt, 2005). However, Black (2002) argues that not all extracurricular activities are of benefit to academic achievement. For example, participation in

student clubs and sport competitions may distract students from their study. Empirical results of the relationship between extracurricular activities and learning approach are inconclusive so far.

Wood et al. (2011) find a positive relationship between transferable skills development and extracurricular activities. The transferable skills include interpersonal skills, team-working skills, presentation skills, self-direction and project management skills. Results by Leung et al. (2011) find a positive relationship between students with low involvement in extracurricular activities and academic performance. A number of studies show a positive relationship between extracurricular activities and academic performance (Camp, 1990; Chambers and Schreiber, 2004). No association between extracurricular activities and academic performance is found in numerous studies (Huang and Chang, 2004; Leung et al., 2011).

Presage components consist of two kinds of factors. Student individual characteristics presage factors brought to the learning situation include prior knowledge, gender, age, academic standard and personality. Teaching presage factors include the teachers' personal characteristics and institutional factors such as teaching methods, course assessment, workload and curriculum content. Learning approach is the process factor. Marton and Saljo (1976) classified two learning approaches including deep approach (DA) and surface approach (SA). A DA is claimed as striving for enhanced understanding by using and comparing concepts and ideas. Students are interested in learning, and they need to understand the reasoning behind any treatment. A SA emphasizes rote learning and reproduction of knowledge with little attempt to integrate information. The heart of the 3P model is the process variable which the learning activity generates or does not generate the desired learning outcomes. Students undertake either a DA or

SA which is influenced by the corresponding motive, where the underlying motive is affected by student individual characteristics and teaching factors. The DA was associated with qualitatively better learning outcomes (Watkins, 2001). It is argued that the DA is often associated with academically high performers and high levels of satisfaction in learning (Fenollar et al., 2007; Sins et al., 2008).

CHAPTER 3: METHODOLOGY

Methodology Overview

This chapter introduces an outline of the methods that will be used for the collection and analysis of data that is proposed for this research. Because this study seeks to explore counter spaces that are used by Black girls in after school online STEM programs, I have adopted a strategy that incorporates several methods for gathering and assessing data that are described throughout the chapter. Further, a description of the research design as well as the criteria for participation selection and the processes of data analysis will be discussed. This chapter begins with highlighting the purpose of my study and sharing the standards used to bound the study.

The Purpose

While there has been a plethora of research done to explore Black girls and their participation in STEM programs (Alfred, Ray, & Johnson, 2019), there is a limited amount of scholarship that addresses how implementation of online STE(A)M programs can be used as a counterspace to address increasing the STEM identity of Black girls. Ensuring that middle grades Black girls have a counterspace to participate in STEAM activities has the potential to shape the course of their future career endeavors. Kang et al. (2018) have concluded, middle grade years are a period in an adolescent's life in which they begin to make career choice decisions. However, career fields in STEAM are not reflective of the diverse cultural makeup of the United States. The STEM workforce continues to be dominated by white males of European descent, thus limiting the opportunity for Black girls to have the ability to self identify in these fields. From a national and global perspective, in order to remain competitive organizations

should be intentional in creating an employee makeup that mirrors its society (Del Carmen Triana & Garcia, 2019; Fuller, E. et al., (2019); Koster S. et al, 2020). Thus, in pursuit of this accomplishment, the following research questions were formulated to gain insight into how this can be pursued:

RQ1: How do online extracurricular STEAM programs created for Black girls serve as a potential space to increase STEAM identity?

RQ2: Are there identifiable features that exist in online extracurricular STEAM programs that are important for creating a counterspace for adolescent Black girls?

As K-12 curriculum developers begin to advance course work that will make accessibility to STEM instruction more inclusive for Black girls, a more robust strategy will be required in order to make this goal come to fruition. Thus, the intention of this study is to explore strategies that have been implemented successfully in extracurricular online STEM programs for Black girls, in an effort to increase their interest in considering STEM careers. It has been noted that careers in STEM fields have been projected to expand as we continue to move forward in the 21st century. Findings by Schafer (2010) buttresses the aforementioned statement through his findings that 65% of elementary school students' future jobs are not yet a reality, with many of these jobs being in STEM fields. Further, current educational reforms stress the necessity of fostering students' intricate technology and engineering skills essential for engagement in a knowledge-based economy (Börner et al., 2018; Kayan-Fadlelmula et al., 2022; Van Laar et al., 2017; Wang et al., 2011). In spite of considerable endeavors to increase inclusion in postsecondary STEM education, students from historically marginalized populations still

encounter systemic obstacles associated with access, departmental climate, and institutional practices (Burt et al., 2023). It is critical that Black girls become equipped with the necessary skills to compete for these future career opportunities. Furthermore, middle grades Black girls need to be placed in a position which will allow them to self identify with these STEM careers by participating in them. Findings have also concluded that middle grades is the epoch in which engagement in science and engineering interest begins to dwindle, even if grades are satisfactory (Kang et al, 2019; Christidou, 2011). Thus, in order to develop a comprehensive understanding of how to engage Black girls in STEM, I will examine online extracurricular STEM programs that target Black girls which are in middle grades. Through semi-structured interviews of program participants, online STEM organization website analysis, and a critique of program curriculum I examined whether there are ideal models of counterspaces that can be developed for Black girls to increase their STEM identity. Thus, this research implemented a collective case study format in order to answer the two research questions.

Research Design

The research design that will be utilized to implement this scholarly inquiry will be that of a collective case study. The model of a case study research incorporates the inquiry of an unique subject matter, which can generally include people, places, as well as events that exist within a bounded system (Stake, 2005; Yin, 2002). Multiple data sources are strategically incorporated in case study research to facilitate triangulation which may use observations, documents, interviews and other artifacts related to the research (Creswell et al., 2007). In this particular case, our study will be bounded by extracurricular online STEM programs for middle

grades Black girls. Further, two middle grades Black girls who have participated in an online extracurricular STEM program will be utilized to assess the implementation of strategies for providing services to their participants. In utilizing a collective case study design, researchers are required to identify an issue and multiple representative cases (Creswell et al., 2007). Through the examination of middle grades Black girls in extracurricular STEM programs, the implementation of a collective case study design will assist in identifying how these cases may be analogous to each other.

Qualitative data is collected and analyzed through a theoretical lens (Gee, 2012). Furthermore, Ezzy (2002) states theory is a type of interpretation of a framework and postulates that theory has a dependency on data. Thus, it should be reemphasized that the theoretical lens that guides this study is Critical Race Feminism (CRF). Critical Race Feminism (CRF) (Wing, 1997) will be utilized to guide the study design and application of methods. The use of counterspace framework (Case & Hunter, 2012) will be used to support the data analysis that seek to answer the research questions.

Table 3

Research Design Chart

CRITICAL RACE FEMINISM (CRF)	
Study Design	*Recruitment and Sample*
COUNTERSPACE FRAMEWORK	
Data Collection/Interview Questions	*Analysis/Coding*
RQ1: How do online extracurricular STEAM programs created for Black girls serve as a potential space to increase STEAM identity?	RQ2: Are there identifiable features that exist in online extracurricular STEAM programs that are important for creating a counterspace for adolescent Black girls?

Note. Shows how the research was implemented and carried out. Adapted from 2022 J. Anderson

Sample Description

This study implemented the use of convenient criterion sampling. As it aimed to seek the strategies used by online extracurricular STE(A)M programs to create a counterspace for Black girls, criterion sampling provided a method for obtaining a representation of the sample that was needed. In order for an organization to qualify for participation in this study, they first had to meet the following criteria: (a) a focus on STE(A)M instruction; (b) serve participants that identify as Black girls; (c) are enrolled in middle grades; (d) be conducted outside of normal school hours. The criteria that organizations had to meet to participate in this study were based on the CRF framework, which was used to guide the research designed to investigate the experiences of middle grades Black girls.

The two programs that were selected as samples for this study were both identified as organizations that implemented some aspect of STE(A)M into their curriculum for middle grades Black girls. Further, an additional criterion was that their services must be provided to the participants outside of traditional school hours. Through the use of my extensive professional social network contacts, I solicited the potential interest of those organizations which might have been compelled to be a part of this study. The first two organizations that agreed to participate and met the criteria were provided with an overview of the study and their requirements. These organizations were then provided with consent/assent forms to sign via email through the use of docusign software. Each form disclosed all information pertaining to the study, including questions regarding STEM and creating counterspaces for Black girls.

Once participants had submitted the required documentation signed and dated, they then received a follow-up email that included a survey of possible times to commit to an interview. As Creswell et al. (2007) stated, it is optimal to choose a limited number of cases to examine in a collective case study so as to provide a more robust analysis of each participant engaged in the research. By selecting two organizations to participate in this study, it created an opportunity to apply the intersectional lens that was required to satisfy a collective case study design. It was fitting to include two organizations in order to compare these cases. Also, I was interested in providing a comprehensive and rich analysis of each case, thus my intent was to limit the number of participants to a relatively small number. As an incentive, it was also my intention to provide a seventy-five dollar gift card to the representative of each organization that volunteered to participate in the study. Interviewees from the selected organizations were given advance notice of their incentive before they formally agreed to participate in the study.

Data Collection

Before information was collected and analyzed, the protocols for this study were submitted and approved by the University of North Carolina at Charlotte IRB Board. Written consent from the parents of the two student representatives was obtained as part of the study's protocols. Participating organizations were also asked to share their STEM curriculum as well as access to any websites that might be associated with use by program participants. All participants were given the assurance of anonymity as they partook in this study. This assurance was critical as Creswell and Poth (2018) stated, collection of data required a strategic confidentiality process during a study's implementation. There was a password-protected folder utilized to collect data

and stored in a Google drive. All protected folders contained a copy of all signed documents and forms of consent, screenshots of affiliated websites, interview transcripts, and video interviews. Participants were also assigned a pseudonym to protect their identity and the organizations which they represented. It was through the assigned pseudonyms that participants' folders were identified and distinguished from each other. As the primary researcher for this study, I was the only individual who had access to the folders outside of my committee chair. Participants also had access to their individual files containing their information.

Data Sources

According to Yin (2009), at least three data sources were constructive for the process of triangulating and assessing the details of each individual case. Additionally, Creswell et al. (2007) postulated that case studies might exercise the use of interviews, observations, documents, reports, and the use of audiovisual platforms. This study intended on using the following data sources to complete an analysis of the participating extracurricular STEM programs and their practices: (a) interviews of program participants (See appendix for interview protocols), (b) evaluation of program website, (c) evaluation of program curriculum. All data sources were collected over the span of a six-week period and analyzed at the conclusion of the study during a final data analysis phase. Through the support of collected background information from the consent and assent packet, insight data into the participants' experiences were evaluated. The use of a semi-structured interview was implemented with the participants through an online conferencing platform (Creswell, 2014). Further, the website was assessed for user tools that allow visitors and participants to view program overview, course descriptions,

registration and enrollment protocols, student resources, testimonials, FAQ, and other pertinent information website traffic may be searching for. Finally, the curriculum of the participating programs was compared and contrasted to determine commonalities and differences that exist between the organizations. This assisted in gauging potential best practices for creating counterspaces for their participants. Table 4 presents a visual overview of how the three data sources were collected for this study. Next, I described additional details on how I intended on collecting and securing the data.

