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## Examining Perceptions of High School Science Teachers Regarding the Participation and Outcomes of African American Girls in Advanced Science Courses

Shanica Cherie Poole

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EXAMINING PERCEPTIONS OF HIGH SCHOOL SCIENCE TEACHERS  
REGARDING THE PARTICIPATION AND OUTCOMES OF AFRICAN  
AMERICAN GIRLS IN ADVANCED SCIENCE COURSES

By  
Shanica Cherie Poole

A Dissertation  
Submitted in Partial Fulfillment of the Requirements for  
the Degree of Doctor of Education  
in Curriculum and Leadership  
(CURRICULUM)

Columbus State University  
Columbus, Georgia

May 2019

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## DEDICATION

I would first like to give thanks and honor to God who has guided me through this dissertation process and is continuing to mold me into an educational change agent. This dissertation is dedicated to my family who have inspired me to become Dr. Shanica Cherie Poole. To my husband, Calvin Poole, thank you for your unyielding love and support. You believed in me when I did not believe in myself and for that I love you forever. To my daughters, Talia, Camryn, and Savannah, this doctorate is for you. I have been in school your whole lives and have not been able to play as much as I would have liked. I hope you understand that every sacrifice made by mommy and daddy were intended to afford a better life for you. May you always know you are magical and capable of achieving anything. This dissertation is also dedicated to my daddy, Mitchel Carthon, who taught me to never quit and that children should always be better off than their parents. I will forever try to live up to the legend with two master degrees. I love you all.

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## ABSTRACT

African American girls were underrepresented in STEM related education and careers. Social and historical factors caused African American girls to be double marginalized based on gender and sex. African American girls had the potential to fill STEM positions with a strong foundation in advanced science courses. The current study focused on the unknown relationship between science teachers, advanced science courses, and African American girls participating in advanced science courses. Critical Race Theory (CRT) and Black Feminist Thought (BFT) theoretical frameworks were used in an integrated approach to understand the unique experiences of African American girls enrolled in advanced science courses. A qualitative descriptive study was conducted to explore advance science teacher perceptions of the participation and outcome of African American girls enrolled in advanced science courses. Face-to-face, semi-structured interviews were used as the instrument to collect thick descriptive data. Criterion sampling was used to recruit 10 advanced science teachers with experience teaching African American girls to participate. Interviews were transcribed and coded, then findings were organized into themes. Findings were further analyzed into four big ideas that included: curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses. Finally, the researcher discussed implications and recommendations for future research and offered concluding thoughts on the research study.

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## CHAPTER I

### INTRODUCTION

#### Background of the Problem

The U.S. economy was fueled by the increasing number of science, technology, engineering, and mathematics (STEM) careers (Alexander & Hermann, 2016; Stipanovic & Woo, 2017; Vilorio, 2014). Although the definition of STEM varied, STEM was generally described as the use of science, technology, engineering, and mathematics in an integrated approach to solve problems (Vilorio, 2014). For the purpose of this study, STEM was defined as a category, which includes biological, physical, environmental, and medical sciences, technology, engineering, and mathematics courses and careers (Means, Wang, Young, Peters, & Lynch, 2016). STEM participation, which included the engagement of students in K-12 science education and obtaining higher education STEM degrees, was necessary to prepare students to occupy STEM related careers in the future (Stipanovic & Woo, 2017; Young, Feille, & Young, 2017). According to the U.S. Bureau of Labor Statistics (BLS), more than one million additional STEM careers were expected to be created between 2012 and 2022 (Vilorio, 2014). The lack of highly qualified people to fill the increasing number of STEM fields was a national issue, and, therefore, efforts were made to recruit and retain African American girls participating in STEM (Young, Ero-Tolliver, Young, & Ford, 2017).

Increasing the number of African American girls and women participating in STEM education and careers improved the ability of the United States to compete internationally in STEM related fields (Charleston, Adserias, Lang, & Jackson, 2014;

Stipanovic & Woo, 2017). According to Stipanovic and Woo (2017), advanced STEM courses and qualified teachers with expectations for achievement, along with counselor and parental support were factors that impacted the participation of African American girls in STEM education and careers. Science served as an important foundational skill for STEM careers (Archer et al., 2015; Young, Feille, et al., 2017). According to Szelényi, Denson, and Inkelas (2013), participating in STEM related high school courses in high school influenced STEM career outcomes by predicting student interest in science careers. Young, Feille, et al. (2017) conducted a study on the achievement of African American girls in science. Although elementary teachers in the study were traditionally qualified, the teachers admit to the lack of continued professional learning in science (Young, Feille, et al., 2017). According to a study conducted by Archer, Dewitt, and Osborne (2015), the science aspirations of African American students was less than Caucasian and Asian students were. The lack of aspirations of African American students to pursue science careers was a social injustice in itself (Archer et al., 2015). A lack of student aspirations for African American exposed the role race, gender, and social class played in discouraging African American students from developing a scientific disposition (Archer et al., 2015; Young, Feille, et al., 2017). In an effort to diversify the STEM workforce, teachers and parents of African American girls encouraged authentic learning opportunities in science because competency in science paved the way to STEM careers (Young, Feille, et al., 2017).

The disparities of African Americans' education were traced back to the 17th century when Africans were enslaved and prohibited from receiving an education (Levine & Levine, 2014; Mazama & Lundy, 2013). The Emancipation Proclamation issued by

President Lincoln freed the slaves in 1863, but the lack of formalized education for the freed slaves prohibited free slaves from becoming independent. During the Reconstruction era, the Freedmen's Bureau laid the foundation for a public school system, but individual states supported separate and unequal policies, such as Plessy versus Ferguson, which suppressed the education of African American people (Levine & Levine, 2014; Rogers, 2013). In addition to social structures and policies that impeded on the education of freed African Americans, freed African Americans also disagreed on the appropriate type of education that African Americans should receive. While some African Americans advocated for industrial training to teach work skills, others believed in well-rounded classical studies (Mazama & Lundy, 2013).

Regardless of the type of education received, African Americans were unable to reach their full potential due a social hierarchy, which African Americans beneath Caucasians (Woodson, 1933). During the Civil Rights Movement in the 20th century, the separate but equal clause was overturned during the *Brown versus Board of Education of Topeka* in 1954 (Brown v. Board of Education, 1954). Although Brown versus Board of Education eradicated legal segregation, African American students continued to experience discrimination in different forms (Bell, 1980).

During the 1910s and 1920s, educational tracking was developed in the prime of the eugenics movement to scientifically justify white supremacy in education. Students were grouped based on ability and confined to certain paths for education. The idea of tracking diminished, but resumed popularity after the Brown versus Board of Education decision in 1954. Tracking continued segregation in education by confining most African American students to low academic and vocational tracks which kept African American

students from participating in advanced courses (Miller, 2018). Segregation also persisted due to African American students being overrepresented in special education programs in comparison with Caucasian students (Ghattas & Carver, 2017). Finally, the Civil Rights Act was signed into law in 1964 to protect rights of racial and ethnic minorities and women (Aiken, Salmon, & Hanges, 2013).

The work of the first Western feminist, Mary Wollstonecraft, including the *Vindication of the Rights of Women* (1792), influenced U.S. feminists in the 19th century. (Reid, 2013). A national convention which took place in Seneca Falls, New York in 1848 became the catalyst for the women's movement in the United States. The primary focus of the women's movement was suffrage until the 19th Amendment was ratified in 1920.

Equality in employment opportunities caused the women's movement to reignite in the 1940s (Aiken et al., 2013; Egnal, 2015). The Title IX of the Educational Amendment of 1972 as well as Lilly Ledbetter Fair Pay Act of 2009 were two pieces of legislation that advanced equal opportunities for women in the United States. Women's rights were not always representative of all women, especially African American women. As a result, the National Association of Colored Women was established in 1896 (Aiken et al., 2013; Egnal, 2015). In the 21st century, several public and private initiatives promoted African American girls and women as a counteragent to racism and sexism (Joseph, Hailu, & Boston, 2017).

African American women had the ability to contribute to STEM fields when the proper supports were in place (Young, Ero-Tolliver, et al., 2017; Young, Feille, et al., 2017). According to Pinder and Blackwell (2014), a relationship existed between high school experiences of African American girls and continued education in STEM fields.

The social interactions African American girls had at school affected their scientific dispositions. Consequently, scientific dispositions were used to predict future STEM participation (Young, Ero-Tolliver, et al., 2017; Young, Feille, et al., 2017). Students from low socioeconomic backgrounds were less likely to be exposed to advanced science courses and more likely to lack necessary academic resources and qualified teachers (Stipanovic & Woo, 2017). Microaggressions, such as isolation and stereotyping, were found to be a common concern for African American girl college students (Adams, Gupta, & Cotumaccio, 2014; Alexander & Hermann, 2016).

Curricula were culturally biased and asserted a colorblind ideology (Aragón, Dovidio, & Graham, 2017; Rector-Aranda, 2016). Colorblind ideology disregarded racial inequality and the factors that caused racial inequality (Collins, 2018). The spaces in which African American women learned science were perceived to be objective. Therefore, culturally responsive teaching practices were not used to engage African American students in science (Codrington, 2014). For example, critics of the National Science Education Standards argued that the standards disregarded the ethnicity and culture of teachers and students (Ghattas & Carver, 2017). Books and media sources negatively stereotyped African American girls as boisterous, ignorant, indigent, and promiscuous (Pinder & Blackwell, 2014; Joseph et al., 2017). Therefore, culturally inclusive curriculum practices had the potential to positively shape socially constructed meanings for African American girls and improve relationships of people regardless of gender and race (Aragón et al., 2017; Pinder & Blackwell, 2014).

The implementation of culturally responsive teaching practices to promote social justice for African Americans was not a national mandate, and therefore efforts needed to



be initiated by educators (Codrington, 2014). Curriculum modifications strengthened the science identities of girls and encourages science participation. Girls typically benefited from a curriculum that incorporated real-world scenarios and research-based strategies (Baker, 2013).

African American girls were historically denied an opportunity to participate in STEM related fields and were still underrepresented in the 21st century (Archer et al., 2015; Pinder & Blackwell, 2014). Although girls and women in general were underrepresented in STEM education and careers, African American girls and women made up an even smaller subgroup of STEM participants (Charleston, Adserias, et al., 2014; O'Brien, Blodorn, Adams, Garcia, & Hammer, 2015). Although several studies described the experiences of girls and women in STEM, very few studies focused specifically on African American girls and women (Pinder & Blackwell, 2014). Additional research was needed to explore how the intersectionality of race and gender impacted the participation of African American girls and women in STEM fields (Ricks, 2014).

For the purposes of the current study, Critical Race Theory and Black Feminist Thought were used in conjunction to explain the experiences of African American girls participating in advanced science courses. The Critical Race Theory was selected as a theoretical framework because Critical Race Theorists were committed to social justice and ending the oppression of all people, including African American women (Alexander & Hermann, 2016; Johnson & Parry, 2015). In addition, Black Feminist Thought was used as a theoretical framework because Black Feminist Thought described the unique

experiences of African American women and promoted self-empowerment (Charleston, George, Jackson, Berhanu, & Amechi, 2014).

### Statement of the Problem

African American women were underrepresented in STEM education and careers. African American girls and women had the potential to persevere in STEM education and careers, but sociohistorical factors often kept African American girls and women from reaching their full potential. The development of a strong science disposition and the mastery of advanced science skills provided a solid foundation for students aspiring to major in STEM disciplines and pursue STEM careers. Furthermore, African American girls and women represented a double marginalized group of science learners that had not been fully studied.

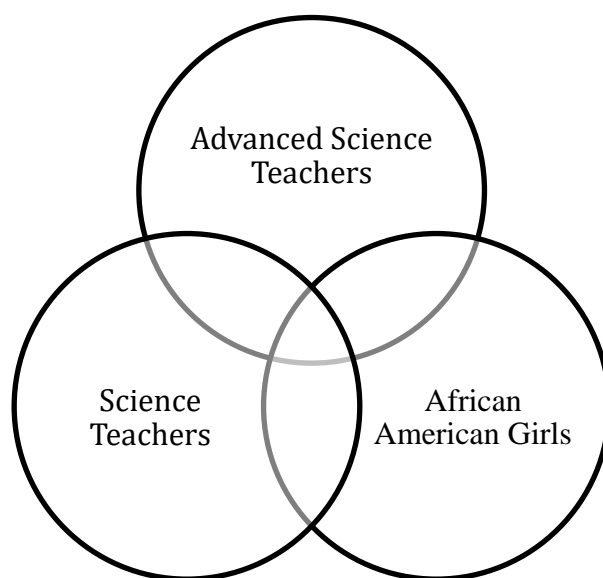
The problem under study was focused on a gap in the literature explaining the experiences of African American girls in advanced science courses. Historical discrimination against African American girls and women in education is well documented. However, studies generally focused on the experiences of women or African Americans and not the double marginalization that African American women faced based on race and gender. The shared experience of teachers of African American girls in advanced science courses and how these teachers perceived the participation and outcomes of African American girls in advanced science courses was unknown.