Table 4
Data Collection Chart

	Data Source 1	**Data Source 2**	**Data Source 3**
Source	Website	Program Curriculum	Program Semi-Structured Interviews of participants (45-minutes)
Data	Testimonials, Videos, Text	Curriculum Content	Transcripts
Purpose	Program Background and Outcomes	Program Practices and Outcomes	Program Background, Practices and Outcomes

Data Source #1: Website of STEAM Programs

Organizational websites of the extracurricular STEM program were analyzed for themes that are indicative of those found in counterspace framework. Key features of the organization's website I looked for included: images, testimonials, program descriptions, student products, staff members, and culturally responsive artifacts. Examining the aforementioned features found on

their websites gave me insight into what potential participants see when they are seeking STEAM opportunities. Once this content was analyzed, artifacts were organized into categories that aligned with the counterspace framework.

Data Source #2: curriculum

Recognizing the curriculum that middle grades Black girls engage with in these programs is essential to understanding if a counterspace is being created. Thus, an analysis of the curriculum that these programs implement was incorporated as a data source. It was critical that an understanding of the curriculum be established in order to aid in the development of a triangulation strategy to ensure data validity. Furthermore, it allowed me to delve deeper into the semi-structured questions that I asked the program participants. If the response of a question was not clear, I could then ask them to elaborate on their answer based on a particular finding in their curriculum. Thus, examining curriculum helped to lay the foundation for a more comprehensive and in depth interview process. Additionally, the curriculum was analyzed for themes related to CRF and countspace framework.

Data Source #3: Semi-structured Interviews

Participants in the study participated in a semi-structured interview process that served as a third method of data collection for this study (Creswell, 2014). Themes that emerged from these semi-structured interviews assisted in determining questions that were asked or omitted (Charmaz, 2010; Patton, 2014). Each participant was asked to commit to one 45-minute interview (See appendix). Interviews were done towards the end of the study after website and program observations took place. This allowed me to ask follow-up questions that were relevant

to findings in the other data sources. Once interviews were completed, I then had the final phase to aid in triangular analysis of my data.

To assist in facilitating the interview process, all participants received a calendar invite to their email with a Zoom link at least two weeks prior to our meeting. Participants were asked several rapport-building questions at the beginning of the interview. All interview questions were asked according to the tenets of the counterspace framework and placed into four theme-related categories. Participants were asked to access their organization's webpage to familiarize themselves with artifacts that would be helpful in clarifying organizational strategies. Additionally, each interview was recorded using the Zoom platform. To assist with the transcription of the interviews, they were recorded into an mp3 file and then downloaded into an online platform to be transcribed. The transcribed interviews were then placed in the secured Google folders. To protect the confidentiality of the interviews, all video recordings were discarded from the drive.

Analytical Procedures

Upon completion of the data collection phase that spanned over a six-week period, all data was transcribed and organized in preparation for analysis. Before the start of analysis, participants and their parents received and approved the transcripts and collected data to confirm accuracy. The analysis approach that was utilized for this study incorporated content analysis, and visual discourse analysis. Two cycles of coding were implemented, and data and themes collected from the cases were analyzed. Additionally, I explained how each analytical method

was utilized in this study. Figure 2 provides an example of how this analysis was conducted for this study.

Content Analysis

The process of content analysis incorporated the use of a set of predetermined categories that had been derived from a theoretical perspective (Mertens, 2014). To explore online extracurricular STEM programs as a potential hub for middle grades Black girls to use as a counterspace, the following predetermined categories were implemented based on the collected data: (a) narrative formation, (b) healing, (c) resistance, and (d) relationship building. Assessed data sources included: (a) website analysis of the two extracurricular STEM programs, (b) comprehensive analysis of organizational websites, and (c) interviews of program participants. The CRF framework provided the lens which guided the analysis of the organization's counterspace practices. Through the use of the counterspace framework, a priori codes were used. All collected data was assigned codes and analyzed through triangulation to determine connections with counterspace tenets.

Coding Procedures

Saldana (2021) postulated that a code is a label interpretively designated by a researcher to describe the composition of text generated from collected data sources. Thus, the task of coding qualitative data required the process of determining codes that led to the categorization of data (Blair, 2015). The implementation of codes could be done through a process known as a priori coding, which involves predetermining them (Belotto, 2018). The coding that I implemented for this study encompassed the use of a priori coding. In this process, I

incorporated two cycles of coding. The initial cycle of coding was utilized to identify potential points of analysis, while the second cycle of coding was synthesized for placement in thematic categories. Cycle one began with my initial processing as I established in vivo codes from the collected data. Once cycle one had been completed, the codes were then used for cycle two, where they were categorized into a priori codes based on the counterspace framework (Case & Hunter, 2012). All data analysis was done by hand using features found on Google Docs such as inserting comments and color highlighting.

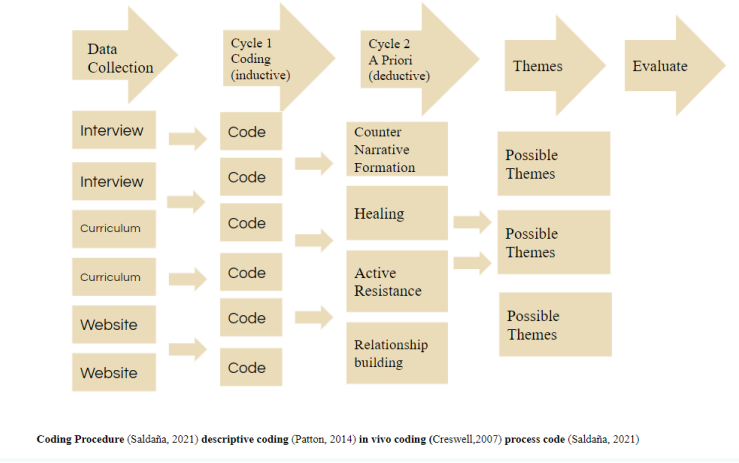

Figure 4
Coding procedure

Cycle One Coding

When initial data was collected and transcribed, I began the process of probing the text in an effort to identify possible themes that could be coded. Initial themes that were collected during the first cycle were identified based on in vivo coding. Creswell (2022) postulated that the use of in vivo coding involved examining the participants' own words instead of using data interpretation. Therefore, in vivo coding was beneficial when data was reliant on the language

use of different cultures. Thus, because this study incorporated the use of discourse found in the interviews and artifacts on the website, in vivo codes were derived from the quotes of program participants, online public websites, and the curriculum of the programs. Upon the conclusion of applying in vivo coding, these codes were then applied to the a priori coding phase of cycle two.

Table 5

In Vivo coding process

Initial read through text data	Identify specific segments of information	Label the segments of information to create categories	Reduce overlap and redundancy among the categories	Create a model incorporating most important categories
Many pages of text →	Many segments of text →	30-40 categories →	15-20 categories →	3-8 categories

Note: Adapted from Creswell, 2002, Figure 9.4, p. 266

Cycle Two Coding

Phase two of the cycle of coding was used to generate a more in-depth understanding of themes expressed through participants' interviews and discourse. By utilizing a line-by-line coding strategy to review previously derived themes, I assigned additional codes that aligned with the counterspace framework tenets. To assist in answering both of my research questions, which sought to better understand best practices for increasing the STEM identity of middle grades Black girls, I implemented the counterspace framework tenets as categories for synthesizing my codes. These predetermined codes, as postulated by Case and Hunter (2012), were derived from the tenets of counterspace framework tenets: narrative formation, healing, resistance, and relationship building.

Analyzing Cases

Upon concluding the coding of all data collected in the two cycles, I began to identify common themes from my cases. The spreadsheet for each case was juxtaposed with others to compare and contrast similarities between the texts. Similar themes were then explored collectively, and differences were also identified. Initial findings from the study were provided to the participants to assist in clarifying any findings and misconceptions. Maintaining a consistent reflexive approach throughout the analysis process aided me in limiting any implicit bias. Glesne (2016), stated that critical reflection done by the researcher is critical in determining the role of their experiences and beliefs in interpreting data analysis. Because subjectivity is paramount in qualitative research, providing a positionality statement assisted in providing transparency of my research.

Researcher Positionality

My research interests have always been centered upon creating opportunities for historically marginalized members of society. In the past I have focused on the disparities that exist between African American male students and the academic disparities that exist between them and their white counterparts. I've also delved into investigating strategies that best create safe spaces of learning for students that identify as members of the LGBTQ+ community. However, my relatively recent experiences as a middle grades science teacher has allowed me to identify the need to create a counterspace for Black girls to participate in STEM programs. As employers continue to increase the number of careers in STEM related fields, it is imperative that we expand student preparation for these 21st century job opportunities. Thus, by providing

counterspaces for Black girls to participate in STEM activities it increases their opportunities to self-identify in STEM related occupations.

Looking at the numbers of black women who participate in STEM related occucpations is underwhelming. For example, of the 44% of women who participate in the STEM workforce only 1.8% are Black women ("Women in science," 2022) . Additionally, according to the previous source, Black women account for 13.9% of the total women population in the US, making the disproportionality clear. In order to begin to address this disproportionate representation, my teaching experiences lead me to believe this issue can best be addressed in middle grades. It is during this stage in adolescence that students begin to formulate an idea of what their career choices might be. With students identifying with career choices at this age, I want to better understand ways I can strategically increase the number of Black girls in STEM careers.

Methods Limitations

This study is intended to provide stakeholders interested in Black girls in STEM, with a better understanding of how extracurricular programs can provide an alternative space for them to thrive. Because this study involves the use of human subjects a sense of integrity is required to ensure the confidentiality and the social-emotional wellbeing of the participants are protected. Additionally, steps will be taken to provide transparency of this study with participants including notes, and final data analysis. As with any study, there are limitations that can be identified with conducting this research as well. One limitation is that the participants may be sharing information about their program that is biased. Because many extracurricular programs receive

conditional funding with the expectation that they provide results, this may influence the positive perception of their program they might share. Additionally, the extracurricular programs may not have access to a database that keeps up with whether or not the middle school girls have advanced to pursue degrees in college STEM courses or careers after high school. Not having access to this information limits the amount of impact a facilitator can report if participants whereabouts are unknown or unreported. Furthermore, in reviewing the websites of these extracurricular programs they may not have a maintenance protocol and thus might not reflect current or relevant information for website visitors. Therefore, I plan to assess the current iteration of the organization's website to check how current it is.

Conclusion

In conclusion, this case study seeks to better understand how extracurricular programs can influence the STEM identity that middle grades Black girls can achieve by their participation in them. Therefore, to increase the diversity of the STEM workforce, stakeholders that influence and or create curriculum should be aware of inclusive practices that consider underrepresented populations. Thus, examining how extracurricular programs can play a role in attracting more Black girls into STEM is critical research that should be shared and considered. It is my belief as an educator that findings from this study can potentially influence the future of STEM education and the diversity in STEM careers. However, the research that guides the outlook will require strategies that demonstrate an intentional and impactful solution.

CHAPTER 4: FINDINGS

Overview of Results and Findings

The purpose of this study is to explore the following two research questions:

RQ1: How do online extracurricular STEAM programs created for Black girls serve as a potential space to increase STEAM identity?

RQ2: Are there identifiable features that exist in online extracurricular STEAM programs that are important for creating a counterspace for adolescent Black girls?

This task, of examining the online programs and the experience of their participants is facilitated through the lens of CRF framework. With the participants of this study self-identifying as Black girls, they are uniquely qualifying to be viewed as individuals who experience a myriad of oppressive actions against them based on their race, gender and class in a society embedded with White supremacy (King & Pringle, 2018; Wing, 1997). Essentially, this study is an in-depth exploration of how, within these programs, there are potential counterspaces for learning and building STEM identity. More importantly, practices of these spaces help contribute to building nurturing and empowering environments for Black girls. The first research question will investigate the structure and dynamics of online extracurricular STEM programs with the objective of teasing out the extent to which they function as counterspaces. Thus, allowing Black girls the ability to engage with topics relevant to STEM in ways distinct from mainstream educational settings typically recognized as hostile towards them.