The current study explored the relationship between advanced science courses, science teachers, and African American girls participating in the courses. Therefore, perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses was studied. This

information was used to inform educators of the unique characteristics of African American girls enrolled in high school science courses and factors that influenced participation in the STEM pipeline. The STEM pipeline included students taking advanced STEM courses, participating in STEM programs, majoring in STEM fields, and actualizing STEM careers.

### Conceptual Framework

The conceptual framework pictured below (see Figure 1) provided a visual diagram to depict the relationship between advanced science courses, science teachers, and African American girls participating in the courses.



*Figure 1.* Poole's Conceptual Framework

In Figure 1, the conceptual framework used for this qualitative descriptive study explored selected high school science teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses. African American women have

been discouraged from participating in science education in the past (Archer et al., 2015; Pinder & Blackwell, 2014).

### Significance of the Study

Using a descriptive study, the researcher explored the experiences and perceptions that high school advanced science teachers had about African American girls participating in advanced science courses. Additionally, the study provided insight into important factors that prepared high school African American girls to participate in the STEM pipeline. Critical Race Theory and Black Feminist Thought Theory were used in an integrated approach to examine and expose the social constructs that perpetuated institutionalized racism and gender bias in STEM education. The critical issues identified in the study include historical discrimination in education based on race and gender, the lack of participation of African American girls in STEM fields, an examination of the access of African American girls in science, and a social justice perspective to culturally responsive science teaching to African American girls.

STEM occupations were the fastest growing in the United States, but there were not enough highly qualified candidates to fill the positions. Furthermore, only a small percentage of STEM degrees and careers were held by African American women. While a significant amount of research was conducted on women in STEM fields and African Americans in STEM fields, very little literature focused on the double marginalization that African American girls and women face while participating in the STEM pipeline. The current study provided insight into factors that affected the participation African American girls in advanced science courses, which was an important prerequisite to success in STEM. The study was significant because the research added to the body of

knowledge of African American girls and women in science education and filled a gap in the literature. The results of this study was used to inform educators of supports, barriers, and implicit bias that impacts the future aspirations of African American girls enrolled in advanced science courses to pursue STEM related fields. Additionally, the study promoted culturally responsive instructional practices and supports to increase the number of African American girls and women who participated in the STEM pipeline. Finally, the information from this study was used in future studies to close the achievement gap in science education and provide appropriate supports to African American girls and women interested in advanced science courses.

### Research Design

A qualitative research approach was employed using a descriptive research design in the current study. Qualitative researchers studied phenomena in a natural setting in an attempt to make sense of a situation (Creswell, 2007). A transformative worldview was used to frame the study because the research focused on social justice for a marginalized group of people (Creswell, 2008). Therefore, Critical Race Theory and Black Feminist Thought theoretical frameworks were used as a lens to study and answer research questions pertaining to the participation of African American girls in high school advanced science courses. This research design was appropriate because according to Creswell (2007), qualitative research was used to study a specific group of people, identify and measure variables concerning the identified group of people, or give a voice to silenced groups of people. A descriptive study in particular described the lived experiences of a group of people pertaining to a specific phenomenon (Creswell, 2007).

A quantitative research approach measured variables and was quantifiable and therefore was not appropriate for the current study. In the same sense, mixed methods research was not utilized because mixed methods also involved quantitative research (Creswell, 2008). Several other types of qualitative research designs were not appropriate for the current study. A narrative research design focused on the life of an individual. A grounded theory research design was not appropriate because the researcher was not attempting to discover a new theory. The participants in a grounded theory study were not similar and did not share behaviors. Grounded theory was contrary to an ethnography research design, which was used to study an entire cultural group. Finally, ethnography focused on the entire culture while a case study used specific cases to address an issue (Creswell, 2007).

The study took place in the state of Georgia, and the participants consisted of advanced science teachers from three high schools in the same school district. Semi-structured interviews were conducted with high school advanced science teachers to describe teacher perceptions of the participation of African American girls in the STEM pipeline. NVIVO 12 Pro was used as a statistical analysis tool to code the data and derive themes. Identified themes were reported in Chapter IV.

#### Research Questions

A qualitative descriptive study was conducted to answer the following research questions:

1. What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?

2. Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

### Methodology

A descriptive qualitative approach to research was used to design the current study. The research took place with high school advanced science teachers in a Georgia school district. This site was selected due to convenience because the researcher is employed in the district. The researcher wanted to explore the participation of African American girls in rigorous advanced science courses, and how the future direction of these students positively contributes to STEM fields. African American girls and women were selected as the focus population because African American girls were marginalized based on race and sex and made up a very small percent of STEM degree recipients and professionals. High school advanced science teachers were selected to participate in the study because high school experiences were found to impact whether or not students pursued a STEM degree. Semi-structured interviews were selected to collect information from this study because semi-structured interviews provided rich insight that could not be obtained through other means. The semi-structured interview questions were designed to collect information on the characteristics of African American girls as learners in science, STEM programs, and supports for students at each school, as well as factors that influenced these students to participate in the STEM pipeline. The data collected were analyzed using NVIVO 12 Pro to code information described in Chapter IV.

### Limitations

The data collected were limited to educator perceptions of African American girls and did not directly involve African American girls. Therefore, student performance of African American girls enrolled in advanced science courses and the potential of African American girls to complete STEM degrees and enter STEM careers were perceptions subjective to educators. The participants were limited to teachers of advanced science courses (i.e., chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, honors human anatomy, and any other science deemed appropriate by the principal at each high school). Although STEM was an important aspect of the study, the study was limited to perceptions from science teachers. A strong foundation in science was a good indicator of interest and participation in STEM related fields of study and careers in the future. The participants were selected from three high schools in a Georgia school district. Therefore, the results were not transferable or easily generalized due to the small sample size and the limited demographics of participants.

### Definitions of Terms

1. *African American*: U.S. citizens of African descent. African Americans have also been referred to throughout history as Negroes, New Negroes, Afro American, and Black (N'Guessan, 2012). For the purpose of this study, the term African American was used.
2. *Advanced Science Courses*: Courses containing advanced science information that is not required by the general population of high school students. Includes but is not limited to chemistry, physics, Advanced Placement biology, Advanced



Placement environmental science, honors biology, honors human anatomy, and any other science deemed appropriate by the principal at each high school.

3. *Banking Concept of Education*: Traditional form of education in which teachers deposit information while students serve as depositories (Freire, 1970).
4. *Black Codes*: Laws passed in southern states after the Civil War to limit the rights of African Americans (Aiken et al., 2013).
5. *Black Feminist Thought*: Social theory framed by the oppression of African American girls and women based on class, race, and sex. The theory reflects various lived experiences of African American women as a collective group and is committed to social justice for African American women and similarly oppressed groups (Collins, 2000).
6. *Colorblindness*: Objective practices that remain the same regardless of race. Science was perceived to be an objective field of study due to a colorblind ideology (Aragón et al., 2017).
7. *Colorblind Racism*: American ideology that did recognize the oppression and discrimination against racial minorities (Aragón et al., 2017).
8. *Critical Race Theory* is a grounded theory research approach used to explain the lived experiences of people of color while examining racism, genderism, and classism (Solórzano & Yosso, 2002).
9. *Culturally Responsive Teaching*: Pedagogy related to diverse cultural backgrounds of students that engages students in inclusive learning practices, and reflects a social justice perspective (Ebersole, Kanahale-Mossman, & Kawakami, 2015).

10. *Descriptive Study*: A descriptive study is a systematic way to describe either something or someone (Dulock, 1993).
11. *Ethnicity*: For the purpose of this study, ethnicity will be a category represented by either Hispanic/Latino or non-Hispanic/Latino (Milan & Hoffer, 2012).
12. *Intersectionality*: For the purpose of this study, intersectionality examines how race and gender intersect to impact the experiences of African American girls participating in the STEM pipeline (Charleston, Adserias, et al., 2014).
13. *Invisibility*: A feeling that the presence of African American girls and women goes unnoticed (Alexander & Hermann, 2016).
14. *Liberatory Education*: Education in which the teacher and students are responsible for fostering a learning environment centered around critical thinking and problem solving (Beckett, 2013; Freire, 1970).
15. *Manumission*: A process of slave owners freeing their own slaves (Levine & Levine, 2014).
16. *Marginalization*: The process of being made to feel unimportant or not accepted in society (Ricks, 2014).
17. *Microaggression*: Day to day injustices, which intentionally or unintentionally demeaned a group of people (Alexander & Hermann, 2016).
18. *Multiculturalism*: Approach to education that acknowledges diversity and is designed to meet the needs of all learners (Aragón et al., 2017).
19. *Race*: For the purpose of this study, race will be a category represented by either African American, Caucasian, American Indian, Native Hawaiian or Pacific Islander, and Asian (Milan & Hoffer, 2012).

20. *Racial Stereotyping*: Negatively characterizations assumed to be associated with African American girls and women. Examples include African American girls being loud, poor, ignorant and sexually boisterous, ignorant, indigent, and promiscuous (Alexander & Hermann, 2016; Pinder & Blackwell, 2014; Joseph et al., 2017).
21. *Scientific Dispositions*: Describes the science identify, utility, self-efficacy, and interest of African American girls (Young, Ero-Tolliver, et al., 2017).
22. *Social Justice*: Social change for marginalized and oppressed groups of people discriminated against based on race, gender, sex, age, and social class (Johnson & Parry, 2015).
23. *Self-efficacy*: Personal belief in the ability to accomplish a task (Young, Feille, et al., 2017).
24. *STEM*: A category including biological, physical, environmental, and medical sciences, technology, engineering, and mathematics courses and careers (Means et al., 2016).
25. *STEM Pipeline*: The educational pathway that students followed to prepare for a STEM career
26. *Stereotype threat*: The suppression of academic performance due to the fear of being negatively stereotyped (McGee, 2013).
27. *Tracking*: The process by which students are placed into higher or lower subject-specific courses, such as math or science—sometimes as early as elementary school—based on their perceived abilities (Miller, 2018, p. 1).

28. *Qualitative Research*: Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. Therefore, qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2005, p.3).

#### Summary

African American girls and women were historically denied opportunities to participate in STEM education and remained underrepresented in STEM education and careers. African American girls had the ability to contribute to STEM fields when proper support was provided through the STEM pipeline. Proper support included equity in educational resources and opportunities, culturally responsive teaching, and research based strategies to support the specific needs of girls. Researchers found that African American girls and women felt invisible in the STEM pipeline. African American girls and women experienced racial stereotyping and bias that impacted self-perceptions of success in both STEM education and careers. The current study sought to describe the perceptions that high school advanced science teachers had about the participation and outcomes of African American girls. Finally, the study contributed to the literature about African American girls and women participating in STEM fields, and could be used in

the future to increase the number of African American girls and women prepared to contribute to STEM fields.

## CHAPTER II

### REVIEW OF THE LITERATURE

#### Introduction

In the United States, science, technology, engineering, and mathematics played a vital role in economic development (Alexander & Hermann, 2016; Vilorio, 2014). The needs of the United States to compete internationally and fill the increasing number of STEM related job positions led to concerted efforts to increase STEM participation in both high schools and colleges (Stipanovic & Woo, 2017). STEM participation ranged from the decision to major in STEM, obtaining an undergraduate STEM degree, obtaining a graduate or advanced STEM degree, and working in a STEM field (O'Brien et al., 2015). Specifically, in high school, STEM manifested as STEM schools, STEM magnet programs, and STEM courses (Stipanovic & Woo, 2017).

The participation of girls in STEM related fields was significantly less than boys (O'Brien et al., 2015), which subsequently had serious consequences on the economy due to a lack of women qualified to pursue specific STEM careers (Alexander & Hermann, 2016). On the other hand, women earned the most doctoral degrees in every broad field with the exception of physical and earth sciences, mathematics, and computer science. Although women only accounted for one-third of doctoral degrees earned in physical and earth sciences and approximately one-fourth of all doctoral degrees earned in engineering, the numbers increased by 6% and 5% respectively from 2005 to 2015 (National Science Foundation, 2015). In the same period, doctoral degrees earned by African Americans increased from 6.2% to 6.5% (National Science Foundation, 2015).

Furthermore, although a vast amount of empirical research investigated experiences of girls in STEM fields, more research needed to be conducted on experiences that influenced girls and women of color to seek degrees and careers in STEM beginning in high school, all the way through graduate school (Adams et al., 2014).

Table 1

*Female Doctorate Recipients, by ethnicity, race, and citizenship status from United States Universities: 2006 and 2016*

Total U.S. citizen or permanent residents	2006	2016
	14,762	18,175
Hispanic or Latino	839	1,420
Not Hispanic or Latino	60	71
American Indian or Alaska Native		
Asian	1,239	1,653
Black or African American	1,140	1,497
White	10,848	12,482
More than one race	259	577
Other race or race not reported	123	124
Ethnicity not reported	254	351

*Note. Adapted from National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates, 2016.*

According to the National Science Foundation (2016), out of the 31,897 doctoral degrees awarded in 2016, 54% were earned by men and 46% were earned by women. The data in Table 1 compared the number of women U.S. citizens who earned a doctoral degree at a U.S. university over a 10-year span. Caucasian women accounted for 73.5% of women who earned a doctorate in 2006 and 68.8% of women who earned a doctorate in 2016. Contrarily, African American women only accounted for 7.7% of the doctorates earned in 2006 and 8.2% in 2016 (National Science Foundation, 2016). Participants in the Survey of Doctoral Recipients reported ethnicity as either Hispanic or Latino or not

Hispanic and Latin. Additionally, one or more races were identified by selecting from African American, Caucasian, American Indian, Asian, or Native Hawaiian or Pacific Islander (Milan & Hoffer, 2012). Although the participation of minorities in STEM fields improved over time, African Americans, Hispanics/Latinos, and American Indian/Alaska Natives were still underrepresented in STEM fields when compared to Caucasians and Asians. Engineering, physical science, computer engineering, and mathematics in particular were STEM fields that lack diversity (CEOSE, 2016).

In addition to building a strong STEM workforce, social justice and critical race theories substantiate the need to provide all people with an equal opportunity to engage in STEM related fields (Archer et al., 2015; Joseph et al., 2017) because discrimination based on age, sex, gender, race, and class threatened social justice for marginalized groups (Johnson & Parry, 2015). African Americans had a long history of inequality in the United States of America. The institution of slavery, legalized segregation, and the present state of education preserved the ideas of institutionalized racism and the inferiority of African Americans (Codrington, 2014). Caucasian girls and African American boys were generally the topic of research concerning marginalized groups, but researchers did not consider the intersectionality of race and gender on African American girls (Ricks, 2014).

A substantial amount of research was done that highlighted gender inequalities in science education, but there is a gap in the literature specifically on gender subgroups such as African American girls (Adams et al., 2014; Pinder & Blackwell, 2014). African American girls had the potential to pursue STEM careers when appropriate science supports were provided by parents and educators (Young, Feille, et al., 2017). The lack of



research concerning the participation and achievement of African American girls in science education, perpetuated the invisibility of African American girls in the field. Therefore, African American girls needed to be studied as a separate entity from Caucasian girls in relation to STEM fields (Pinder & Blackwell, 2014; Ricks, 2014). The National Women's Law Center (2014) identified the lack of exposure to STEM courses as well as gender and racial stereotypes as root causes for the lack of African American girls and women participating in STEM fields.

### Historical Perceptions of Race in Education from Past to Present

#### 17th Century (1601-1700)

The increase in the tobacco industry in the American colonies led to an increase in the importation of slaves to do the physical labor (Aiken et al., 2013). Historically, African slaves were referred to as Negroes (N'Guessan, 2012). Many Caucasians viewed African slaves as inferior beings and did not permit Negroes to be educated. In spite of the risk of punishment, enslaved Africans and their descendants risked their lives in pursuit of literacy (Mazama & Lundy, 2013). However, some slaves were chosen to be educated informally to increase working skills and read the Bible to spread Christianity. Other slave children were educated secretly by wives of slave owners and by the children of slave owners while playing school (Levine & Levine, 2014). Girl slaves also understood how important education was and risked their lives to teach other people. For example, Milla Granson learned to read from her slave master's children. She then opened a school from midnight until two o'clock a.m. to educate other slaves (Ricks, 2014).

Historically, inaccurate scientific data from the 17th and 18th centuries was used to prove that girls and minorities were inferior beings, and was not questioned until the middle of the 20th century (Pinder & Blackwell, 2014). Research practices involved stereotyping, discrimination, gender bias, and manipulating data to prove inaccurate predictions. For example, the human anatomy of girls, including the brain, was presumed to be inferior to boys to justify the primary role of girls as child-bearers. This mindset hindered the participation of all girls in science in both European and U.S. schools. Inaccurate scientific data further attempted to prove that African Americans were less intelligent than Caucasians due to brain size and activity. (Pinder & Blackwell, 2014).

#### 18th Century (1701-1800)

During the 18th century, religious objections to slavery and tension created between the British and U.S. settlers led to northern states creating emancipation laws (Aiken et al., 2013). A small population of African slaves were freed because of working as indentured servants. Other freed slaves resulted when skilled slaves saved money to buy freedom. Finally, some slave owners freed slaves in a process known as manumission (Levine & Levine, 2014).

Once freed, former slaves learned the difference between freedom and equality because freedmen were still not granted full citizenship and had to fight for formalized education (Kerrison, 2015; Levine & Levine, 2014; Mazama & Lundy, 2013). Once slaves were free in the south, freedmen were required to leave the south causing an influx in the African American population in places like Washington, D.C., which placed the least restrictions on African Americans. Some African Americans wrote about their

experiences as slaves, which fueled abolitionists to fight against slavery and affected the attitude of Caucasians on educating African Americans (Levine & Levine, 2014).

Moreover, gender bias and racial bias intersected as an important social construct of the 18th century. Men presumed authority over women. Although, Caucasian women were considered inferior in Caucasian men, Caucasian women were superior to African American women in social rankings, which left African American women at the bottom (Kerrison, 2015). Despite having limited access to formalized education, African Americans, such as Cotton Mather, George Washington Carver and Lewis Latimer, were still able to contribute to advancements in science, medicine, and technology during the 18th century (Rogers, 2013). The invention of the technology, such as the cotton gin and expansion of territories, caused tension amid the northern and southern states (Aiken et al., 2013).

#### 19th Century (1801-1900)

In the late 18th century to early 19th century, African Americans were educated mainly at schools established by religious groups and private schools founded by free African Americans (Levine & Levine, 2014). Sabbath schools were established around the time of the U.S. Civil War by former slaves to educate Africans and their descendants (Mazama & Lundy, 2013). Although free from physical bondage, life was still difficult for African Americans because freedmen were vulnerable to racism, segregation, and discrimination.

In 1860, Abraham Lincoln was elected president. Subsequently, the tension over slavery peaked and led to the Civil War between the U.S. states. (Aiken et al., 2013). In 1863, Lincoln issued an executive order declaring the freedom of all slaves, known as the

Emancipation Proclamation (Aiken et al., 2013; Rogers, 2013). After the U.S. Civil War, the Thirteenth Amendment was ratified to outlaw slavery in the United States. Individual states reacted by creating “Black codes” to restrict the rights of African Americans and enacted separate and not equal educational policies (Aiken et al., 2013; Rogers, 2013).

Many former slaves departed from the south after the Emancipation Proclamation was announced to northern states protected by Union troops. Over 20,000 African Americans migrated to Washington, D.C. in 1865 (Aiken et al., 2013; Levine & Levine, 2014). As a result, some race riots occurred in the northern states. In order to provide further protection for newly freed African Americans, northern republicans drafted the Fourteenth Amendment as well as the Civil Rights Act 1866 to provide equal protection under the law for all citizens. The Fifteenth Amendment was enacted to allow all citizens an opportunity to vote. Although these amendments were designed to create equity among all citizens, states created rules and laws, which were used to handicap African Americans (Aiken et al., 2013).

The Reconstruction era followed the U.S. Civil War from 1865 to 1876 (Aiken et al., 2013; Levine & Levine, 2014). In an effort to unite the states after the U.S. Civil War, Confederate states were required to write a new constitution to submit to the Union states for approval. Formal education was a key component to making former slaves independent; therefore, African Americans rallied in support of legislation for public education. While all Southern states passed laws supporting public education, desegregated schools threatened the socioeconomic and cultural way of life in the South (Levine & Levine, 2014).

In an effort to support the education of African Americans, Congress created the Freedmen's Bureau in 1865 (Levine & Levine, 2014). Although some states supported educational efforts, funding issues got in the way of the education of African Americans. Tennessee for example, created a public education system for African Americans in 1867, but the funding was later rescinded (Rogers, 2013). In spite of barriers, the Freedmen's Bureau built 3,000 schools, the origin of the public school system. The Freedmen's Bureau also sent General S. C. Armstrong to oversee Hampton Normal and Agricultural Institute in Virginia, which emphasized vocational training for African Americans. From 1872 until 1875, Booker T. Washington attended Hampton and later founded Tuskegee Institute. The Freedmen's Bureau established Howard University in 1867, named for General Oliver O. Howard. Howard was open to all genders and races (Levine & Levine, 2014).

The Reconstruction era ended in 1876 due to an economic recession, which resulted in less protections for African Americans. Therefore, African Americans were subjected to unfair labor, segregated schools, and disenfranchisement (Aiken et al., 2013). For example, the Plessy versus Ferguson decision legalized "separate but equal" in public places in 1896 and resulted in restrictions on specific employment opportunities (Aiken et al., 2013; Levine & Levine, 2014). As a result of brutal treatment and the Jim Crow laws enacted in the south, African Americans migrated north in the 1890s (Aiken et al., 2013).

20th Century (1901-2000)

Although African Americans agreed on the need for education, the type of education that was most useful led to a great debate among African American scholars in

the late 19th and early 20th centuries. Booker T. Washington, along with his Caucasian supporters, advocated for African Americans to receive industrial training. On the other hand, W.E.B Du Bois believed that African Americans needed to broaden their horizons to make the most impact and educate the most talented African Americans in classical studies (Lundy & Lundy, 2014; Mazama & Lundy, 2013; Woodson, 1933). Eventually, education for African Americans was expanded to include liberal arts in schools, such as Hampton and Tuskegee that were traditionally focused only on vocational training. While liberal arts expanded the spectrum of education for African Americans, its Eurocentric foundation played a role in curriculum bias (Mazama & Lundy, 2013).

In the *Mis-Education of the Negro*, Woodson (1990) vividly described the circumstances that prevented African American students from receiving a proper education, including a lack of educated teachers, segregated and underfunded schools, and a curriculum in which African Americans did not get an opportunity to learn an accurate account of their history. In addition, technically educated and classically educated African Americans were still unable to use the skills learned to function in the real world due to the hierarchy of social order (Woodson, 1933).

During the 1910s and 1920s, educational tracking was developed in the prime of the eugenics movement to scientifically justify white supremacy in education. Students were grouped based on ability and confined to certain paths for education (Miller, 2018).

African Americans continued to face discrimination through World War I although the war did give African Americans opportunities to fill jobs previously off limits due to the enlistment of Caucasian men in the military. In the 1920s, the term New Negro or Afro American became popular terms used to describe African Americans

(N'Guessan, 2012). During the Great Depression, African Americans continued to face discrimination but groups, such as the National Association for the Advancement of Colored People, educated African Americans on their rights and encouraged African Americans to speak out. Events taking place during World War II brought the social injustices toward African Americans to the forefront. Although African Americans were able to fight against enemies in wars abroad for the United States, African Americans were still treated as second-class citizens at home (Aiken et al., 2013). Rallies and protests for the rights of African Americans caused President Franklin D. Roosevelt to order the full participation of all U.S. citizens without bias. President Truman's stance on civil rights evolved during his presidency. However, President Truman established a civil rights committee and integrated the military. The military was integrated out of fear of African Americans boycotting a potential military draft (Aiken et al., 2013).

Historically, African Americans began to embrace the term Black in the 1960s (N'Guessan, 2012). At the beginning of the Civil Rights Movement, African American parents believed that segregation prevented African American children from receiving a quality education (Mazama & Lundy, 2013; Ricks, 2014). Therefore, African American parents rallied together and claimed a victory during the *Brown v. Board of Education of Topeka* decision of 1954, which ended segregation in public schools. The legal team that included Thurgood Marshall argued against the "separate but equal" doctrine previously adopted in *Plessy v. Ferguson* (Aiken et al., 2013; Levine & Levine, 2014). In the court case, *Brown v. Board of Education* (1954), the Supreme Court ruled segregation as unconstitutional because segregation did not provide equal protection to African American children guaranteed to all people under the Fourteenth Amendment ratified in

1868. Subsequently, the "separate but equal" doctrine previously adopted in *Plessy v. Ferguson*, in 1896 was overturned by this court decision.

The ruling was supposed to mend a broken educational system and create equity in education (Ricks, 2014). Despite the Supreme Court's decision, 60 years later African American students were still fighting against segregation and inferior schools (Bell, 1980; Ricks, 2014). According to Bell (1980), the court's decision was not made primarily for the benefit of African Americans, but out of convergent interests. The outcome of the *Brown versus Board of Education* case was inevitable due to the climate of the United States at that particular time, and the fact that Caucasian Americans gained economic and social advancements by ending segregation (Bell, 1980).