The second question will look at the pedagogical strategies these programs incorporate into their websites and online curriculum. The purpose is to capture how online STEAM

programs are intentional regarding the creation of spaces for learning while at the same time attending to the unique barriers that Black girls face in identifying with STEAM opportunities. Ultimately, these programs navigate a complex interrelation between reality, space, pedagogy, and identity as a whole that will promote an educational experience for Black girls in STEM through strongly based CRF tenets.

As such, CRF is the theoretical framework that is used to guide this study on middle grades Black girls who participated in an online extracurricular STEAM program. The findings will discuss the experiences of these participants in a descriptive manner. Through the use of CRF it lends to a more comprehensive and robust understanding of their lived experiences in these online spaces. CRF seeks to represent Black girls' experiences from more than one standpoint. It exhibits the point of intersectionality of race, gender, and class (Collins, 1996; Evans-Winters & Esposito, 2010; Wing, 1997). In chapter 5, the findings are discussed through the lens of CRF.

The first part of Chapter 4's findings section will provide an insightful description of the participants and their personalities, drawing from their responses to a semi-structured survey. This section will not only explore the individual characteristics and backgrounds of the participants but will also include a comprehensive comparison of differences and similarities among them. Such comparative analysis will enhance understanding of the varied experiences and perspectives within the participant group, setting a solid foundation for interpreting the study's findings in relation to its broader research questions.

In the second part of this section, the focus shifts to analyzing the themes that emerged. This was done through in vivo and a priori coding, employing the counterspace framework as a lens for a deeper understanding of the data. This analytical approach is particularly suited to examining the experiences of Black girls, as the counterspace framework offers a lens to explore spaces of resistance, empowerment, and identity formation(Case & Hunter, 2012). By utilizing this method, the study aims to uncover the ways in which Black girls navigate and make sense of their experiences within the context of the research, providing critical insights into their interactions and perceptions.

Participant Description Data

An essential aspect of ensuring the accuracy of qualitative data depends on developing a sense of the background and lived experiences of the participants in the study. According to Yin (2011), when conducting qualitative studies it is critical for data to be descriptive to better examine differences and commonalities that exist between participants. Thus, this section will provide a deeper understanding of who the participants are so their experiences in online extracurricular STEM programs can benefit other Black girl's STEM identity. Additionally, by exploring the descriptive data of the two participants it will assist in better identifying the emergent themes of this study. With this research being categorized as a collective case study, participants were bounded by several factors. The first is they had to identify as Black girls who participated in their respective program as middle grades students. The second factor that was required for participation in this study was the program they participated in had to be intentional about providing service for Black girls. Although the program should not be discriminatory of

participants outside of Black girls, the scope of the program should be centered around the need to provide STEM services for Black girls.

Part One: The Hidden Figures

While looking to gain insight into the participants' personalities via establishing rapport with them during the initial part of their interview, I leveraged some of their shared information to create pseudonyms for them. The choice of the pseudonym "Ava" for the first research participant was inspired by her profound admiration for the director and producer Ava DuVernay. This admiration was not just in name but also reflected in the participant's passion for the art of filmmaking, mirroring DuVernay's path in the world of cinema. The participant's love for recording films and her expressed interest in wanting to engage in projects both in front of and behind the camera strongly resonated with DuVernay's groundbreaking work and her advocacy for diversity in the film industry. Selecting "Ava" as a pseudonym thus served as a meaningful nod to the participant's aspirations and the figures who inspire her journey in the realms of STEAM, specifically within the innovative intersection of technology and film.

Moreover, the pseudonym "Ava" encapsulates the participant's desire to excel in using film technology, an area where Ava DuVernay has significantly influenced by leveraging her platform to tell compelling stories through advanced cinematic techniques. This choice reflects a deeper connection than mere admiration; it signifies a shared vision of breaking barriers and making impactful contributions in traditionally male-dominated fields. By adopting "Ava" as her pseudonym, the research participant carries a beacon of inspiration and a symbol of her ambition to carve out a space for herself and other young women in STEAM, particularly in film and

technology. This aligns with the broader goals of STEAM education to empower students by highlighting role models who exemplify success in integrating arts and technology to create meaningful, societal impacts.

For the second participant, her multifaceted talents and aspirations immediately reminded me of Mae Jemison, the first African American woman astronaut and a polymath who has excelled in various fields, including dance and medicine. Jemison's varying achievements resonate with the young participant's own range of interests, from her passion for dance and sports to her aspiration to become a physician. This connection inspired the choice of the pseudonym "Mae" for the participant, symbolizing the range of her talents and her ambitious dreams that align closely with Jemison's unique career journey.

Choosing "Mae" as a pseudonym not only honors the participant's multidimensional talents and aspirations but also personifies the inspirational power of Mae Jemison's legacy for young Black girls in STEAM. Jemison's life story embodies a cross section of arts and sciences, demonstrating how diverse interests can converge and make a significant impact. The pseudonym serves as a source of motivation that I can use to inspire my work with Black girls, encouraging their pursuit in various interests with the confidence that they too, can achieve greatness across multiple disciplines. It reflects a belief in the potential of young women to break barriers and make significant contributions in STEAM fields, driven by their unique talents and passions.

Table 6

Descriptions, Similarities and Differences

Pseudonym	age	grade	hobbies	STEAM program	Years doing STEAM Program	Free or Reduced lunch
Ava	15	10	acting	BGSTEAM	3	no
Mae	15	10	Reading Playing B-Ball Dancing coding	Black Girls Code	2	yes

Ava- The Producer

Ava, a 10th grader from a middle-class neighborhood in a Southeastern urban city, embodies the personification of a self driven and highly motivated teen scholar. Her passion for storytelling is evident in her dedication to producing short films, a craft she has honed since participating in the BlackGirlSTEAM in 8th grade. This experience, alongside her love for spending time with her friends and reading self-help books, exhibit her commitment to personal growth and the art of filmmaking. Ava's interests reflect a balance between spending time with friends, self-improvement, and creativity, shaping her into a dynamic and introspective young creator.

Her admiration for Beyoncé is not just about the music; it's about the empowerment and resilience that Beyoncé represents. Ava mirrors those aforementioned qualities in her filmmaking, as she has been recognized with awards for her writing and films that celebrate her talent and hard work. These awards hold a special place in her heart, not just for the recognition

they bestow, but for the journey it represents. Her accolades are a testament to her ability to refine her vision, accept guidance, and persist through challenges. It was an achievement that came unexpectedly but was embraced as a milestone in her artistic journey.

Ava's life was further enriched by a memorable moment when she received an award from her church, presented by Michelle Williams of Destiny's Child, one of her musical idols. This accolade stood out to her not only for the celebrity encounter but also for the positive acknowledgment of her talent and potential. When asked about a proud moment she mentioned receiving a writing award from the BlackGirlSTEAM, stating:

> *I would say probably best writer award that I won for black girls film kit was like one of my like, very esteemed awards. I really liked that award, because I wasn't expecting to get it. Like it was a complete shock, honestly. Because, it took a lot to write that script, like a lot of people helping me, a lot of people reading it and me rewriting it, like over and over again. Because with BlackGirlSTEAM, we're only supposed to have five pages, a five page script, six max, and mine was 12 at first, so I wanted to add like so many like, inspirational things in it, but I had to learn how to condense it. So I think that was one of my proudest awards because I worked really hard.*

In summary, Ava is ambitious and extremely goal oriented. She thrives in the joy of surprising herself through the use of her innate gifts.

Mae- The Polymoth

Mae is the oldest of four siblings and is currently being raised by her grandparents. She lives in an urban community in the Southeastern part of the United states. Mae and her siblings

qualify for free and reduced lunch and live below the city's median income level. During her 8th grade school year, Mae participated in the Our Girl Coders program after it was suggested to her by her science teacher. Not surprisingly, her participation in this program exemplifies a dedicated and curious mindset as it reveals her willingness to take on her new found passion for computer coding. Additionally, her academic pursuits are complemented by her surprising love for Greek mythology and stories like "Percy Jackson and the Lightning Thief," illustrating a blend of literary appreciation and technical skill.

Beyond finding joy in computer coding, Mae expresses her multi talents through dance and sports, toting her accomplishments as a dancer and a member of her high school's basketball and girls flag football teams. This array of activities showcases Mae's multifaceted talents and her capacity to balance intensive technical learning with creative and physical outlets, painting a picture of a well-rounded and driven individual. Mae, makes it clear that although she has athletic gifts, her career aspirations are to become a medical doctor.

When reflecting on her proudest moment, Mae cites winning the Defensive Player of the Year award for JV basketball as a proud moment, a recognition that symbolizes her commitment and prowess in athletics. In describing this event she stated the following:

> *So last year, we had a banquet for basketball, we didn't have it yet. We're going to have one like, I think in like two months, in May, but we didn't have one for this year. But thinking about the last school year, I won Defensive Player of the Year for JV basketball. And I have the trophy for it. But it's at my dad's house.*

Mae’s recount of her proud moment, emphasizes not only her dedication to her sport but also the significant role these experiences play in her personal growth and self-esteem.

Online STEAM Program Our Girl Coders

Our Girl Coders (OGC pseudonym) is a non-profit organization founded in 2011 by Kimberly Bryant, aiming to provide African American girls with the skills and education to pursue careers in technology and computer science. The organization's inception was motivated by Bryant's personal experiences in the tech industry, where women, especially those of color, were significantly underrepresented. OGC seeks to address this disparity by introducing young Black girls to coding and technology through workshops, after-school programs, and summer camps, focusing on areas such as web design, robotics, and mobile app development.

Since its establishment, Our Girl Coders has expanded its reach beyond its initial San Francisco base, establishing chapters across the United States and even abroad. The organization targets girls aged 7 to 17, offering them exposure to STEM fields in a supportive, culturally relevant context. OGC programs not only teach technical skills but also aim to build confidence, leadership, and entrepreneurial spirit among its participants.

The impact of Our Girl Coders has been profound, with thousands of girls participating in its programs to date. The organization's success highlights the critical need for diversity in tech and has spurred a broader conversation about inclusivity in STEM education. OGC continues to grow, driven by its mission to empower young Black women to become innovators and leaders in the technology industry, ultimately changing the face of technology to be more reflective of the world's diversity.

Online STEAM Program Black Girls STEAM

BlackGirlSTEAM (BGSTEAM pseudonym) is a 501(c)(3) non-profit organization whose focus is centered around empowering young Black girls through the art of filmmaking, addressing the industry's underrepresentation by providing immersive workshops, mentorship, and hands-on film production experience. According to their webpage, part of their mission statement is "to create safe spaces for Black girls to build critical media literacy skills, construct their own narratives centering on Black girlhood, and share their stories through film with the world." This initiative not only imparts valuable skills but also boosts confidence and encourages the sharing of diverse perspectives.

The camp offers a unique, free 16-week hybrid program annually, where participants from across the U.S. can pitch story ideas, with ten finalists selected to produce their short films. These young filmmakers are equipped with cameras, tech gear, software, and a professional production team, culminating in a showcase of their work at various prestigious events and film festivals across the country. Additionally, at the conclusion of the 16 week program, alumni participate in international outreach events throughout the year to share their stories with global audiences and support other aspiring young Black girl filmmakers.

The program features guest speakers from the industry, including award-winning filmmakers, enhancing the educational experience. These speakers assist in bringing to light the vision of BGSTEAM of closing the representation gap of Black girls in media by cultivating the next generation of Black girl storytellers and amplifying their stories from "dream to screen." Although the existence of BGSTEAM has only been in existence for 3 years, they are in a

position to serve as a catalyst for change and the celebration of Black female creativity in cinema.