Following the *Brown v. Board* decision, southern democrats and republicans united to announce the Southern Manifesto in 1956 to block desegregation. This decision resulted in tension between state and federal governments. For example, in 1957, the governor of Little Rock Arkansas instructed the National Guard to block nine African American students from segregating an all-Caucasian high school. President Eisenhower responded by sending in a division of the Army to keep the students safe and enforce the national mandate (Aiken et al., 2013). In 1961, President Kennedy used his executive power to issue an order, which prevented discriminatory practices in employment. Additionally, in 1961, violence over the desegregation at the University of Alabama, University of Mississippi, and the University of Georgia further demonstrated the contention over race relations in education.

President Kennedy was a champion for civil rights and laid the foundation for the enactment of the Civil Rights Act. Unfortunately, President Kennedy was assassinated in



1963, and the succeeding president, Lyndon Johnson, passed the Civil Rights Act in 1964 as a tribute to former president John F. Kennedy. The original bill only advocated for racial civil rights, but Howard Smith suggested that women's rights be added to the bill (Aiken et al., 2013). The addition of women's rights to the bill caused controversial debates between congressional representatives, but, when the bill was finally made a law, Title VII was included, a provision that protected racial minorities and women from workplace discrimination based on race, ethnicity, sex, or religious beliefs (Aiken et al., 2013; Quffa, 2016). Finally, the term African American became the preferred label to describe people of African descent that were formerly known as "Negros", "New Negroes/Afro Americans", and "Black" in the 1980s (N'Guessan, 2012). Important peer-reviewed journal articles related to the early education of African Americans, particularly African American girls, was presented in Concept Analysis Chart 1 (see Figure 2).

Topic: Studies Related to Historical Perceptions of Race in Education

Study	Purpose	Participants	Design/Analysis	Outcomes
Aiken, Salmon, & Hanges, 2013	Provide a historical overview of the Civil Rights Act of 1964.	N/A	Historical Narrative	The Civil Rights Act causes a shift in gender and racial equality.
Levine & Levine (2014)	To provide a historical overview of the education of African Americans.	N/A	Historical Reflection	Educational attainment continues to increase for African Americans although an achievement gap persists.
Mazama & Lundy (2013)	Explore reasons that	74 homeschooled	Quantitative: Survey	African American

	African Americans choose to homeschool children and reject Eurocentric education.	African American children	Qualitative: Interviews	homeschoolers believe that Eurocentric education affects self-esteem.
Ricks (2014)	To address the oversight of African American girls in education and suggest supports to assist educators with closing the achievement gap.	N/A	Review of Literature	There is a lack of programs and policies designed to address the role race and sex plays in the education of African American girls. Therefore, initiatives need to be created.
Rogers (2013)	To discuss the history of education for African Americans and how the lack of education affects economic growth.	N/A	Review of Literature	A culturally relevant curriculum as well as resources is needed to provide a quality education to African American students.

Figure 2. Concept Analysis Chart 1

### Historical Perceptions Gender in Education from Past to Present

#### Women's Movement

While African Americans fought for access to formalized education (Levine & Levine, 2014), the women's movement was developing simultaneously (Egnal, 2015).

Born in London, England in 1759, Mary Wollstonecraft was the first Western feminist theorist well known for fighting against men domination and oppression of women in the 18th century (Parpart, Connelly, & Barriteau, 2000; Reid, 2013; Wollstonecraft, 1792). Despite receiving a very simplistic education, Mary Wollstonecraft along with her younger sister and friend Fanny started a school for young children in the 1780s. After the death of Fanny, Mary Wollstonecraft went on to become a prominent writer. In the *Vindication of the Rights of Men* (1790), Wollstonecraft wrote about her opposition to aristocracy and advocated for egalitarianism. Her similarly, controversial follow-up work *Vindication of the Rights of Women* (1792) argued against a hierarchy based solely on sex and urged women to seek the same equality naturally afforded to men. Although Mary Wollstonecraft died in 1797, the work of Mary Wollstonecraft influenced the feminists and abolitionists Sarah Grimké, Elizabeth Cady Stanton, Lucretia Mott, and Susan B. Anthony in the United States in the 19th century. These women played a significant role in women's suffrage in the United States (Reid, 2013).

The 1848 women's convention in Seneca Falls, New York represented a milestone in the development of the women's rights movement, and resulted in widespread recognition and progress for women's rights activists (Aiken et al., 2013; Egnal, 2015). Beginning in 1850, the National Woman's Rights Convention was held every year until the U.S. Civil War with the exception of 1857 (Egnal, 2015). Abolitionists, such as Frederick Douglas and Wendell Phillips, joined women's rights leaders at these events (Egnal, 2015; Reid, 2013).

Susan B. Anthony and Elizabeth Cady Stanton created the Woman's Loyal National League to advocate for not only women, but also African Americans as well in

1862. In 1865, the American Equal Rights Association was created during the 11th National Woman's Rights Convention, and Lucretia Mott served as the president. Tensions arose over the African American agenda, which resulted in the development of two clashing organizations, the National Women's Suffrage Association and the American Women's Suffrage Association. However, the two groups came back together in 1890 to continue to fight for suffrage (Egnal, 2015). Additionally, feminist groups, such as The Women's Christian Temperance Union and the National Woman's Trade Union, were established at the turn of the 19th century to shield women from injustices in employment and education. However, many of these women empowerment groups were led by white supremacists, which disregarded the rights of African Americans (Aiken et al., 2013).

#### Legislation for the Progression of Women's Rights

The 19th Amendment was ratified in 1920 finally giving women the right to vote in the United States. The women's movement died down thereafter because suffrage was the primary focus of women's protests (Aiken et al., 2013). The Equal Rights Amendment was suggested in 1923 to support equality regardless of sex under the law but did not gain popularity until the 1940s. Ratification for the amendment began in 1972, and, although the amendment did not receive enough state support to pass, many states have since adopted equality laws to discourage gender discrimination (Aiken et al., 2013; Quffa, 2016). In 1941, World War II caused the women's movement to pick up steam again as women filled occupational roles left open during the war by men. At the end of the war, women were fired from these positions to make room for returning male veterans (Aiken et al., 2013).

In the 1950s, women enrollment in college was the lowest since 1870 (Aiken et al., 2013). The Title IX of the Educational Amendments of 1972 proved to be significant legislation for women's rights because the amendment banned sex discrimination in education from all educational institutions funded by the federal government. Title IX included all K-20 programs and any educational programs or activities that benefited financially from federal funds. In 1976, the legislation was extended to eradicate sex discrimination and implicit bias in vocational programs as well (Quffa, 2016).

In the 21st century, gender inequality was further perpetuated by the gap in earning opportunities. Women were paid less for the same work as men even though the Civil Rights Act of 1964 was amended in 2009 in what was known as The Lilly Ledbetter Fair Pay Act to outlaw workplace discrimination (Quffa, 2016).

#### The Road to Rights for African American Girls and Women

African American girls and women dealt with both gender and racial discrimination in the 19th century. Gender discrimination was further encouraged by theories to keep girls away from school and working in the home (Pinder & Blackwell, 2014). Due to the fact that all women's rights groups did not advocate for the rights of African American women, the National Association of Colored Women was established in 1896 (Aiken et al., 2013). Racism and sexism was still a reality in the 21st century, and, therefore, national efforts were made to recognize and promote the lives of African American girls and women. For example, the NoVo Foundation collaborated with other organizations, such as the African American Policy Forum and Girls for Gender Equity, to pledge \$90 million dollars in order to deal with inequalities that affect women of color in 2016. Similarly, in 2016, *Black Girl Movement: A National Conference* was sponsored

by the Congressional Caucus on Black Women and Girls, to address issues and recognize the accomplishments of African American women. The movement was further perpetuated with the use of #BlackGirlMagic on social media to celebrate African American girls and women (Joseph et al., 2017). Literature reviews were highlighted in Concept Analysis Chart 2 (see Figure 3) to explain the history of women's rights and equity in education.

Topic: Studies Related to Historical Perceptions of Gender in Education

Study	Purpose	Participants	Design/ Analysis	Outcomes
Reid (2013)	To describe the prehistory of the women's rights movement	N/A	Literature Review	The first Women's Convention is held in Seneca Falls, New York in 1848.
Quffa (2016)	To analyze the social and legal framework associated with gender inequality.	N/A	Literature Review	A gender gap still exists in American society.

Figure 3. Concept Analysis Chart 2

### The Impact of Curriculum Design on the Education of African American Girls

Race played a significant role curriculum design (Aragón et al., 2017; Pinder & Blackwell, 2014; Rector-Aranda, 2016). For instance, students were taught about race in social studies courses in a manner that was neutral or avoided domestic situations altogether. Students were rarely introduced to topics, such as the Tulsa Riots, Tuskegee

syphilis experiment, violent Indian removal, and the effects of Manifest Destiny on Mexicans. Contrarily, curriculums were designed to discuss foreign matters in detail, such as the Holocaust in Nazi Germany. This strategy of incorporating colorblind content into the curriculum was used to prevent students from engaging in tough conversations about race (Rector-Aranda, 2016).

Colorblindness emphasized objective practices that remain the same regardless of race, while multiculturalism acknowledged diversity and supported varied instruction to meet individual student needs. Although colorblindness was perceived as a fair practice, colorblindness was also associated with colorblind racism, an American ideology that failed to recognize the oppression and discrimination against people who were not Caucasian (Aragón et al., 2017; Collins 2018). According to the idea of colorblindness, science was perceived to be objective in education; however, racism and sexism were found to play a significant role in the achievement of African American girls and women (Codrington, 2014; Joseph et al., 2017). According to Ghattas and Carver (2017), multiculturalism was not pervasive throughout science curriculum. Therefore, school curriculum needed to have a multicultural approach and designed to meet the needs of diverse learners (Aragón et al., 2017; Pinder & Blackwell, 2014).

A culturally inclusive curriculum met the needs of all students, not just middle-class Caucasian students. Students, specifically African American girls and women, learned more when the curriculum reflected various cultural backgrounds. Incorporating culturally relevant teaching strategies into the curriculum increased the participation of African American girl students in STEM fields (Farinde, & Lewis, 2012). Aragón et al. (2017) conducted a study focused on inclusive teaching practices including the

curriculum, teaching techniques, learning environment, and implicit biases and concluded teachers who endorsed a multicultural ideology were more likely to encourage underrepresented groups to participate in STEM education than teachers that took a colorblind approach to instruction.

Negative stereotypes often associated with African American girls and women influenced teacher perceptions, especially the perceptions of teachers who were Caucasian and unfamiliar with the culture of African Americans (Joseph et al., 2017). According to Pinder and Blackwell (2014), cultural bias in the curriculum and textbooks perpetuate negative stereotypes about African American girls. Literary texts traditionally reflected the dominant culture in society. In the 1800s, girls were encouraged to read books that showed girls in domestic, submissive, and romantic roles while boys in literature were portrayed as strong and heroic. In the 21st century, some popular books continue to illustrate African American girls and women in negative roles, such as poor, uneducated, diseased, and as young mothers. Additionally, girls and women were less likely to see themselves depicted in literature, history, math, and science (Pinder & Blackwell, 2014). Baker (2013) suggested the use of non-stereotypical non-fiction books with young girls to develop the belief that girls are proficient science learners.

Additionally, Baker (2013) suggested several curriculum modifications to increase participation of girls in science. Achievement increased when the curriculum included standards-based units were related to real-world concepts that interested girls. The science identity of girls improved when the curriculum included a strong conceptual framework embedded with real-world scenarios. Interests of girls in science peaked when the curriculum appealed to aesthetics and the emotional nature of girls (Baker, 2013).



Furthermore, science education involved developing the science identity of students while fostering student motivation, interest, and competency (Ghattas & Carver, 2017).

School curriculum needed to reflect all students, but discriminated against minority groups of students (Aragón et al., 2017; Baker, 2013; Rector-Aranda, 2016).

Pedagogy was also analyzed to illustrate the continued discriminatory practices that further explain the underrepresentation of African American girls in STEM fields.

Concept Analysis Chart 3 (see Figure 4) summarized journal articles that explained how curriculum impacted African American girls.

Topic: Studies Related to the Impact of Curriculum Design on the Education of African American Girls

Study	Purpose	Participants	Design/ Analysis	Outcomes
Pinder & Blackwell (2014)	To discuss the underrepresentation of African American girls in science, science education, and science literature.	N/A	Review of Literature	African American girls are denied a chance in science because of historical/biological arguments, culturally biased texts, and socially constructed meanings.
Young, Feille, & Young (2017)	To gain an understanding of how African American girls achieve in science.	A subsample of African American fourth-grade girls from the 2009 National Assessment of Educational Progress	Quantitative: Descriptive Statistics	Composite scores are lower and African American girls achieve the highest in life science (1st), physical science (2nd), and earth science (3rd). Science dispositions are positive, but students are not engaged in the

				content. Teachers lack resources and training.
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Figure 4. Concept Analysis Chart 3

### Pedagogy as a Learning Support for African American Girls in STEM

#### Social Justice: Culturally Responsive Teaching

Culturally biased teaching practices contributed to the disinterest of African American girls and women in STEM education (Farinde & Lewis, 2012), but the use of inclusive teaching practices encouraged minority and girl students to participate in STEM education (Aragón et al., 2017). According to Codrington (2014), the perceived objectivity of science made the implementation of culturally responsive teaching strategies difficult. Therefore, the researcher encouraged science teachers to liberate African American students from conventional thinking about science in an effort to promote culturally responsive science teaching. This mindset led to a revolution in

teaching methods, which empowered African American students to face barriers and take control of their own destiny (Codrington, 2014).

A study conducted by Alexander and Hermann (2016) determined microaggressions as well as a lack of school support for African American women at Predominantly White Universities (PWUs) and suggested cultural sensitivity training for faculty. Codrington (2014) argued an educational reform to promote social justice in science were not likely come from national mandates. Universal standards, for example, were not designed to consider the needs of oppressed students. Therefore, change should be encouraged by local educators and researchers in order to liberate a historically abused group of students (2014).

A Framework for K-12 Science Education and the Next Generation Science Standards have changed science education from simply teaching students content to teaching students to solve problems through phenomena. Inquiry and equity were fundamental ideas related to the Framework for K-12 Science Education and the Next Generation Science Standards (Ghattas & Carver, 2017). The standards involved the use of three-dimensional instruction, which included crosscutting concepts, disciplinary ideas, and science and engineering practices (Krajcik, 2015). The goal of science educators was to provide equitable education through rigorous standards. Although student experiences varied depending on the culture of the students, teachers could improve scientific reasoning of students through different methods (Ghattas & Carver, 2017). An important part of improving the student performance of diverse students included fostering positive student-teacher relationships. Next Generation Science Standards focused on inquiry, which engaged students in questioning, discussions,

investigations, and data analysis (Asowayan et al., 2017; Ghattas & Carver, 2017). Inquiry was the basis of several pedagogical approaches including maker centered learning, project-based learning, and the 5E model of instruction (Rodriguez, Allen, Harron, & Qadri, 2019).

Social constructivism, developed by Vygotsky in 1978, helped explain how context and culture influenced student understanding of science in a multicultural environment (Ghattas & Carver, 2017). The Biological Science Curriculum Study developed the 5E model, which evolved from social constructivism and challenged students to make connections between personal experiences in a collaborative setting. The five stages of the 5E model were engagement, exploration, explanation, elaboration, and evaluation (Pangestika & Prasetyo, 2018; Rodriguez et al., 2019). First, teachers engaged students in an activity or discussion to spark student interest. During exploration, students designed experiments to ask and answer questions. The explanation phase allowed students to communicate what was being learned. Elaboration caused students to gain a deeper understanding of the content. Finally, the evaluation phase assessed students on content while providing teachers with data used to evaluate student progress (Rodriguez et al., 2019). According to Pangestika and Prasetyo (2018), the 5E Model of instruction improved cognitive learning when compared to traditional methods of science education.

#### Strategies to Support African American Girls and Women in STEM

Although African American girls were underrepresented in science in general, physical science was a specific area that lacked diversity (Archer et al. 2015; Young, Feille, et al., 2017). Student-centered instructional strategies helped close the

achievement gap between boys and girls, particularly in high school physical science courses (Baker, 2013). Other examples of appropriate student-centered instructional strategies included introducing real-world scenarios that were of interest to girls, using rubrics to assess learning, providing hands-on laboratory exercises, ensuring sufficient materials to engage all students in active learning, implementing reading strategies, and providing homework and out-of-school activities (Baker, 2013). Museums, for example, were shown to help young people access science, strengthen science identities, and shape decisions of student to pursue careers in STEM fields (Adams et al., 2014). Other suggested strategies to make STEM participation accessible for African American women in PWUs included enrichment programs for minority students and mental health (Alexander & Hermann, 2016).

#### Motivations and Self-Efficacy

Historically, scientists were stereotyped as middle class Caucasian men, which contributed to the idea that African Americans could not be successful scientists (Archer et al., 2015). For example, traditional stereotypes depicted chemistry as a field hard and masculine, which discouraged girl high school students from participating in the course (Baker, 2013). This conclusion was also affirmed by the study conducted by Bernard and Dudek (2017) when 89% of 935 secondary students participating in the Draw-A-Scientist Test drew Caucasian men as scientists. The results reflected the original Draw a Scientist Test conducted by David Chambers in 1983 in which elementary school participants depicted images of scientists as Caucasian men with glasses and wild hair (Bernard & Dudek, 2017; Chambers, 1983).

Further insight into motivations of African American girls in STEM fields came from the study conducted by Archer et al. (2015) in which science aspirations of 10 to 14 year old African American/Caribbean students were investigated. The research used a mixed methods approach consisting of a survey and longitudinal interviews over the course of 5 years. The interviews were conducted with two Nigerian women pursuing careers in forensic science. African American/Caribbean students were less likely to express interest in science compared to Caucasian and Asian students. The student participants perceived science as difficult subject reserved for intelligent people and associated intelligence with race, gender, and class. Additionally, the lack of self-efficacy based on sociohistorical factors made African American students believe that science was not intended for African American students (Archer et al., 2015). Self-efficacy involved the belief that a person could be successful in a specific field, such as science. Self-efficacy was improved by positive reinforcement from teachers and administrators (Baker, 2013). Furthermore, African American students' knowledge of science careers was found to be limited to science teachers, medical doctors, and research scientists. A substantial amount of research supported low teacher expectations for minority students particularly African American students compared to students with Asian and Indian ethnicities (Archer et al., 2015). Researchers found no evidence that a lack of parental support played a role in low STEM participation, contrary to the popular belief that African American parents did not provide academic support to their children (Archer et al. 2015; Young, Feille, et al., 2017). Journals outlined in Concept Analysis Chart 4 (see Figure 5) discussed teaching strategies that were effective at educating African American girls in STEM courses including science.

## Topic: Studies Related to Pedagogy as a Learning Support for African American Girls

Study	Purpose	Participants	Design/Analysis	Outcomes
Aragón, Dovidio, & Graham, (2017)	To encourage college educators to use inclusive teaching practices in an effort to support minority students and women in science, technology, engineering, and mathematics (STEM).	628 STEM educators that attended the National Academies Summer Institutes on Undergraduate Science Education	Quantitative: surveys	Educators favoring multicultural ideologies are more likely to implement more inclusive teaching practices compared to educators in support of a colorblind ideology.
Codrington (2014)	To discuss Wallace and Brand's research findings on liberatory education and offer ideas for culturally responsive teaching practices ideas to science teachers.	N/A	Review of Literature	Liberation is the first step to transforming science teaching practices. Universal standards are generic and not designed to meet the needs of oppressed groups. Teachers and administrators are responsible for implementing social justice into pedagogy and curriculum.

Farinde & Lewis (2012)	To encourage African American girls in STEM fields through the use of culturally inclusive teaching practices in math and science courses	N/A	Review of Literature	Hold African American girl students the same standards as their peers. Nurture an interest in math and science. Engage students in discussions and hands-on activities. Use culturally relevant strategies to teach.
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Figure 5. Concept Analysis Chart 4

### Experiences of African American Girls in STEM

Inequalities in K-12 education was a social justice issue that prevented African American girl students from participating in advanced science courses in high school, selecting STEM majors in college, and working in STEM careers (Alexander & Hermann, 2016; Archer et al. 2015; Farinde & Lewis, 2012; Young, Feille, et al., 2017). The decisions of girls and women to pursue STEM fields were influenced by social, familial, financial, and motivational factors. One explanation for the lack of African American girls and women in science was their own socially constructed meaning. Their own socially constructed meaning involved the daily interactions that African American girls had with their peers and teachers, which shaped the self-perception of these girls (Pinder & Blackwell, 2014). Similarly, the scientific disposition of African American girls was shaped by their level of competency through academic achievement and



acknowledgement at school (Young, Feille, et al., 2017). African American women reported experiencing invisibility, racial stereotyping, and a lack of recognition, which contributed to interests and achievement in science (Archer et al. 2015). Due to the increasing need to fill STEM careers, educators and parents were more responsible than ever for preparing African American girls beginning in elementary school through high school, to become students capable of achieving in STEM fields (Stipanovic & Woo, 2017; Young, Feille, et al., 2017).

#### STEM High School Experiences

Issues of inequality were overlooked in K-12 education, which led to the lack of quality STEM education for African American girls (Farinde & Lewis, 2012). A process known as tracking placed achievement labels on students that followed students from primary to secondary school. Once labeled as low achievers, African American girls were not given the opportunity to participate in rigorous mathematics and science courses (Farinde & Lewis, 2012; Miller, 2018). According to Miller (2018), tracking denied students the opportunity for equality in education and suggests detracking as alternative. Detracking involved offering an advanced curriculum to all students to increase the readiness of all students to complete advanced and honors courses.

A descriptive study conducted by Stipanovic and Woo (2017) investigated perceptions of high school seniors in reference to their desire to pursue STEM careers. In the study, STEM was infused in high school through STEM schools, STEM magnet programs, and STEM courses. Small focus groups were conducted with African American senior participants, 11 girls and six boys. Major themes that arose were intrinsic motivation and perseverance of students to meet goals. The structures

surrounding students, such as counseling, college prep programs, career assessments, and parental support, also played a role in STEM participation in college. Finally, on a larger scale, socioeconomic status limitations prevented students from pursuing STEM fields. Participants noted a lack of advanced courses being offered due to a lack of funding (Stipanovic & Woo, 2017). For example, Advanced Placement and International Baccalaureate programs were frequently seen in the majority of high-income schools, but were lacking in low-income schools (McGee, 2013). Stipanovic and Woo (2017) found that students from low socioeconomic backgrounds experienced disparities in education through limited course offerings and limited opportunities to participate in dual enrollment programs at local colleges. Additionally, students in high-poverty schools lacked resources, suffered from poor environmental conditions, and had inexperienced teachers (Stipanovic & Woo, 2017).

McGee (2013) described the experiences of Tamara who was a high achieving African American girl high school student. Although Tamara scored in the 93rd percentile on the entrance exam to a prestigious private school and earned a full scholarship, Tamara decided to stay at her own school. In conclusion, the pressures were not worth the opportunity. This type of pressure could have caused a stereotype threat. Stereotype threat occurred when African American and/or girl students that were conscious of implicit stereotypes felt anxiety during testing, which resulted in lower test scores and a loss of motivation and pride (McGee, 2013).

Young, Ero-Tolliver, et al. (2017) examined the relationship between science dispositions of African American high school girls and their participation in advanced science courses. The data collected were taken from a longitudinal study between 2009

and 2012. Surveys were administered to students, teachers, parents, and administrators each year to understand how science dispositions affected enrollment. Science identity, science interest, and self-efficacy were found to be strong indicators of enrollment in high school advanced science courses. The dispositions of African American girls were used to predict STEM participation not only in education, but also in future careers (Young, Ero-Tolliver, et al., 2017).

A study was conducted by Archer-Banks and Behar-Horenstein (2012) to investigate the experiences of high achieving African American girls in high school. The sample consisted of eight African American girls that participated in honors programs including Advanced Placement courses, international baccalaureate , and the magnet program. The major themes that surfaced from conducting the research included school policies and practices, caring adults, and self-identity and academic engagement. Students reported the varied treatment of students in regular educational classes versus students in honors programs. Information was disseminated to honors students to prepare honors students for college more frequently and these students received a higher quality of instruction. The students also felt unfairly targeted for dress code infractions and disciplinary referrals at higher rates than Caucasian and Asian girls. Secondly, some teachers provided a positive and nurturing learning environment for students from diverse cultural and socioeconomic backgrounds while other teachers did very little to promote critical thinking skills and high scholastic achievement. Teachers looked down on students considered to be “loud” and disrespectful. All of the students felt that family support was important in helping students become successful. Finally, the participants were self-motivated and confident in their own abilities to be successful. All of the girls

desired to improve their quality of life both socially and economically through excelling in school (Archer-Banks & Behar-Horenstein, 2012).

Underrepresented groups of students were interested in science in middle and high school, but lost interest before finishing college. As a result, college professors teaching in a STEM field were encouraged to use inclusive teaching practices (Aragón et al., 2017). For example, The Lang Science Program at the American Museum of Natural History created an opportunity for students in Grade 6 through Grade 12 to participate in a long-term out of school science program to increase interest in science. The primary focus of the study was to investigate the impact of the Lang Science Program on influencing minority girls to major in STEM fields of study. A focus group was used to collect qualitative data, and information collected was analyzed and organized into themes. The majority of focus group participants expressed a feeling of solitude, competition, remote learning environments, and distant relationships with college professors (Adams et al., 2014). Concept Analysis Chart 5 (See Figure 6) was used to describe experiences of high school African American girls in STEM related courses.