	Pseudonym	Non-Profit	Target Participants	Cost
CASE 1	Black Girls STEAM (BGSTEAM)	YES	Black Girls Age 13-18	Free
	Pseudonym	**Non-Profit**	**Target Participants**	**Cost**
CASE 2	Our Girls Code (OGC)	YES	Girls and women of color age 7-25	Free or nominal cost

Figure 5
Comparison of online STEAM programs for case study

Part two: Cracking The "Code"

Study Themes

The use of a dual step coding process which incorporated the use of in vivo coding and a priori coding were used to develop and organize themes gathered from the study. Through the use of in vivo coding I was able to begin to formulate themes that could be used to answer the two research questions. in Vivo coding and Participants and their respective STE(A)M program were selected based on the tenets of CRF. To reiterate the point these tenets include the following categories: a. CRF is Intersectional b. CRF is multidisciplinary c. CRF is non-hegemonic d. CRF involves counter storytelling. Ava and Mae, the study participants, along with the programs they engaged in, exemplify the standards of Critical Race Feminism (CRF) through a multifaceted

approach that challenges systemic barriers in STE(A)M education. The curriculum of their respective programs was meticulously designed not just to impart technical knowledge, but to empower Black girls by incorporating elements that reflect CRF principles. These programs, by acknowledging the intersectionality of race and gender, provided a supportive environment where Ava and Mae could see themselves reflected on the curriculum and the role models presented.

Upon the completion of the interviews with the two participants, an analysis of the respective program's website and their programs curriculum, five distinct emerging themes were produced, reflecting the essence of the participants' experiences and the programs intentions. The first theme, "new experiences," emerged from participants' descriptions of engaging in activities and learning opportunities that they had not encountered before, highlighting the innovative aspect of the programs. "Stories and dreams" was the second theme, derived from the participants' shared narratives and aspirations, which were often encouraged and explored within the program settings, indicating the programs' roles in fostering imagination and future planning. The third theme, "building community," surfaced from the repeated emphasis on collaborative projects, group discussions, and the sense of belonging, pointing to the programs' success in creating a cohesive and supportive environment. "Opportunities to self identify" was allocated as the fourth theme, reflecting moments where participants were encouraged to explore and affirm their personal identities, interests, and strengths within a STEM context. Lastly, "creating a safe space" was recognized as a critical component of both programs, as mentioned by participants and observed in program practices and curriculums. This theme underscored the importance of

establishing environments where Black girls felt secure, valued, and free to express themselves without fear of judgment or bias. These in vivo codes work in unity to deliver better clarity of the participants' experiences.

Theme #1: New experiences for learning

Ava -The producer:

Ava's quotes illustrate the theme of “new experiences” through her engagement with BlackGirlSTEAM, an environment distinctly designed to introduce and immerse participants in various aspects of STE(A)M-related fields. Her statement:

> *Because like I said, I didn't know anything about the behind the scenes part of film, I just knew about being in front of the camera. So a lot of the terminology. And the things that were being said, it was all new to me.*

The quote above highlights the transformative experience of going beyond familiar territories into the technical and creative realms of film production. Ava's journey into the world behind the camera opened up a new vision and a whole new perspective on film, a field she was already passionate about but only understood from the viewpoint of an on screen talent.

Further emphasizing the theme, her quote:

> *So BlackGirlSTEAM like being behind the scenes wasn't really like I never even thought about that. Honestly, I'm in you know, like, Well, time has changed like just since, you know, 2020 to now.*

This point underscores not only the personal growth and expanded awareness she gained through the program but also acknowledges a broader shift in her understanding of possibilities within the film industry for Black girls and women. Ava further explains:

> *I applied for BlackGirlSTEAM, I was more into acting. And I don't know, like, if you've ever heard those commercials like that will come on the radio about like, Disney acting jobs and like, like talent agents and stuff. So I wanted I wanted to be on Disney Channel. Like I always wanted to be an actor, because I've always had so much personality and I'm like, very dramatic. So everyone will either tell me like you need to be a lawyer because like, you know how to talk a lot or you need to be an actor, because I was very dramatic, but very, like entertaining. Um, so I wanted to do acting on television, and I was already in theater. So BlackGirlSTEAM like being behind the scenes wasn't really like I never even thought about that. Honestly, I'm in you know, like, Well, time has changed like just since, you know, 2020 to now about like the black directors in the film industry. But I will say like, there wasn't, especially at my age because I was in middle school. I wasn't really seeing that representation. Like my fave, one of my favorite movie directors was Ava DuVernay and still is. Because I remember like watching A Wrinkle in Time and like all of the elements in there.*

Mae the Polymoth:

Two quotes by Mae resonated with the theme of new experiences, indicating how her participation in her STE(A)M program significantly enriched her understanding and skills in technology, specifically in coding and robotics. Her remark:

> *I get to meet new people. And you know, I'm a social butterfly, and I like to meet new people. Um, overall, the experience was very fun. It was very interesting. Like, I learned a bunch of new things like how to code more how to make robots move*

This statement captures the essence of entering a new learning environment. It highlights the dual excitement of social interaction and the accomplishment of inheriting new coding skills. Mae's description of her experience reflects the program's success in creating an engaging and educational space that promotes both personal connections and practical learning.

Further emphasizing the impact of these new experiences, Mae shared, "I like coding, and we were basically coding the whole time and learning how to code robots and make them move and using technology to help them move and to do different types of things." This quote underscores the hands on learning experiences that allowed her to deepen her coding skills, specifically in the context of robotics. It reflects a shift from merely liking coding to actively applying it in complex tasks such as programming robots to move, which represents a significant leap in her technical competence and confidence.

Mae continues, she explains her experiences in Black Girls STEM program. She notes:

> *We use, we do some things that were physical to like Legos, like we had to build a Lego robot. And then we had to code it to do certain things like Legos were a major key unit. And we use a Lego app. I don't remember what it was. But it was something that included Legos, to the point*

where we have to code with Legos can do and, and to make our own website, we I forgot what the websites were called, I'm sorry. But that's what we use to make our own website. And it was a little difficult, because I wasn't really like familiar with it, or how to use it, but I just continued to ask for help so that I can know how to use it.

BGSTEAM website:

The BlackGirlSTEAM's website, homepage showcases Black girls actively participating in a Hollywood gala experience, correlating with the theme of new experiences in an inspirational manner. This depiction not only highlights the presence and significance of Black girls within spaces traditionally perceived as exclusive but also serves as a powerful motivator for both current and prospective program participants. It symbolizes the beginning of a journey into the technological and creative aspects of filmmaking that lie behind the camera.

Our Girl Coders website:

Our Girl Coders's website, specifically under the "What We Do" section, provides an illustration of the theme “new beginnings” through its images and descriptions of several new STE(A)M-related programs. This section serves as a pathway for Black girls to discover a number of opportunities to enhance their technical skills but to broaden their perspectives on what is achievable within the fields STE(A)M. The showcasing of these programs highlights the organization's commitment to accessibility to the STE(A)M fields for Black girls.

Additionally, by highlighting various programs designed to expand STEM skills, the website informs visitors about the practical learning opportunities available and also plays a role in inspiring a sense of curiosity and ambition among Black girls. It signals the start of new journeys into unfamiliar territories of knowledge and skill development in STE(A)M.

BGSTEAM curriculum: Session 3 allows the girls the experience of developing a film budget as they get closer to producing their own films.

Theme #2: Stories and Dreams

Ava The producer:

Ava demonstrated her connection to stories and dreams in her quote in which she discussed her proudest moment was winning an award in her STEAM program for writing. She stated:

> *I would say, probably best writer award that I won for BGSTEAM was like one of my like, very esteemed awards. I really liked that award, because I wasn't expecting to get it. Like it was a complete shock, honestly. Because, um, it took a lot to write that script, like a lot of people helping me, a lot of people reading it and me rewriting it like over and over again. Because with BlackGirlSTEAM, we're only supposed to have five pages, a script of six Max, and mine was 12 at first, so I wanted to add like so many like, inspirational things in it, but I had to learn how to condense it.*

Additionally Ava explains:

> *So I see myself always sticking in STEAM, I think the art is very important. And it's very important that like people in the arts community or like the Steam community in general that we protect that um, because you know, art is everything like without that without steam are our world we probably wouldn't even have a world you know, like our world would literally just be boring like all of that plays a big part into what's going on everywhere in the world. So I definitely think that I will stay a part of that I want to be like*

a director slash producer. Um, but I also want to give back so I like one of my biggest dreams is to like create a youth focus like production company were like under serve youth. I think just for you to have a dream, but don't know how to implement themselves into the world. I want to create like a hub or a creative hub for them you know, to come fulfill their dreams and funded you know, so they can put their dream out there and help others like that's my that's what I want to do. That's how I want to give back for what BlackGirlSTEAM gave to me and then I'll go me to that. But yeah, I do think black girls from game played a huge part like now to the creative part of it to them the learning experience to me watching, like even their philanthropy, philanthropy side of BlackGirlSTEAM, like BlackGirlSTEAM has not only impacted me, but its impact impacted others lives. It's impacted the lives of people who donate to us like on Giving Tuesday, the people who watch our films, like the film festivals in like every life that black girls film Camp touch, even like my family, like they love BlackGirlSTEAM, and probably even though they never met Ms. Mica, but just the things that BlackGirlSTEAM is doing for other people's lives.

Similarly to Ava, Mae had a connection to storytelling and dreaming. During her interview she stated as part of the program they had to speak in public. When asked what are

some new skills she has, she responded: “speaking in front of people.” Mae also contemplated between wanting to be a doctor and a realtor, stating:

> *I really want to be in the medical field like, well, I just wanted a real estate agent, because I love looking at houses, like houses, I love the modeling of houses. I love the insides. Like, I just love houses overall.*

When asked about her future in STEM Mae’s response was:

> *I imagine being in it in the future because it overall, it just helped me feel more welcome, like to ask questions and to do new things for the future. So yes.*

BGSTEAM website: Poster expressing “Wild Dreams Fire Stories” girls can dream and share their stories.

Figure 6
BGSTEAM program depicting story telling
Note. Retrieved from BGSTEAM website

Our Girl Coders website: Music is a way for artists to express their stories. The homepage references the winners of a competition in which they built a beat that was judged by the musician Ciara. In a sense giving them the dream of perhaps one day being a music producer.

The beats were made using computer coding. b, Also invited girls to participate in a program that helps them code stories that is hosted by the creators of Lil Ruby.

BGSTEAM curriculum: Curriculum is divided into sessions they access via the Zoom platform. The first week of curriculum starts out with the subject being about storytelling.

Our Girl Coders curriculum: Host explains how artist can create their own stories and sharing visual messages using digital art.

Theme #3: Building community

When discussing opportunities to build community within her STEAM program Ava stated:

> *honestly, like it being a group of us, 10 of us. And we instantly like click I remember making a group chat with everyone and I was getting to know each other. And I'm speaking like, what the other team directors right now, how we communicated with each other how we lifted each other up for even like our smallest accomplishments, like, just making good grades at school things, but that were outside of BGSTEAM.*

Ava explains:

> *I think some of the things they did to make me feel supported was the speakers they brought in and who they brought in like, how particular they were in choosing who spoke to us they did a good job at making sure people who look like me who talk like me, who had like you know the same similar struggles or even like insecurity as insecurities as me to talk to me to pour*

life into me. One of my favorite speakers was Dr. M, she's actually I think she's a professor at UNCC. Yeah. So I know she does like a lot with like women's and girls like research, but like her tone is everything like how she communicates with others. Like her tone is perfect, but her words and her message is also right where her tone is. I'm just like, I don't even remember because I was crying that session. But I just know like, everything was powerful that She was saying she was uplifting us, like telling us, this is who you are like, don't be afraid of who you are. I know one of the things we talked about, like, was like RBF. Like having, you know, like, when black women just had the straight face and people automatically think we're mad, or like, like just telling her to be telling us to be comfortable within ourselves and not, you know, hating ourselves because the world hates us.