Topic: Experiences of African American Girls in STEM

Study	Purpose	Participants	Design/ Analysis	Outcomes
Archer, Dewitt, and Osborne (2015)	To explore why African American students do not think that science is for them.	10 African/ Caribbean students and their parents	Quantitative: Online Survey Qualitative: Longitudinal interview data	Science is perceived to be only for clever students and African Americans are discouraged from participating.
Archer-Banks & Behar-	To investigate the experiences	eight African American high	Qualitative methods:	The major themes include:

Horenstein (2012)	of high achieving African American girls in high school	school girls	Semi-structured individual interviews, focus group interviews, journaling, and field notes.	1) inconsistent school policies and practices 2) caring adults 3) positive self-identity 4) academic engagement
Miller (2018)	To argue tracking limits educational equity.	N/A	Literature Review	Tracking limits advanced academic opportunities.
Young, Ero-Tolliver, Young, & Ford (2017)	Investigate the relationship between science dispositions and advanced science courses.	1,810 African American girls participating in the High School Longitudinal Study	Quantitative: online surveys	Science identity correlate with AP and IB sciences. Science interest and self-efficacy are positive indicators for participation in advanced science courses.

Figure 6: Concept Analysis Chart 5

### Theoretical Frameworks

Critical Race Theory and Black Feminist Thought were used to provide the theoretical foundation for the current study. Both theories were useful in framing the experiences of African American girls and women (Alexander & Hermann, 2016; Charleston, George, et al., 2014; Delgado & Stefancic, 2012; Ricks, 2014). Additionally, the intersectionality of both Critical Race Theory and Black Feminist Thought were explored to show historical marginalization of African American women based on both race and gender (Charleston, Adserias, et al., 2014).

The Brazilian educator Paulo Freire, one of the forefathers of critical theories, was well known for his contributions to the development of the critical educational theories in an effort to invoke social justice (Gottesman, 2010; Lac, 2017). Freire believed that education was the key to social change and therefore called for pedagogy to empower the oppressed and transform the educational system (Beckett, 2013; Gottesman, 2010). According to Friere (1970), “pedagogy of the oppressed cannot be developed or practiced by the oppressor. It would be a contradiction in terms if the oppressors not only defended but actually implemented a liberating education” (p. 8).

Friere used the term banking education to describe traditional methods of education in which students depended on teachers to provide knowledge while students passively learn. On the other hand, liberatory education described education in which both teachers and students were responsible for teaching and learning (Beckett, 2013; Freire, 1970; Smith-Maddox & Solorzano, 2002). Critics of Freirean pedagogy note the universalism of Paulo’s ideas, which failed to analyze gender (Beckett, 2013) and race (Lac, 2017). Therefore, some scholars recommended the Critical Race Theory as a means to explore social justice in education (Lac, 2017).

### Critical Race Theory

The Critical Race Theory was a qualitative approach to research that varied from other critical theories because recognized race as a social construct that threatened education in America (Collins, 2018; Smith-Maddox & Solórzano, 2002). Critical Race Theorists critically analyzed the distribution of power within social systems to get to the root of injustice and discrimination. Understanding the causes of inequality led to a greater understanding of social justice (Johnson & Parry, 2015).

Critical Race Theory was explained by Solórzano and Yosso (2002) as the following:

We define critical race methodology as a theoretically grounded research approach that seeks to accomplish the following: (a) center race and racism in all aspects of the research process; (b) challenge traditional research paradigms, texts, and theories that have been used to explain Students of Color's experiences; (c) provide a liberatory or transformative response to oppression and subordination (racism, genderism, classism); (d) focus on Students of Color's racialized, gendered, and classed experiences; and (e) apply an interdisciplinary knowledge base, drawing from ethnic studies, women's studies, sociology, history, humanities, and law to develop an enhanced understanding of Students of Color's experiences in higher education. (p. 24)

Critical race theorists held specific beliefs or tenets that guided the Critical Race Theory perspective. Racism was a normal experience of people of color in the United States. Racism was deeply rooted in U.S. culture. Racism was difficult to address due to objective perceptions of equality for all people. This ideology only served to address overt racism and not overt racism towards people of color. Race was a social construct created by people, and, therefore, Critical Race Theory advocates were instrumental in eradicating all forms of oppression including racism (Alexander & Hermann, 2016; Delgado & Stefancic, 2012). Critical Race theorists embraced the evolution of races and denied the idea of monolithic races (Delgado & Stefancic, 2012). Finally, Critical Race Theory challenged the normalization of both conscious and unconscious racism by Caucasian people and the minority groups affected by racism. According to Rector-

Aranda (2016), the educational system had the ability to challenge social injustices or perpetuate the stereotypes. All races had rich cultures, histories, values, but Western European core principles were typically embraced while other cultures were diminished.

The Critical Race Theory movement was encompassed by activists and scholars who studied the relationship between race, racism, and power. Similar to civil rights, Critical Race Theory involved economics, history, conditions, whole group and self-regard, feelings, and the unconscious. The movement began in the 1970s, a result of the stagnant state of the civil rights movement heavily emphasized a decade earlier. The three people that were instrumental in starting the movement included Derrick Bell, Alan Freeman, and Richard Delgado. Derrick Bell, a law professor at New York University, was the intellectual father of the Critical Race Theory movement and continued to be active through writing articles, books, and delivering speeches. The first Critical Race Theory conference was held in Madison, Wisconsin, in 1989. He documented how the Supreme Court legitimized racism in decisions, such as *Brown versus the Board of Education* (Delgado & Stefancic, 2012).

#### Black Feminist Thought

Feminists were aware of the social injustices that girls face in a patriarchal society and fought for equal rights for all. Feminist literature recognized the interconnections between race, gender, nationality, sexuality and socioeconomic status (Johnson & Parry, 2015). Mary Wollstonecraft, the first Western feminist theorist, expressed her ideas in her treatise titled *A Vindication of the Rights of Woman with Strictures on Political and Moral Subjects* (Parpart et al., 2000). Wollstonecraft (1792) criticized the civil and



political oppression of girls and stressed the importance of educating girls to think outside of cultural norms that society placed on them.

U.S. women were historically marginalized based on race and gender. The feminist movement of the 1960s largely focused on the rights of Caucasian girls to be educated equally and work outside of the home. On the other hand, African American girls were already working outside of the home so the needs of African American women were slightly different. Some concerns of African American girls included working conditions, welfare, and physical/sexual safety (Love, 2016). Therefore, a theoretical framework was needed to deal with specific ideologies of African American women (Ricks, 2014).

The current study used Black Feminist Thought as a theoretical framework, which was a type of feminism focused on the multiple identities (i.e., race, class, and gender) of African American girls (Love, 2016). Black Feminist Thought is based on the unique experiences of African American women and their marginalization based on race and gender (Charleston, George, et al., 2014). Maria W. Stewart was the first African American woman to speak out publicly on political issues in the 1830s, and was a pioneer in what would later be known as Black feminism. Stewart encouraged African American women to reject negative socially constructed stereotypes and form a positive self-identity (Collins, 2000). In 1990, Hill Collins published *Black Feminist Thought*, which validated Black Feminist epistemology (Collins, 2000; Ricks, 2014). Other significant Black feminist scholars included Hooks, Lorde, and Walker, but very few scholars have continued the work of these women (Ricks, 2014).

## Summary

Historically, African American girls and women were academically challenged because opportunities for educational participation have not always been available. African American students were not exposed to advanced science courses, which prevented students from participating in STEM fields. Furthermore, African American girls overwhelmingly reported a feeling of hostility and invisibility in science.

With the growing necessity to fill STEM related jobs, all students were encouraged to work in STEM related fields; however, African American girls need to be provided with both opportunity and academic prep to work in STEM fields. While extensive research was conducted in reference to the inequity of girls in science, the literature focused mainly on middle class Caucasian girls. Similarly, African American boys were the subjects of most studies concerning the education of African Americans. Race and gender were generally researched separately and very little research documented equity issues for African American girls. The available research disregarded the intersectionality of race and gender on the participation of African American girls in STEM fields. Critical Race Theory and Black Feminist Thought were used as theoretical frameworks in the study to help explain the unique experiences of African American girls in science education.

## CHAPTER III

### METHODOLOGY

#### Introduction

STEM occupations fueled the U.S. economy and the need for highly skilled workers in the field grew exponentially. Therefore, a strong foundation in STEM education became vital in preparing students to fill the increasing number of STEM careers in the 21st century (Alexander & Hermann, 2016; Stipanovic & Woo, 2017; Vilorio, 2014). African American girls had the potential to occupy STEM related jobs of the future (Young, Feille, et al., 2017). However, there was a great disparity in race and gender in reference to the participation in STEM education and careers, and African American women remained underrepresented (Alexander & Hermann, 2016; Archer et al., 2015; Young, Feille, et al., 2017). Ricks (2014) suggested bringing attention to educational inequalities so that African American girls are not overlooked and left behind. Science was an important foundational skill for STEM careers (Archer et al., 2015; Young, Feille, et al., 2017) and therefore has been chosen as the area of focus for the current study.

A study conducted by Young, Feille, et al. (2017) found that although the majority of elementary African American girls had a positive science disposition, most were not engaged enough in science content to successfully learn and do science. Although African American students liked science, African American students were less likely to envision being a scientist (Archer et al., 2015). A strong self-identity in science encouraged African American girls to deal with difficult situations and persist in science

education (Young, Feille, et al., 2017). This finding was significant because according to Young, Ero-Tolliver, et al. (2017), science dispositions of high school African American girls predicted participation in rigorous science courses. Finally, the underrepresentation of African American women in high school and college science courses directly affected the number of African American women working in STEM related fields (Alexander & Hermann, 2016; Archer et al., 2015; Young, Feille, et al., 2017).

The problem being investigated was the underrepresentation of African American girls in advanced science courses, which served as a prerequisite into STEM related degree programs and STEM careers (Archer et al., 2015; Pinder & Blackwell, 2013; Young, Feille, et al., 2017).

A descriptive qualitative study was conducted to explore the perceptions that high school teachers had of African American girl students that participated in advanced science courses. Research questions were designed to describe teacher perceptions regarding the participation and outcomes of African American girls in advanced high school advanced science courses. The critical issues identified in the literature review included historical discrimination in education based on race and gender, the lack of participation of African American girls in STEM education and careers, an examination of the access of African American girls to an advanced science education, and a social justice perspective to culturally responsive science teaching to African American girls.

#### Research Questions

The following questions were used to guide the current study:

1. What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?

2. Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

### Research Design

The three types of research designs were qualitative, quantitative, and mixed methods. Quantitative research involved testing objective theories by comparing variables and statistically analyzing data. Qualitative research explored how people perceive a certain problem. Mixed method research combined both quantitative and qualitative practices (Creswell, 2007, 2014). However, neither quantitative nor mixed method approaches to research were appropriate for the current study. A qualitative approach to research was used to explore teacher perceptions of the participation and outcomes of African American girls in advanced science courses. Qualitative research operated in a variety of disciplines and had a complex history that meant different things in different time periods. Therefore, a single definition needed to acknowledge the complexity of qualitative research (Denzin & Lincoln, 2005). According to Denzin and Lincoln (2005),

Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative

researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (p.3)

There were many methods of classifying qualitative approaches to research (Creswell, 2007). For example, Miles and Huberman (1994) categorized qualitative research as either interpretivism, social anthropology, or collaborative social research. Denzin and Lincoln (2005) described the approaches to research as performance, critical, and public ethnography, interpretive practices, case studies, grounded theory, life history, narrative authority, participatory action research, and clinical. Furthermore, Creswell (2007) described five qualitative approaches to research including ethnography, narrative, phenomenology, grounded theory, and case study. However, none of these research designs were appropriate for this particular study. Ethnography research focused on the shared culture of a group. Narrative research described a method or phenomenon concentrated on stories told by people. Although a narrative study focused on one person, a phenomenology research study focused on the lived experiences of a group of people. The intent of grounded theory research was to discover a new theory. Finally, a case study involved studying an issue using more than one case in a system with defined boundaries (Creswell, 2007).

Descriptive research of a central phenomenon was employed in the absence of a specific theory in a qualitative study (Creswell, 2008). The lack of theory allowed for flexibility when designing an appropriate theoretical framework to conduct the study (Kim, Sefcik, & Bradway, 2017). A descriptive study was a systematic way to describe something, such as a phenomenon or a characteristic (Dulock, 1993; Kim et al., 2017). Furthermore, a descriptive study described a person or group of people (Dulock, 1993). A

descriptive approach to research examined situations in a natural setting to make sense of the situation (Creswell, 2007; Kim et al., 2017; Williams, 2011). Due to the lack of manipulation, there was no independent variable (Dulock, 1993). Descriptive researchers either identified characteristics of a phenomenon or determined the relationship between different phenomena (Dulock, 1993; Williams, 2011). Good descriptive studies provided data, which were used to build hypotheses for future studies (Dulock, 1993). Qualitative descriptive research was analyzed using content analysis or thematic analysis, and findings were reported using detailed descriptive summaries. Furthermore, there was limited existing literature discussing qualitative description as a research method (Kim et al., 2017).

### Population

The population studied were all high school teachers that taught advanced science courses in a school district in the state of Georgia in the United States. Advanced science courses were defined as courses that contained advanced science information and was not required by the general population of high school students for graduation. In the district under study, teachers of advanced science courses, which included chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, and any other science deemed appropriate by the principal participated in the study. Advanced science teachers were used to collect information pertaining specifically to African American girls. African American girl students were not selected to participate in the current study because high school students were under the age of 18 and unable to consent to participate without parent or guardian consent.

## Participants

According to Dulock (1993), participants were selected for a descriptive study based on their possession of characteristics relevant to the study. Therefore, high school advanced science teachers with at least two years of experience teaching African American girls in advanced science courses were selected to participate in a semi-structured survey. For the purpose of this study, teachers of advanced science courses including chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, honors human anatomy, and any other science deemed appropriate by the principal were used as participants. The participants were selected from one school district in the state of Georgia. Permission to involve teachers in the study was gained from the superintendent and high school principals prior to contacting teachers. Eligible participants were identified by principals agreeing to participate at each school.

## Sample

According to Kim et al. (2017), qualitative descriptive research commonly utilized purposeful sampling. Purposeful sampling was commonly used in qualitative research studies to select information-rich cases related to a known phenomenon. Criterion sampling was the most commonly used form of purposeful sampling and required participants in a qualitative study to meet specific criteria to participate (Palinkas et al., 2015; Patton, 2002). Therefore, criterion sampling was used to identify participants in the study. Participants in the study met the following criteria: Teachers participating in the study had at least two years of experience teaching high school advanced science



courses to African American girls. Principals identified 16 potential participants to participate in the study.

Miles and Huberman (1994) suggested having between eight and 14 fourteen participants when using a semi-structured interview to collect qualitative data. Contrarily, “There are no rules for sample size in qualitative inquiry” (Patton, 2002, p. 244). Sample size depended on the goal of the researcher. A smaller sample size provided a more in-depth and information rich account of participant experiences when compared to larger sample sizes (Patton, 2002). Typically, the sample size in qualitative studies were not typically predetermined. Participants were interviewed until data saturation was reached (Sargeant, 2012). In the current study, the researcher selected between 8 to 14 participants out of an available population of 16 advanced science teachers to provide rich insight into teacher perceptions of African American girls participating in advanced science courses. Although a sample size was preselected, the researcher was mindful of the need to reach data saturation, which meant that no new themes emerged.

#### Instrumentation

The instrument used in the current study to collect data was a face-to face, semi-structured interview. Interviewing was commonly used as a qualitative method for collecting data (Creswell, 2007; Patton, 2002). The purpose of qualitative interviewing was to understand perspectives of other people. Therefore, qualitative researchers assumed that stories told by other people were important and capable of being clearly described (Patton, 2002).

Face-to-face individual interviews were conducted in the current study. The structure of interviews ranged from either unstructured, structured, or semi-structured

(Jamshed, 2014). Semi-structured interviews were used in the current study because semi-structured interviews were a means of conducting in-depth interviews with predetermined questions allowing for rich data to be collected in reference to the research questions. Semi-structured interviews were conducted once with each participant for a duration of 30 minutes to an hour (Jamshed, 2014).

Qualitative researchers usually did not rely on previously created instruments (Creswell, 2007). The researcher created a semi-structured interview protocol to guide the interview process. There was no need to obtain permission from another author. The questions asked during the interview allowed the researcher to collect information concerning advanced science teacher perceptions of the participation and outcomes of African American girls enrolled in advanced science courses. Finally, the qualitative researcher was an important instrument in collecting data and determined the quality of the information collected (Creswell, 2007; Patton, 2002).

### Validation

#### Trustworthiness

Validity and reliability were not addressed in the same manner in a qualitative study as in a quantitative study (Creswell, 2014; Shenton, 2004). According to Creswell (2014), the researcher articulated the process of ensuring the integrity of the data collected, which was referred to as qualitative validity. On the other hand, reliability referred to the consistency of research approaches. Therefore, trustworthiness was demonstrated through credibility, transferability, dependability, and confirmability (Shenton, 2004). The researcher took several steps to validate the data collection and analysis processes.

**Credibility.** Credibility in a qualitative study referred to efforts made by the researcher to ensure that the study is designed to measure what was intended to be measured (Shenton, 2004). To accomplish credibility, the researcher used participant/member checking, a strategy used to check the accuracy of participant statements (Creswell, 2014; Denzin & Lincoln, 2005; Maxwell, 2009; Shenton, 2004). The researcher also provided rich, thick descriptions to report the data. Detailed descriptions made the data appear realistic, which added credibility to the research (Creswell, 2014; Shenton, 2004).

**Transferability.** Transferability referred to the ability to apply the research approach in a different setting or generalize the study (Miles & Huberman, 1994; Shenton, 2004). Transferability was achieved by disclosing important factors related to the study. As a result, the researcher communicated the number of participants, criteria of participants, the instrumentation used, thorough methods for collecting data, and the data analysis process (Shenton, 2004).

**Dependability.** Dependability referred to the reliability or consistency of the research approaches. However, researchers had more difficulty predicting outcomes of research in a natural setting. A detailed report of processes and procedures were given so that the study could be repeated although the results may vary (Shenton, 2004). Flick (2009) rejected the idea of establishing reliability of data and procedures to ensure the same outcomes. To address dependability, the researcher clearly articulated the research design, thoroughly explained the data collection processes, checked transcripts for accuracy, used member checking, and ensured consistent coding (Creswell, 2014; Flick, 2009; Miles & Huberman, 1994; Shenton, 2004).

Confirmability. Confirmability referred to objectivity and reflection of research bias in the study (Miles & Huberman, 1994; Shenton, 2004). The researcher took steps to reduce researcher's bias while using the instrument so that the results would truly reflect the perceptions of the participants rather than the will of the researcher (Shenton, 2004). Therefore, the researcher explained the selection of the research design, instrumentation, and data collection process. Furthermore, the researcher maintained a reflexive journal throughout the research process to establish transparency and reduce researcher bias.

#### Validity Threat

Validity threats were acknowledged in qualitative studies. Two general threats to validity in qualitative research included researcher bias and reactivity. Researcher bias explained how data could be misconstrued due to preconceptions and values of the researcher (Maxwell, 2009). Clarifying researcher bias through reflectivity created trustworthiness (Creswell, 2014; Shenton, 2004). Reactivity referred to the personal effect the researcher had on the participants or the setting of the study. Rather than eliminating researcher bias, the researcher understood how to ethically use his/her influence in a productive manner to get the research questions answered (Maxwell, 2009).

#### Data Collection

A semi-structured interview protocol was designed to help the researcher collect information related the research question: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? In addition, race information was collected from each participant to determine if there is a relationship between the race of teachers and teacher

perceptions regarding the participation and outcomes of African American girls in advanced science courses. The interview protocol included 12 questions and was three pages in length.

The researcher emailed a letter to the superintendent requesting permission to conduct the study in the designated school district. Next, the researcher emailed a letter to high school principals to obtain permission to include teachers from the various high schools in the study and to identify eligible teachers. Teachers eligible to participate met the following criteria: Teachers had at least two years of experience teaching high school advanced science courses to African American girls. Advanced science classes included chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, and honors human anatomy. After the principals identified the eligible teachers, the researcher reached out to candidates through email to solicit participation from the identified group of science teachers. The researcher submitted an Institutional Review Board (IRB) application and addendum documents and waited for approval prior to conducting the study.

Ten high school science teachers from a school district in Georgia with at least two years of experience teaching advanced science courses to African American girls volunteered as participants in the study. An interview protocol (Appendix A) and informed consent form (Appendix B) was sent to teachers via email prior to the interview to familiarize the participants with the study. An appointment time and location were arranged and documented for each participant. The interviews took place over a 2-week period between October 25, 2018 and November 7, 2018, and the duration of each interview was approximately 35 minutes.

Prior to each semi-structured interview, informed consent forms were signed in person by participants. The researcher began the interview process by explaining the purpose of the study and how the information collected would be used. Next, participants were invited to express questions or concerns. Then, the researcher conducted face-to-face, semi-structured interviews with participants using the predesigned interview protocol (Appendix A). At the end of the interview, participants were invited once again to express any questions of concerns. The conversations were audiotaped to assure quality data collection. The recorded conversations were then transcribed using Temi, a speech to text transcription service. Transcribed interviews were emailed to participants for approval to ensure participants were satisfied with the responses before data analysis took place.

### Response Rate

Response rate was defined as the total number of people that participated in the interview divided by the total number that were eligible to participate in the interview. An acceptable response rate was difficult to determine and did not provide a good measure of validity when used alone (Morton, Bandara, Robinson, & Atatoa Carr, 2012). However, the researcher aimed to get a response rate that was equivalent to 8 to 14 teachers out of a population of 16 advanced science teachers as recommended by Miles and Huberman (1994).

Table 2

#### *Expected Interview Response Rate*

Age Group	Expected Interview Response Rate
18-64	50%-88%

## Data Analysis

The process of analyzing data in qualitative research involved the preparation and organization of data, the use of coding to create themes, and display of the data graphically and/or in text format (Creswell, 2007). The challenge of qualitative data analysis was making sense of a large amount of information (Patton, 2002). The use of computer programs improved data analysis by speeding up the process and assisting in the manipulation of data (Adams, 2012). Therefore, NVIVO 12 Pro, a data management software program, designed to store, manage, and analyze information was used in the current study. The interview transcripts were imported into NVIVO 12 Pro and coded.

Coding was a strategy used to categorize pieces of information during data analysis (Adams, 2012; Flick, 2009; Maxwell, 2009). Coding began by opening each interview file in NVIVO 12 Pro and turning on the coding stripes. Next, nodes were created to represent themes found in the transcripts. Then information from the transcripts was dragged and dropped into the appropriate node (i.e., theme). After the interview responses were coded, common themes were identified, interpreted, and reported as findings in the form of summary tables. Thematic analysis was a method of systematically determining the meaning of the data collected by organizing information and describing common patterns (Braun & Clarke, 2012). Finally, the themes and subthemes were interpreted, and big ideas were identified. The data collection and analysis processes provided insight into the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses.

## Reporting the Data

The common themes that were generated as a result of analyzing all of the responses to items on the interview protocol (Appendix A) were reported as findings and finally organized into big ideas to answer the research question: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? Race data collected from each participant were used to answer the second research question: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? Qualitative data analysis included the representation and interpretation of information collected in the form of graphs, tables, and figures (Creswell, 2014). Therefore, the analyzed data were presented in Chapter IV in the form of summary tables to explain the data. In addition to graphic representations of the data, the data were explained in a text format. The recorded interviews were transcribed in a text format and interpreted by the researcher. According to Creswell (2014), the general idea of analyzing data is to make sense of text and image data. A qualitative item analysis of the interview protocol was presented in Table 3, and a research confirmation table was presented in Table 4.



Table 3

*Qualitative Item Analysis*

<b>Item</b>	<b>Research</b>	<b>Interview Questions</b>	<b>Research Question</b>
1. Course Description	Archer, Dewitt, Osborne, 2014; O'Brien, Blodorn, Adams, Garcia, & Hammer, 2015;	1	1
1. Demographics	Archer, Dewitt, Osborne, 2014; O'Brien, Blodorn, Adams, Garcia, & Hammer, 2015;	2	1
2. Reason for enrollment	Stipanovic & Woo, 2016;	3	1
3. Performance	Baker, 2013; Young, Feille, & Young, 2017	4	1
4. Preparation	Young, Feille, & Young, 2017	5	1
5. Curriculum and pedagogy	Baker 2013; Codrington, 2014; Pinder & Blackwell, 2014	6	
6. Enrollment patterns	Archer, Dewitt, Osborne, 2014; Young, Ero-Tolliver, Young, & Ford, 2017	7	1
7. Support	Ricks, 2014; Stipanovic & Woo, 2016;	8	1
8. Recruitment	Young, Ero-Tolliver, Young, & Ford 2017	9	1
9. Encouragement	Ricks, 2014; Charleston, Adserias, Lang, & Jackson, 2014	10	1
10. Future Direction	Alexander & Hermann, 2015;	11	1
11. Outcome data	Charleston, George, Jackson, Berhanu, & Amechi, 2014; National Science Foundation, National Center for Science and Engineering Statistics, 2015	12	1

Table 4

*Research Confirmation Table*

Research Question	Instrumentation/Analysis	How will strategy answer research question?
What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?	Semi-Structured Interviews	The semi-structured interview will provide insight into the perceived views that teachers have of African American girls participating in advanced science courses.
Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?	Semi-Structured Interviews	Race data collected from each participant during the semi-structured interview will be used to determine if there is a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

## Summary

African American women represented a unique group of people that were capable of flourishing in STEM careers and education, yet African American women remained underrepresented in the field. A strong foundation in science was imperative to future success in STEM fields. Therefore, the current study was centered on the participation,

performance, and motivations of African American girls participating in high school advanced science courses. The research question focused on the perceptions of high school science teachers regarding the participation and outcomes of African American girls in advanced science courses.