During Maes' reflection on building community she replied:

It was very fun meeting someone that was I guess, different than me and she somewhat acted just like me and I think I needed someone, someone just like that. Like, her personality was just sweet. Like, everything was just good about her. And we still keep in touch to this day.

Mae continues:

When I asked for help… I was honestly, I was kind of confused on when we made our own websites because everything was just code. And I didn't understand what the code meant. So I had extra people that were there, like, hey, how do I do this? Like, what does this mean? What does that mean? And they were open to help me so that I could understand what we were doing overall. So I can know how to make my own website just as well as anyone else could.

BGSTEAM website: Home page shows an image of the teen participants and how they are part of one community with the film coaches, editors, organization board members and other program staff.

Our Girl Coders website: Upcoming events section shows that participants can be a part of building community with upcoming guest speakers.

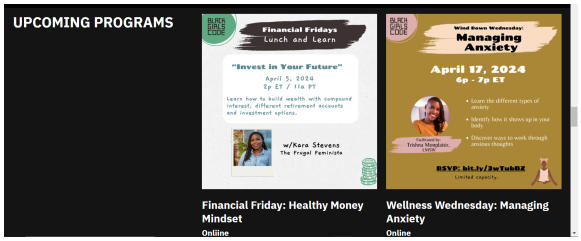

Figure 7
Programs from OGC for building relationships

BGSTEAM curriculum: Building community is done throughout the week during the program. The participants meet with their editor, and story coach as they begin to build community before production of their film.

Figure 8
BGSTEAM online relationship building curriculum

Our Girl Coders curriculum: Builds community by sharing stories of using art as a way to promote social justice. Participants are paired with a team consisting of an editor and coach. This team works together over a 16 week period to produce a final film.

Theme #4: Modeling and Self Identifying

An important part of career awareness lies in the opportunity of seeing individuals that look like yourself in those professions. For Ava, participating in her STEAM program was the first time she was able to self identify as an individual working in a pivotal role behind a movie camera. Regarding this topic Ava was quoted as saying:

> *"But I will say like, there wasn't, especially at my age because I was in middle school. I wasn't really seeing that representation. Like one of my favorite movie directors was Ava DuVernay and still is. Because I remember, like watching A Wrinkle in Time and like all of the elements in there."*

Ava went on to communicate her organization supports her new found desire for working in a technical aspect behind the camera in this quote:

some of the things they did to make me feel supported was the speakers they brought in and who they brought in like, how particular they were in choosing who spoke to us they did a good job at making sure people who look like me who talk like me, who had like you know the same similar struggles are even like insecurity as insecurities as me to talk to me to pour life into me.

Mae similarly expressed an extreme appreciation for the opportunities that were given to her to develop her STEM identity. By taking advantage of her access to hands-on activities she was able to self identify as someone who can see themselves in STEM. She confirmed this sentiment through the following statement:

Um, well, there actually everything was hands on, we got to play games and do more activities, so we can further our learning. But at school, we somewhat do the same thing. But it's not more activities, it's more just writing and reading, not a lot of hands on.

BGSTEAM website: Visual images of Black girls performing behind the scenes technical tasks, that can be a model to other black girls visiting the page. This will help to increase the self identity of new potential campers or web page visitors.

Figure 9
BGSTEAM working with industry leaders for self identification

Our Girl Coders website: webpage displays videos that girls can watch that are produced by the organization. The videos show Black females giving instruction on how to do coding and create a webpage.

BGSTEAM curriculum: Participants get to meet philanthropist Dr. Monique Couvson who has helped mobilize over 1 billion dollars for programs that focus on Black girls and their empowerment. .

Our Girl Coders curriculum: Host modeled how she created digital artwork as a way to showcase her skills and give the participants ideas on how they can express themselves through coding.

Theme #5: Creating a safe space

Another major theme that emerged from the data is Creating a Safe Space. Initially, Ava believed she was too young to participate in her STEAM program. She was really interested in joining so she made a decision to fabricate her age. Once she entered the program and developed essential relationships with the program's staff, she was able to be forthright about her age. She jokingly explains:

> *So um, no,I lied about my age I didn't really talk about my age because I lied about it. So I didn't really want people to know until I got comfortable with them. And then I told them like, yeah, I'm really in middle school.*

Ava continues:

> *Dr. J, and Miss S, just the support from them that we had, and like them always having open arms towards us, like, Okay, if you need help with your script, if you*

need extension time, for you know, your assignments, you know, just ask that was a big thing.

But later on, like, I realize, we're all human, and they're here to help us. So I don't have to act like I know everything. And that was a big thing. They weren't they never criticize us, or judge me like, particularly, for not knowing anything.

Mae:

Like Ava, Mae had a similar experience. She explains how she became comfortable in her STEM program:

Yes, they definitely made me feel comfortable. Some things that I weren't that I was not, excuse me, that I was not familiar with. They helped me. They helped guide me through it so that I understood what I was doing and understood how to perform the task.

Mae also added:

They asked me what I like and we did things that I definitely liked. And while I also did things that, that wasn't familiar with me, like, with the different people that I was with, we did things that they wanted, and they did things that I wanted, like it just all tied in together as one.

Mae goes on to state:

It was a little difficult, because I wasn't really like familiar with it, or how to use it, but I just continued to ask for help so that I can know how to use it.

BGSTEAM website: In the “About” tab visitors can see how the organization values Black girls and their mission to do the following: narrative change, build community, Joy, representation, storytelling, equity.

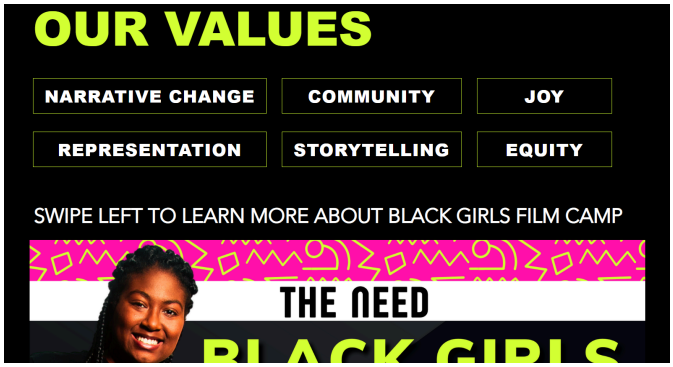

Figure 10
BGSTEAM values for creating a safe space for Black girls

Our Girl Coders website: The home page ensures that Our Girl Coders is a safe space for all Black Girls and gender nonconforming youth.

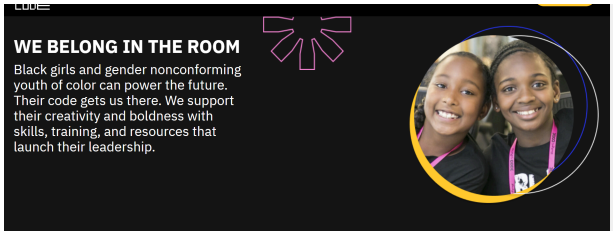

Figure 11
OGC statement of commitment to a safe space

BGSTEAM curriculum: By exploring the importance of being your authentic self and representing who you are sends a message to participants that encapsulates the idea of promoting a safe space.

Figure 12
BGSTEAM curriculum on building a safe space while being their authentic selves

Our Girl Coders curriculum: highlighted an image by a digital artist "Octavia Ink" and how she expressed through her works the positive aspects of being Black. This is done through the use of Octavia as a main character and participants create a positive storyline using this Black girls' image.

Conclusion

In sum, this chapter introduced the participants of the study and discussed the STEAM programs they were enrolled in. The chapter also explained the five major themes of the study. Moving forward, the next chapter aims to further discuss the findings and suggest recommendations for strategies to increase the STEM identity of Black girls. Recommendations are provided for educators and other policy stakeholders that are interested in increasing the STEM participation of k-12 students.

CHAPTER 5: DISCUSSION

Findings Discussion

Chapter five discusses the findings of the study and provides recommendations as As we analyzed the findings of chapter four, the research suggested that the participants had an overwhelmingly positive experience in their respective STEAM programs. Findings of the study which are discussed in this chapter reveals that Black girls encountered: Theme: 1 new experiences; Theme 2: stories and dreams; Theme 3: building community; Theme 4: self identifying; and Theme 5: creating a safe space. This was accomplished by following a framework of CRF that assisted in answering the following two research questions:

RQ1: How do online extracurricular STEAM programs created for Black girls serve as a potential space to increase STEAM identity?

RQ2: Are there identifiable features that exist in online extracurricular STEAM programs that are important for creating a counterspace for adolescent Black girls?

It is important to note that the CRF framework is designed to investigate Black women's identities as well as their unique struggle in a racialized and patriarchal society (Collins, 1996: Wing, 1997). CRF seeks to uncover and mitigate the sources and systems of oppression surrounding minority women's well being. Thus, per CRF, when studying minority women and girls it is not practical to view them through a lens that is colorblind and does not take into consideration their intersectionality. Doing so would overlook critical issues that adversely affect this demographic group, and undermine any attempts at creating greater diversity, equity, and inclusion (Wing, 1997). Therefore, considering the following tenets of CRF should be taken into

account when studying Black girls and women: a). CRF is intersectional b). CRF is Multidisciplinary c). CRF is Non-hegemonic d). CRF involves counter storytelling (Childers-McKee & Hytten, 2015).

Discussion found in Chapter 5 will continue to be guided through the lens of CRF, however it will be complimented by the counterspace framework in order to aid in answering the research questions. An overview of counterspace framework can be summed up by the following description, counterspaces are used to create a sanctuary for marginalized students in both academic and social settings (Case & Hunter, 2012). These spaces provide opportunities for students to validate their experiences as meaningful knowledge, foster their own learning, express frustration by sharing stories of isolation, microaggressions, and discrimination, and challenge negative stereotypes about people of color and or other marginalized groups (Solórzano et al., 2000; Solórzano & Villalpando, 1998).

CRF and Counterspace Experience

For the purpose of data analysis and discussion, I employed CRF and counterspace framework to explore the experiences of two Black girls who participated in an online STE(A)M program. This theoretical approach allowed me to investigate how the Steam program served as a supportive environment that countered the often exclusionary nature of traditional STEM spaces. By conducting in-depth interviews, I gleaned insights into how the program's structures, content, and community aspects influenced their sense of belonging and identity within the STE(A)M field. My analysis focused on identifying elements within the online program that either facilitated or hindered their ability to see themselves as part of the STEM community. I

paid particular attention to the ways in which the program acknowledged and celebrated diversity, provided role models, and encouraged peer support and collaboration. This approach was instrumental in uncovering the nuanced ways in which the online STE(A)M programs could act as a counterspace, enabling these young Black girls to realize a stronger self-identity within the STE(A)M disciplines. The findings highlighted the critical role of inclusive, affirming educational environments in supporting underrepresented students in STEM fields.

Research Questions and Themes

Figure 13
Themes developed from data analysis and research questions

Theme 1: New experiences

Ava's engagement with BlackGirlSTEAM and her quotes poignantly illustrate the essence of "new experiences" within CRF framework. Ava's initial focus on acting, influenced by mainstream depictions of success and fame, mirrors the limited narratives often available to Black girls about their possible places in the world (Harris & Kruger, 2023). Her admission of

unfamiliarity with the behind-the-scenes aspects of filmmaking speaks to a systemic issue of the invisibility of Black women in technical and creative roles within STEAM fields (Kayan-Fadlelmula, et al., 2022). This invisibility is not just a matter of representation but reflects deeper structural barriers to access and recognition.

Ava's revelation that her STEAM program helped her see beyond traditional roles to the possibilities of being behind the camera demonstrates the transformative potential of spaces that are explicitly designed to counteract racial and gender biases in STEAM education. BlackGirlSTEAM, by introducing her to the technical and creative sides of film production, acts as a counterspace. Counterspaces are environments that offer marginalized groups a sanctuary from the dominant culture's stereotypes and limitations, providing them with opportunities to explore their identities and interests freely (Case & Hunter, 2012; Solórzano et al.,2000). Through BlackGirlSTEAM, Ava was able to step into a role that she had never envisioned for herself, challenging the traditional expectations of Black girls' aspirations and capabilities.

Moreover, Ava's acknowledgment of a broader shift in her understanding of the film industry and her admiration for Black directors like Ava DuVernay showcases the power of representation and counterspaces in reshaping perceptions. Per CRF, her experience illustrates how critical it is for Black girls to see themselves in a variety of roles within STEAM, not just for their personal development but also for the broader impact on diversifying the field (Childers-McKee & Hytten, 2015). By learning about and identifying with successful Black women in film, Ava and others like her can begin to see these career paths as viable and worthy of pursuit, thereby challenging the status quo and contributing to the slow but necessary process

of transforming STE(A)M fields to be more inclusive and representative of the society they serve.

Mae's experiences within her STEAM program illustrates the transformative nature of new experiences, resonating well with the sentiment of Ava. Her journey into the field of coding and robotics is characterized by excitement of meeting new people and the challenge of mastering new skills, underscores the program's role as a counterspace (Case, 2012). This environment not only facilitated her exploration of technology but also nurtured her social skills, showcasing the development that occurs when Black girls are provided with opportunities that affirm their identities and expand their skill sets (King & Pringle, 2019). Mae's engagement with the program led to significant personal and academic growth, highlighting the critical intersection of social interaction and learning in STEAM education for Black girls. Per CRF, her words are evidence of how such programs serve as vital platforms for overcoming the historical underrepresentation of Black women in STEAM by creating environments that celebrate diversity and academics.

The hands-on learning experiences Mae encountered, especially her work with coding robots and utilizing technology in new and challenging ways, reflect a significant departure from traditional education models. These experiences not only enhanced her technical abilities but also increased her confidence, illustrating the impact of immersive STEAM programs in developing both competence and confidence in young Black girls. Through these experiences, Mae, like Ava, began to see herself as an able and innovative contributor to the STEAM

community, embodying the transformative power of education that bridges the gap between interest and expertise, particularly for students from historically marginalized backgrounds. Additionally, Mae's engagement of coding with Lego robots and her attempts at web development, despite initial difficulties, highlight the resilience and determination that STEAM programs can instill in participants. Her willingness to seek help and persist in the face of challenges is a testament to the supportive nature of counterspaces that encourage risk-taking and problem-solving (King & Pringle, 2019). Mae's narrative, alongside Ava's, highlights the relevance of STEAM programs in paving the way for adolescent Black girls in technology in the present and the future.

Theme 2: Stories and Dreams

Ava's connection to stories and dreams is vividly encapsulated in her recounting of winning the Best Writer award in her STEAM program, a moment she cherishes. Per CRF, her surprise and pride in receiving this award reflect her dedication and the iterative process of creation she underwent, rewriting a script that initially exceeded the page limit, due in part to her desire to fill it with inspiration while learning to condense her ideas effectively (Winters & Esposito, 2010). . This experience not only signifies Ava's commitment to storytelling but also highlights her journey of personal and creative growth within the STEAM fields.

Further, Ava's desire to remain involved in STEAM, emphasizing the importance of the arts and her dream of establishing a youth-focused production company, underscores her desire to contribute to and enrich the community. Her vision extends beyond personal achievement; it's about creating a space where underserved youth can realize their dreams, modeling the support

and inspiration she received from BlackGirlSTEAM. Ava's narrative is a reminder of the transformative power of integrating arts into STE(A)M, where storytelling and creative expression become vessels for change, personal development, and community engagement.

Mae, similarly, demonstrates a connection to storytelling and dreaming through her new skill of public speaking, developed as part of her STEAM program's requirement to present in public (Harris & Kruger, 2023). This newfound ability signifies a crucial step in Mae's journey, empowering her to voice her ideas and share her stories confidently. Mae's contemplation of her future career paths wavers between the medical field and real estate. This reveals a broader spectrum of interests fostered by her engagement in STEAM, highlighting the program's role in broadening her perspective and encouraging exploration (Wing, 1997). Her inclination towards the medical field and real estate underscores a love for innovation and design, reflecting the diverse interests that STEAM education can nurture. Mae's belief in her future within STEM, fueled by the welcoming and nurturing environment of her program, showcases the impact of STEAM on participants, fostering a sense of belonging and encouraging them to pursue new ventures.

Both Ava and Mae's narratives underscore the theme of "stories and dreams," illustrating how their STEAM program engagements nurtured their storytelling abilities, creative aspirations, and confidence in exploring diverse career paths. These experiences are indicative of the counterspace framework, which posits that creating environments where underrepresented students feel supported and encouraged to explore their identities and interests can lead to transformative educational outcomes (Case, 2012). By offering a platform for Black girls to

share their stories, dream big, and experiment with their creativity, programs like BlackGirlSTEAM function as essential counterspaces. They uniquely challenge the traditional confines of STEAM education and also affirm the importance of including diverse voices and perspective

Theme 3: Building community

Ava's recounting of her experiences within the STEAM program highlights the vital role of community building in educational settings, particularly for Black girls navigating STEAM fields (Case, 2012; Harris & Kruger, 2023). By fostering a tight-knit group among the participants, the program not only facilitated mutual support and encouragement but also provided a space where the achievements of each individual, both within and outside the program, were celebrated. This sense of belonging and mutual upliftment is crucial for minority students in predominantly white and male-dominated fields (Bertrand & Numukasa, 2020) . Furthermore, Ava's appreciation for speakers who shared similar backgrounds and struggles underscores the importance of representation and relatability in mentorship. The intentional inclusion of speakers like Dr. Meg, who could address specific experiences and challenges faced by Black girls, exemplifies a thoughtful approach to building a supportive community that affirms their identities and encourages resilience against societal biases.

Similarly, Mae's reflections on her STEAM program experience emphasize the significance of finding commonality and support within diverse groups. Her connection with a peer who, despite initial differences, shared similar interests and behaviors, illustrates the power

of STEAM programs to transcend superficial differences and foster deep, lasting friendships (Childers-McKee & Hytten, 2015; Winters, & Esposito, 2010).

Mae's narrative also highlights the program's supportive learning environment, where asking for help and collaborative problem-solving were encouraged. This aspect of community building is essential, as it not only aids in the academic and technical development of participants but also instills a sense of confidence and belonging. Mae's experience with coding and website development, and the readily available support she received, reflect a communal learning atmosphere that values curiosity, resilience, and mutual assistance.

Comparing Ava and Mae's experiences, it is clear that both found immense value in the communities fostered by their respective STEAM programs. For Ava, the sense of camaraderie and the impactful speakers played a significant role in affirming her identity and bolstering her confidence. For Mae, the discovery of a like-minded peer and the supportive learning environment were crucial in her STEAM journey. Per CRF, both narratives underscore the importance of creating spaces where Black girls can find both reflection and support, allowing them to navigate the challenges of STEAM fields with confidence. These shared experiences highlight how community building within STEAM programs can serve as a powerful tool for empowering According to Smith (2023), Black girls require a sense of belonging, and encouragement for their academic and personal growth. The significance of community building within the STEAM programs for Ava and Mae can be distinguished as Counterspaces. Building community offers marginalized individuals a refuge from mainstream environments that often mitigate or misunderstand their experiences. In these STEAM programs, building a community

acted as a counterspace by providing Black girls with a supportive network of peers and mentors who reflect their identities and understand their struggles. This environment not only nurtured their STEM interests but also reinforces their sense of self-worth and belonging in fields where they are underrepresented.

Theme 4: Self identifying

Ava's journey in her STEAM program reveals the high impact of representation and support in fostering a sense of identity within technical and creative fields. Her ability to self-identify with a role behind the camera was significantly influenced by the visibility of successful figures like Ava DuVernay, who embody the possibilities awaiting Black women in areas traditionally dominated by others. This connection not only inspired Ava but also filled a gap in representation that she experienced in her formative years. The STEAM program's intentional inclusion of speakers who mirrored the students' backgrounds and shared their experiences further influenced Ava's self identity in the STEAM domain. By facilitating interactions with professionals who not only look like her but also share similar stories and challenges, the program played a crucial role in affirming Ava's place and potential in the technical aspects of filmmaking, reinforcing the idea that her goals are achievable (Carter, 2005).

Mae's appreciation for the hands-on learning experiences in her STEAM program underscores the importance of active engagement in solidifying one's identity within STEM fields. Unlike the traditional classroom setting, which often relies on passive learning methods, the program provided Mae with a dynamic environment where she could immerse herself in STEM activities (Harris & Kruger, 2023; Kang et al., 2019). This engaging approach allowed

Mae to envision herself as a competent participant in STEM, breaking down the barriers of self-doubt and delivering a stronger connection to the field. Mae's realization that she could excel in STEM through hands-on activities highlights the transformative power of experiential learning in allowing students to explore their interests deeply and identify with careers they might not have considered otherwise.

In comparing the experience of Ava and Mae's program interactions, it becomes evident that both young women benefited immensely from the STEAM program's emphasis on representation and hands-on learning. While Ava found inspiration and self-identification through visible role models and supportive speakers, Mae discovered her STEM identity through active participation and engagement in the program's activities. These narratives underscore the critical role that exposure and support play in helping Black girls to see themselves in STEAM professions (Harris & Kruger, 2023). By providing these adolescent Black girls continued support, it helps to dismantle the barriers that might prevent them from pursuing careers in STEM.

Additionally, a connection can be made regarding the theme of self identifying as a method of STEAM programs creating a counterspace for their participants (Case, 2012). Ava and Mae’s STEAM programs exemplify the concept of counterspaces by offering them environments where their racial and gender identities are affirmed rather than marginalized. These programs serve as counterspaces by challenging the dominant narratives that often exclude Black women and girls from STEM fields, providing them with the tools, confidence, and support to create their paths. Through representation and hands-on learning, Ava and Mae were

able to develop and embrace their STEM identities, illustrating the counterspace framework's effectiveness in creating inclusive and empowering educational experiences.

Theme 5: Creating a safe space & Relationship building

Ava's participation in her STEAM program illustrates the importance of creating a safe space where young Black girls feel comfortable revealing their vulnerabilities. Initially hesitant to disclose her true age due to fear of exclusion or judgment, Ava's decision to fabricate her age underscores the pressure many young participants feel in educational settings to meet certain criteria or expectations. However, the open and supportive environment fostered by the program's staff, encouraged Ava to embrace her authenticity and seek assistance without fear of criticism. This shift from apprehension to openness is significant, reflecting the program's success in creating an environment where students can be honest about their challenges and receive the support they need to overcome them (Smith, 2023). Ava's experience highlights the transformative actions of a nurturing educational space that prioritizes understanding and support over judgment, allowing students to grow and learn confidently.

Similarly, Mae's recounting of her STEM program experiences demonstrates the sentiment of finding comfort and support within an educational community (Kelley & Knowles, 2016). Her narrative emphasizes the program's role in making her feel at ease with unfamiliar tasks and topics, guiding her through challenges, and creating a collaborative learning environment. The inclusivity of the program, which tailored activities to incorporate Mae's interests alongside those of her peers, created a dynamic and engaging learning experience. This approach not only accommodated individual preferences and learning styles but also promoted

mutual respect and understanding among participants (Nagle & Andrews, 2019). Mae's ability to seek help and engage in activities outside her comfort zone without fear of judgment or failure is indicative of the safe and supportive atmosphere cultivated by the program, crucial for fostering a sense of belonging and confidence in STEM fields.

Analyzing Ava and Mae's experiences, it becomes evident that STEAM programs play a crucial role in creating safe spaces that encourage personal growth, learning, and authenticity (Kelley & Knowles, 2016). Both adolescent girls found themselves in environments where their concerns and uncertainties were met with empathy, guidance, and encouragement, allowing them to engage fully with the program without the burden of hostility or judgment. This nurturing atmosphere enabled Ava and Mae to explore their interests, confront challenges, and ultimately, thrive in their respective fields. The programs' success in providing such environments underscores the importance of supportive educational communities in the development and retention of underrepresented students in STEM fields.

Just as important, the narratives of Ava and Mae within their respective programs exemplify the counterspace framework, where educational settings act as refuges from the broader contexts of marginalization and exclusion often experienced by Black girls in STEM (King & Pringle, 2019). The potential of counterspaces in empowering young Black women to pursue their passions in STEAM fields is paramount to formulating a STEM identity. By acknowledging and addressing the unique challenges faced by these students, the programs not only facilitated their self-identification and growth within STEM but also contributed to the broader goal of diversifying and enriching these fields with new perspectives and skills.

Implications

The experiences of Ava and Mae in their respective online STEAM programs illuminate several implications for K-12 stakeholders aiming to close the disparity in the number of Black women working in STEM careers. Per CRF, first and foremost, these narratives highlight the critical importance of early exposure and representation (Winters & Esposito, 2010). Stakeholders must recognize that the journey toward a STEM career begins long before college or the job market; it starts in the classroom and online educational platforms where young Black girls can see themselves reflected in the fields they may choose to pursue. Incorporating more Black professionals and role models into STEM curricula and extracurricular activities can inspire students by showing them that their aspirations are attainable and that they too belong in these spaces. This representation can significantly impact students' ability to envision themselves in STEM roles, thereby fostering a deeper interest and commitment to these fields from an early age (Nagle & Andrews, 2019).

Secondly, the creation of safe and supportive educational environments, as exemplified by Ava and Mae's programs, is paramount. K-12 stakeholders need to ensure that educational settings are not just physically safe but also emotionally and intellectually nurturing, allowing Black girls to express curiosity, make mistakes, and seek help without fear of judgment. This requires a conscious effort to understand and address the unique challenges faced by Black girls in STEM, including combating stereotypes, providing mentorship, and ensuring that educational materials and teaching practices are inclusive and affirming of their identities (King & Pringle, 2019). These efforts can help in building confidence and resilience among students, qualities that

are essential for navigating and succeeding in the predominantly white and male-dominated fields of STEM.

Furthermore, the emphasis on hands-on, experiential learning strategies, as seen in the programs attended by Ava and Mae, underscores the need for innovative teaching methods that engage students actively in STEM subjects (Childers-McKee & Hytten, 2015). K-12 stakeholders should advocate for and implement curricula that go beyond traditional lecture-based models to include project-based learning, coding workshops, science labs, and other interactive activities (Nagle & Andrews, 2019). These approaches can make STEM subjects more engaging and accessible, helping to spark interest and sustain engagement among Black girls by allowing them to explore real-world applications of STEM concepts. By making STEM education more dynamic and relevant, educators can help students develop a tangible connection to these fields, encouraging continued interest and academic pursuit in STEM.

Lastly, the implications for K-12 stakeholders extend to the need for systemic change within educational policies and practices to support the inclusion and success of Black girls in STEM (Smith, 2023). This includes advocating for equitable access to resources, technology, and opportunities for advanced coursework in STEM subjects for schools serving predominantly Black communities. It also involves training educators to recognize and challenge their biases, implementing anti-racist and gender-inclusive teaching practices, and fostering partnerships with organizations and programs that support Black girls in STEM. By addressing these areas, K-12 stakeholders can play a pivotal role in dismantling the barriers that contribute to the

underrepresentation of Black women in STEM careers, paving the way for a more diverse, equitable, and innovative future in these critical fields (Smith, 2023).

Limitations

While this study provided great insight into the experiences of Black girls in STEAM programs, it is also limited by the region of the programs as well as online accessibility. Because these programs require access to the internet, this may limit some students' ability to participate in these online programs. Additionally, my perspective as a Black male may impose a certain amount of bias in the findings of the study. Although I bracketed my personal, I also taught one of the students who participated in the online program. Even though I instructed her that all answers will be confidential, there is a possibility that some of her responses might have been influenced by my classroom pedagogy. Notwithstanding, the student narratives provided rich data.

Recommendations [federal, state, local,]

Based on the insights gained from the experiences of Ava and Mae in their STEAM programs, several recommendations emerge for implementing STEAM programs equitably at the federal, state, and local levels. These recommendations aim to address systemic barriers and enhance the accessibility and effectiveness of STEAM education for all students, particularly those from underrepresented backgrounds.

Federal Level

With the support of federal funding specifically targeted at developing and expanding STEAM programs in underserved communities. This funding should support the creation of

inclusive curricula, provide training for educators in culturally responsive teaching practices, and ensure access to necessary technologies and materials. Additionally, investment in scholarships for underrepresented students pursuing STEAM education and careers can help alleviate financial barriers (Chudnovsky et al., 2008).

The development and implementation of national standards for accessibility to STEAM programs would also serve as a viable solution for closing the opportunity gap in access to STEM careers (Hoeg & Bencze, 2017). These standards should ensure that programs are inclusive, culturally responsive, and designed to meet the needs of diverse student populations. The development of these standards should involve stakeholders from various backgrounds, including educators, students, and community leaders, to ensure they are comprehensive and effective.

State level

There are also opportunities for states to leverage statewide initiatives for professional development focused on equity in STEAM education. This could include training educators on bias recognition and mitigation, culturally responsive teaching practices, and strategies for creating inclusive and supportive classroom environments (Brown & Bogiages, 2019). Encouraging educators to foster counterspaces within STEAM education can help contribute to a more equitable and inclusive learning experience for all students.

The Fostering of partnerships between schools, local communities, and industries to provide real-world STEAM learning opportunities would also assist in granting access to members of society that have historically been left out. These partnerships can offer mentorship

programs, internships, and project-based learning experiences that connect classroom learning to practical applications (Brown & Bogiages, 2019). State agencies can play a pivotal role in facilitating these partnerships, ensuring that students across the state have access to diverse STEAM experiences.

Local level

At the local level, schools and programs should actively engage with communities and parents to build support systems for students participating in STEAM education. This includes organizing community events, workshops, and information sessions that highlight the importance of STEAM education and showcase student achievements. Engaging parents and communities not only fosters a supportive environment for students but also raises awareness of the value of STEAM education and careers (Jones, 2013).

Implementing these recommendations requires a collaborative effort across federal, state, and local levels to ensure that STEAM education is accessible, inclusive, and responsive to the needs of all students(Nagle & Andres, 2019). By addressing structural barriers and fostering environments that support diversity and inclusion, policymakers and educators can significantly enhance the quality and impact of STEAM programs, paving the way for a more diverse and innovative future in STEAM fields(Smith, 2023).

Summary

This study investigated the impact of online extracurricular STEAM programs and their impact on Black girl's STEM identity. The findings reveal the importance of representation and early access to STEAM programs. The outcomes of this study suggests that STEAM

participation for middle grades Black girls helps to nurture interest in a STEAM careers. These programs also help students build a sense of community as well as create a counterspace for Black girls. The study provides implications and recommendations for educators and other stakeholders who are interested in improving minority student STEAM achievement. This study also provides recommendations for policymakers who are interested in increasing minority STEAM participation.

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APPENDIX A: INTERVIEW PROTOCOL

Rapport Questions

- Can you tell me a bit about your favorite activities or hobbies?
- What is your favorite subject in school, and why do you like it?
- Do you have a favorite book, movie, or TV show? What do you like about it?
- If you had the choice of attending any concert or any athletic event which would you, why?
- What are some achievements or moments you are really proud of?
- If you could learn something new, what would it be and why?
- How do you like to spend time with your friends?

Interview Protocol

1. Can you share a bit about your experience in the extracurricular STEM program? What motivated you to join, and how long have you been participating?"
Sense of Belonging:

2.In what ways does the STEM program make you feel like you belong? Are there specific aspects or activities that stand out to you as creating a sense of community?"
Cultural Relevance:

3.How do you see the STEM program incorporating or valuing aspects of your cultural background or identity? Are there specific elements that resonate with you on a cultural level?"
Peer Relationships:

4.Have you formed friendships or connections with other Black girls in the program? How do these relationships contribute to your overall experience, and do you feel a sense of support from your peers?

Learning Environment:

5.In what ways does the STEM program provide a unique learning environment compared to your regular school classes? Are there teaching methods or approaches that you find particularly effective or engaging?

- How did the STEM program help to create an alternate space [counterspace]of learning for you?

Personal Growth and Skill Development:

6.How has participating in the STEM program impacted your personal growth and skill development? Are there specific skills or knowledge areas that you feel you've gained through the program?

Describe some of the technology you had access to while doing the program. Ie. cameras, ipads, microphones, editing equipment, etc.

Challenges and Overcoming Barriers:

7.Have you faced any challenges in your STEM journey, and how has the program helped you overcome them? Are there specific resources or support systems within the program that have been beneficial?"
Future Aspirations:

8.Looking ahead, do you see the STEM program influencing your future goals or aspirations? Are there specific aspects of the program that you believe will have a lasting impact on your academic or career path?

APPENDIX B: RECRUITMENT PHONE SCRIPT

Recruitment Phone Script (Parent and Child Aged 12- 17)

Researcher (Keith): Good afternoon, may I please speak with [*parent name*]?

If the Person is not available: Thank the person who answered and say goodbye.

If the Person is available: First confirm that you are speaking to the correct person.

Researcher (Keith): This is [*Keith Burgess*] calling from University of North Carolina at Charlotte. I am currently a doctoral candidate working on my dissertation study with my faculty advisor, Dr. Greg Wiggan. I am recruiting participants for my research study and wanted to share information with you and [child's name] to see if you would be interested in giving permission for [child's name] to participate. But most importantly, I want to know if [child's name] will be interested in doing the study.

Is this an Ok time for you both to speak?

If the Person says "No"
[The researcher will ask if they can schedule another time to talk. If the person is not sure or seems hesitant, the researcher will thank him/her and say goodbye.]

If the Person says "Yes"

Researcher (Keith): Great. I wanted to let you know about my dissertation research study. I am not sure if you are aware that Black women are disproportionately underrepresented in STEM careers. Ensuring there is diversity in STEM is essential for innovation and problem solving, as it brings a range of perspectives and experiences to the table. Therefore, spaces where Black girls can engage in STEM programs may be a solution for making the STEM career workforce more inclusive.

Engaging Black girls in STEM not only addresses the underrepresentation of minorities in these fields but also empowers them to explore their interests, build confidence, and pursue fulfilling careers. Encouraging diversity in STEM programs not only benefits the individuals involved but also contributes to a more equitable and prosperous future for the entire STEM community and society at large.

Researcher (Keith):

For my dissertation study, I am recruiting two Black girls between the ages, 12 and 17, who have participated in an online extracurricular STEM program. [Child/legal ward] will be asked to

participate in this study which will be conducted over a two-month period. However, [Child/legal ward] is only required to participate in one interview during this time span. If interested, I will provide a parental consent form and child assent form for you both to complete. When the required documentation and forms are completed we can then begin the process of scheduling an interview time to begin the study.
Do you have any questions thus far?

If the Person says "Yes"
[Researcher (Keith) will answer questions]

If the Person says "No"

Researcher (Keith): Okay, if selected, your child will participate in one 45-minute interview via Zoom (virtual) that will be audio and video recorded. A $50 gift card will be provided to [Child/legal ward] at the end of the study in approximately two months for their participation. Once all three interviews are complete, you both will be allowed to look at the transcript and report of the study.

Do you have any questions thus far?

If the Person says "Yes"
[Researcher (Jimmeka) will answer questions]

If the Person says "No"

Researcher (Keith): If there are no additional questions, and you provide consent for [child's name] to take part, and [child's name] expresses interest in participating, I would be delighted to forward both a consent form for the parent to sign and an assent form for the child. These documents will offer detailed information about the research study, outlining the participant's rights, the study's purpose, and the potential risks and benefits associated with participation. Reviewing these forms will provide both the parent and [child's name] with a comprehensive understanding of the study before making a decision to participate.

Would you like for me to send you a consent form and [child's name] an assent form?

If the Person is interested in receiving a copy of the consent form:

Researcher (Keith): Does email work for you?

If the Person says "Yes", confirm their email(s): _____

Researcher (Keith): Thank you, I got it. I will email you a copy of the consent form and [child's name] a copy of the assent form. You can contact me with any questions as well. I will check back in with you in a few days as a follow up.

Do you have any questions for me at this time?

Answer any questions they may have.

It was a pleasure talking with you, and we will be in touch.

APPENDIX C: ASSENT FOR CHILDREN 12-17

Assent for children 12-17 years old unless emancipated

Study Title: The Rearview Mirror: Navigating the STEM Identity of Middle Grades Black Girls Through Online Extracurricular Counterspace

My name is Keith Burgess and I am a doctoral candidate at The University of North Carolina at Charlotte. I am doing a study to see if middle grades Black girls can increase their interest in STEM careers if they participate in online extracurricular STEM programs.

I would like you to take part because you have previously participated in an online extracurricular STEM program. Through your participation, you gained experiences that might help other people understand if these types of programs have value in our society. More specifically, we hope you can use the findings from this study to design programs that may influence Black girls to have an increased interest in participating in STEM careers as adults.

For this study you will be asked to participate in one interview via the Zoom platform. The interview will take approximately 45 mins to an hour to conduct. The questions that I will ask you are all related to STEM and about your experiences in STEM programs. Your video and voice recorded answers will be protected at all times during the interview process and study. Your image nor your audio will never be shared with anyone outside of the study group (which includes me and my academic advisor).

Your parents said it was ok for you to be in this study and have signed a form like this one. You do not have to say “yes” if you do not want to be in the study. If you say “no” or if you say “yes” and change your mind later, you can stop at any time and no one will be mad at you. Additionally, you can ask questions at any time during this study and they will be answered for you.

It is my hope that this study will assist in increasing the interests of Black girl’s for wanting to work in STEM careers as adults, but I cannot be sure it will. This study will not hurt you and has no risk of future harm. At the completion of me analyzing the data you provided me in the interview, you will be provided with a $50 gift card for sharing your time and experience as a study participant.

Upon completion of analyzing your interview transcripts you will be notified. This process may take up to a month and you will then have the opportunity to verify and confirm any findings I have concluded. It is at this point I will provide you with the $50 Visa gift card. I will then begin writing my report

(dissertation) and that report will also be shared with you. The dissertation may take approximately another month to complete. I will not use your name in the report. Any reference to you in this report will utilize a pseudonym (a made-up name). This is so no one who reads the report will be able to identify you. Additionally, all files containing your audio/video recordings will be permanently deleted from all platforms and saved spaces.

If you want to be in this study, please sign your name.

_____ _____

Participant Name/Signature Date

_____ _____

Signature of Investigator Date

Emancipated Minor (as defined by NC General Statute 7B-101.14) is a person who has not yet reached their 18th birthday and meets at least one of the following criteria: 1) has legally terminated custodial rights of his/her parents and has been declared 'emancipated' by a court; 2) is married, or 3) is serving in the armed forces of the United States.

APPENDIX D: PARENT OR GUARDIAN CONSENT

Parent or Legal Guardian Consent for Child/Minor Participation in Research

Title of the Project: THE REARVIEW MIRROR: NAVIGATING THE STEM IDENTITY OF MIDDLE GRADES BLACK GIRLS THROUGH ONLINE EXTRACURRICULAR COUNTERSPACES

Principal Investigator: W. KEITH BURGESS, DOCTORAL CANDIDATE, THE UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Faculty Advisor: DR. GREG WIGGAN, DISSERTATION RESEARCH ADVISOR, THE UNIVERITY OF NORTH CAROLINA AT CHARLOTTE

Your [child/legal ward] is invited to participate in a research study. Your [child's/legal ward's] participation in this research study is voluntary. The information provided is to help you decide whether or not to allow your [child/legal ward] to participate. If you have any questions, please ask.

Important Information You Need to Know

· The purpose of this study is to find out how the online extracurricular STEM program [child/legal ward] can increase the STEM identity of middle grades Black girls to self identify with STEM careers.

· Your child [child/legal ward] may participate in this study if they identify as a Black girl between the ages of 12 and 17 and have participated in an online extracurricular STEM program.

· Your child [child/legal ward] will participate in one 45-minute interview for this study to discuss how her experiences in an online STEM program have shaped her STEM identity. This interview is a critical part of determining if online STEM programs can be a tool used to encourage Black girls to participate in STEM careers. Before any findings regarding this study can be made, your child's interview responses will first be transcribed using the transcription tool on the Zoom platform. Those transcripts will then be analyzed for themes related to their STEM identity and career aspirations. Participants will have the opportunity to verify the transcripts and my findings before they are added to my dissertation.

· Your child [child/legal ward] will be required to participate in an interview on Zoom and share their STEM experience via an interview. Once the study is complete in approximately a two-month period (dissertation written and defended in front of the committee), all information related to your child will be destroyed and deleted from all study files. A final copy of the findings will also be shared with parents and participants before the final dissertation and after the dissertation is written.

· Please read this form and ask any questions you may have before you decide whether to participate in this research study.

Why are we doing this study?
There is a need to explore solutions that will increase the STEM identity of Black girls with the intention of increasing their career aspirations in STEM fields. Currently Black women are disproportionately underrepresented in STEM careers, in order to increase diversity and inclusion in these fields, solutions that allow middle grades Black girls to self-identify in STEM need to be developed and put into action.

Why is your [child/legal ward] being asked to be in this research study.
You are being asked to allow your [child/legal ward] to participate in this study because they are an adolescent Black girl between the ages 12 and 17 and have participated in an online extracurricular STEM program while in middle school.

What will children do in this study?
Your [child/legal ward] will be asked to participate in this study by providing information about their online STEM participation via an interview on Zoom. Although the final dissertation will be complete in about two months, your child's segment of the required participation will be completed in one month. Initially, they will be required to participate in one 45-minute interview via Zoom (virtual) that will be audio and video recorded. At the conclusion of the interview a transcript will be prepared and analyzed for themes that might be relevant for the study purpose. Once the interviews are complete, the participant will be allowed to look at the transcript and report of the study to verify the accuracy. A digital copy of the report and transcript will be shared privately within a month following the interview. No additional personal information or online profile will be required or collected for this study.

What are the benefits of this study?
There are no direct benefits experienced from this research.

What risks might children experience?
While uncommon, there are potential minor risks associated with emotional experiences that may arise during the study and must be disclosed. Some participants might undergo emotional reactions while discussing their online experiences. It is important to note that participants will not be compelled to answer any questions that make them uncomfortable during the interview, and they are encouraged to respond with "pass" if there is a question they prefer not to answer. Participation is voluntary, and individuals are willingly sharing their experiences. The interviewer will prioritize providing support to ensure each interviewee feels comfortable. To safeguard identity and prevent potential embarrassment or exposure, all interview audio files will be transcribed verbatim, and names will be replaced with pseudonyms during the transcription process.

How will the study information and information about my [child/legal ward] be protected?
We will not use your [child's/legal ward's] name. Instead, we will use a pseudonym (fake name) and this fake name will be used on all data for the study. Interview recordings conducted via Zoom will refrain from capturing full names of participants. A restricted-access private Google folder will be established in Google Drive to organize all data collection content. Within this private folder, individual subfolders will be designated for participants, storing their interviews and digital copies of their interview transcripts. A Google Doc within the private research folder will link participants to their assigned pseudonyms,

ensuring that folders and content exclusively use pseudonyms as identifiers. Access to the comprehensive research folder will be limited to the researcher and a faculty advisor, while participants' subfolders will be accessible to the researcher, faculty advisor, and the respective participant. At the conclusion of the dissertation defense all transcripts will be erased and wiped clean from the researchers drive.

How will information be used after the study is over?
The data collected for this study will contribute to the researcher's dissertation and doctoral defense, forming the basis of the final paper. Following approval from participants and the successful defense of the research in front of the dissertation committee, all folders and identifying documents will be permanently deleted from Google Drive and any associated computer hardware. All collected audio and video from the Zoom interview will also be permanently erased from the Zoom platform as well.

Will [children/legal wards] receive an incentive for taking part in this study?
Your [child/legal ward] will be rewarded with a $50 Visa Gift Card as a token of appreciation for their participation in the study at the conclusion of the coding and analyzing of their interview transcripts. This will take approximately one month or less to complete. They will also be asked to check the transcripts and codes for accuracy; however, it will not be a requirement to receive the $50 gift card incentive. This is a one-time incentive that will be provided to the participant from the primary researcher's personal funds. To qualify for the gift card, participants must complete the interview. The gift card will be sent via USPS mail and addressed to both the parent/guardian and the child. Upon receipt, both the child and the parent/guardian are required to sign and confirm the gift card's delivery through a digital form.

Who is sponsoring this study?
The researcher nor the institution is receiving any funding or sponsorship for this study.

What other choices are there if I don't want my [child/legal ward] to take part in this study?
Your child is not obligated to participate in this study and there are no consequences for choosing not to participate.

What are my [child's/legal ward's] rights if they take part in this study?
Participating in this study is voluntary. Even if you decide to allow your [child/legal ward] to be part of the study now, you may change your mind and stop their participation at any time. You and your [child/legal ward] will not lose any benefits to which you are entitled.

Who can answer my questions about this study and participant rights?
For questions about this research, you may contact Keith Burgess, wkburges@uncc.edu (704) 724-1595 and faculty advisor Dr. Greg Wiggan, gwiggan@charlotte.edu

Parent or Legally Authorized Representative Consent
By signing this document, you are agreeing to [your child's OR the person's named below] participation in this study. Make sure you understand what the study is about before you sign. You will receive a copy of this document for your records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above. I understand what the study is about and my questions so far have been answered. I agree for [my child OR the person named below] to take part in this study.

_____
Participant Name (PRINT)

_____
Parent/Legally Authorized Representative Name and Relationship to Participant (PRINT)

_____
Signature Date

_____
Name and Signature of person obtaining consent Date