The researcher conducted a qualitative descriptive study because that research method and design was best suited to explore a phenomenon through the perceptions of participants. The study took place in a school district in Georgia and involved high school science teachers. Permission was granted from the district superintendent, high school principals, and IRB prior to contacting teachers to participate. Purposeful criterion sampling was used to select eligible participants. The researcher selected high school advanced science teachers who had at least two years of experience teaching African American girls to provide insight into the subject matter. Face-to-face semi-structured interviews were conducted for 30 minutes to an hour using an interview protocol designed by the researcher. To validate the data collection and analysis processes, the researcher took several steps to ensure trustworthiness. The interviews continued until 8 to 14 participant responses were recorded and data saturation was reached. The data were analyzed electronically using NVIVO 12 Pro. Thematic analysis was used to present the findings, which were organized graphically and in text format. Themes were interpreted and organized into big ideas including curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

## CHAPTER IV

### RESULTS

#### Introduction

STEM was one of the fastest growing careers, but there were not enough highly qualified applicants to fill the positions (Alexander & Hermann, 2016; Stipanovic & Woo, 2017). A strong science disposition and skills served as important prerequisites to success in STEM careers (Archer et al., 2015; Young, Feille, et al., 2017). Therefore, K-12 student engagement in science was necessary to prepare students for future STEM careers (Stipanovic & Woo, 2017; Young, Feille, et al., 2017). African American women have historically been double marginalized in education and constituted a very small percentage of people participating in STEM education and careers (Alexander & Hermann, 2016; Archer et al., 2015; Charleston, Adserias, et al., 2014; O'Brien et al., 2015, Young, Feille, et al., 2017). Furthermore, African American girls were disproportionately underrepresented in advanced science courses and enrichment programs (Adams et al., 2014; Archer et al., 2015; Young, Feille, et al., 2017).

The problem under study was the underrepresentation of African American girls in advanced science courses. High school advanced science teachers were used as participants in the study to explore teacher perceptions of the participation and outcomes of African American girls participating in advanced science courses. The researcher chose to conduct a qualitative descriptive study and used semi-structured interviews as an instrument to collect data. Black Feminist Thought and Critical Race Theory theoretical frameworks were used in an integrated approach to address the unique characteristics and

qualities of African American girls.

### Research Questions

A qualitative descriptive study was conducted to answer the following research questions:

1. What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?
2. Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

### Research Design

A qualitative descriptive study was conducted in the state of Georgia in the United States to gain insight into the perceptions of advanced science teachers on the participation and outcomes of African American girls participating in advanced science courses. The researcher obtained permission from the superintendent to conduct the research study in the designated school district. Next, the researcher submitted an IRB application and addendums to the IRB at Columbus State University to approve the research study prior beginning the study (Appendix G). After the IRB granted permission to proceed, the researcher contacted high school principals to gain permission to contact science teachers who met the criteria to participate in the approved district. The researcher used information provided by consenting principal and the district listserv to identify the names and emails of high school advanced science teachers from approved schools in the school district. Advanced science teachers were contacted through email and solicited to participate in face-to-face interviews. The email included an informed

consent form (Appendix B) as well as the interview protocol (Appendix A), which was used to guide the interview process. Participants signed the informed consent in person prior to beginning the interviews.

Face-to-face interviews were conducted using a 12 question semi-structured interview protocol (Appendix A) aligned to the research question: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? In addition, race data were collected on each participant to determine the answer to the second research question: (2) Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? The interviews were conducted at a time and location convenient for teacher participants after school hours. Interviews lasted 30 minutes to an hour and were recorded using an electronic device and stored on a password protected device. Audiotapes of interviews were transcribed using Temi, a speech to text transcription third party service. The researcher checked transcripts for accuracy and then conducted member/participant checks to ensure the participant interviews represented the interview accurately. The transcribed interviews were uploaded into NVIVO 12 Pro, a data management software program for data analysis. The responses were coded and categorized as one of the following themes: reasons for participation, factors impacting participation, factors impacting readiness, curriculum design, pedagogical approaches, and student outcomes. The themes and sub-themes were further analyzed and organized into four big ideas, which included: curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for

African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

#### Demonstration of Trustworthiness

The following steps were taken to demonstrate the trustworthiness of the study: The researcher disclosed the processes used to conduct the study to the superintendent, principals, and teachers, which included the number of participants, criteria of participants, the instrumentation used, and the method for collecting data to promote transferability. The researcher collected thick, rich descriptions during interviews and conducted participant/member checks to ensure credibility. The researcher checked the accuracy of transcripts to address dependability. Finally, the researcher maintained a reflexive journal throughout the research process to establish transparency, reduce researcher bias, and promote confirmability.

#### Respondents

The study was conducted in the state of Georgia in the United States in a school district with three high schools. A total of 16 advanced science teachers in the approved school district met the criteria to participate in the study. Out of the 16 perspective participants, 10 advanced science teachers agreed to participate in the study. The demographic data collected during each interview were reported in Table 5.

Table 5

#### *Demographic Profile*

Category	Participant Responses	Percent
Race	African American ( $n=7$ )	70%
	Caucasian ( $n=3$ )	30%

Years of Experience Teaching	2-5 Years ( $n=5$ )	50%
High School Advanced Science Courses	6-10 Years ( $n=1$ )	10%
	11-15 Years ( $n=1$ )	10%
	16-20 Years ( $n=3$ )	30%

As described above in Table 5, 10 advanced science teachers participated in the study. Due to the small population size, the researcher elected to not report the years of experience and race of participants individually to protect the privacy of participants.

Demographic data collected on each participant included race and years of experience teaching high school advanced science courses. Years of experience was collected to determine if the participant met the criteria of having at least two years of experience teaching high school advanced science courses. According to the information collected, 50% of participants had 2 to 5 years of experience, 10% of participants had 6 to 10 years of experience, 10% of participants had 11 to 15 years of experience, and 30% of participants had 16 to 20 years of experience.

Race data were collected to answer the following research question: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? The majority of the participants identified as African American (70%) while Caucasian teachers made up 30% of participants.

### Findings

The following research questions were developed to explore teacher perceptions of African American girls that have participated in advanced science courses: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? Is there a relationship



between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

The researcher created a semi-structured interview protocol to guide the interview process. The 12 questions presented on the interview protocol were designed by the researcher to answer the research question 1. Interview questions were grouped into big ideas related to research question 1. Interview questions 1 and 2 identified and described the advanced science courses taught by teachers and the demographic data of the students enrolled in advanced science courses. Interview questions 3, 7, and 8 concerned the enrollment of African American girls in advanced science courses. Interview questions 4, 5, and 6 addressed the performance, preparation, readiness, and the effectiveness of curriculum and pedagogy. Interview questions 9 and 10 addressed recruitment of African American girls to participate in advanced science courses. Finally, interview questions 11 and 12 addressed student outcomes as outlined in research question 1.

Race data collected from each participant were used to provide insight into research question 2. Participant responses to each question were analyzed using the data management software NVIVO 12 Pro, which was used to code responses and organize information into themes.

#### Organization of Findings

Participant responses provided the foundation for interpreting the raw data and helped the researcher understand teacher perceptions of African American girls participating in advanced science courses. Thematic analysis was used to organize the data and create meaning for the information collected. Upon the completion of coding, the following themes emerged: reasons for participation, factors impacting participation,

factors impacting readiness, curriculum design, pedagogical approaches, and student outcomes.

Themes were organized under each research question. Summary tables, which included descriptions from each participant, were used to organize findings. Descriptions were used as the primary source of data because the research method was qualitative descriptive. The explanations provided in each table served to answer the research questions.

#### Research Question 1

What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?

Course and demographic descriptions. Interview question 1 and 2 served to provide information about the advanced science courses each participant taught and the demographics of the students participating in those courses. This information affirmed that participants had experience teaching high school advanced science courses to African American girls. Therefore, the participants were able to provide information regarding participation and outcomes of African American girls in advanced science courses

Interview question 1 asked participants to describe advanced science course(s). Participants identified and described the advanced high school science courses taught in the approved school district in Table 6.

Table 6

*Description of Advanced Science Course(s)*

Participant	Advanced Science Course(s) Taught	Description
1	Honors Physical Science	Involves a level of physics and chemistry.
2	Chemistry	A specific study of the composition of elements, the reactions, the equilibrium of reactions.
3	Honors Physical Science	Physical science is a foundational course extended from middle school.
4	Honors Biology	Primarily focused on science as it relates to life science.
5	Physics	The course allows them to further investigate, more of physical science
6	AP Environmental Science	A conglomeration of all the sciences in the relative impact on the environment of humans.
7	Chemistry and Physics	Chemistry is the study of matter where they start integrating mathematics in with science. Physics in Algebra based and focuses on energy and motion.
8	Chemistry and AP Biology	AP biology is aligned with the College Board of education and relates to ecology, cells, human anatomy, physiology, as well as biochemistry. Chemistry is related to everything that it is chemical bonding, atomic modern theory, stoichiometry. Requires the use of math to convert molarity as well as heat kinetics.
9	Honors/ Gifted Human Anatomy	Students learn all about systems of the body through hands on activities, which prepares students for medical field courses.
10	AP Biology	AP Biology is a College Board course comparable to a college biology course in which high school students can receive college credit.

Out of the 10 participants in the study, 20% of the participants reported having experience teaching honors physical science. Thirty percent of the participants reported having experience teaching chemistry. Twenty percent reported having experience teaching physics. Ten percent of the participants reported having experience teaching honors/gifted human anatomy. Ten percent of the participants reported having experience teaching honors biology. Ten percent of the participants reported having experience teaching AP environmental science. Finally, 20% of the participants reported having experience teaching AP biology.

Interview question 2 asked participants to describe the demographic data of the students participating in advanced science courses as shown in Table 7. The majority of the participants reported teaching mostly African American students and gender demographics varied for each teacher.

Table 7

*Student Demographic Information*

Participant	Description
1	The demographics were 80 to 90% African American, but keep in mind our school system is 80 to 90% African American. It was probably about even as far as the boys and girls were concerned.
2	Most of my students are African American and the ratio for most classes. Probably, I can't give a specific, but all of my classes are majority girls.
3	The majority of the students were black, African American. Majority of the classes had more females than males. The ratio will probably be 70 to 30 ratio for females to males. Um, a lot of them came from poverty stricken homes, low income families.
4	African American students were predominantly female with maybe one percent other, other being, either Hispanic and/or Caucasian.
5	All of my kids in physics are African American. I would say out of 12 students, I have about two or three males. So, the majority of the students that I teach are female.

- 6 I only have 14 students in that class, so there are about seven girls and about seven boys and all of the girls are African American. I would say they're all middle class just referenced to the girls. In reference to the girls, I would say they're all middle, lower, middle to middle, middle class. The boys in the class, most of them are Caucasian Americans. They range. They're, they're probably more up or middle, middle to upper middle class. I have some doctors, children in that class.
- 7 Primarily African American. There's maybe a handful of Caucasian students and less other students. I'm in my physics and chemistry classes, the ratio of males to females is exactly half and half. I have noticed compared to my other physical science class, it seems like the kids who were in the chemistry and the physics classes are kind of better off financially at home, it seems like that, but I could be wrong.
- 8 The students participating in advanced science courses are students that are mostly first generation college goers. They are coming from homes of lower social economic status. They, a majority minority, African American are also students that may possibly lack full exposure to science and I would say have intermediate Lexile scores.
- 9 Eighty percent of the students are African American. Forty percent are African American girls and 10% White and 10% other. Fifty percent boys and fifty percent girls.
- 10 Right now, the girls are actually underrepresented. I only have two girls and three guys, there's only five kids taking it. In the past girls and guys have been kind of the equal. The race this year is all African American. In previous years, it was a mixture, but primarily African American.
- 

One hundred percent of the participants reported teaching majority African American students. This statement was reaffirmed by Participant 1 who stated, “keep in mind our school system is 80 to 90% African American” (p. 1).

Forty percent of the participants reported teaching more girls than boys. Forty percent of the participants reported an equal distribution of boy and girl students. Ten percent of participants reported teaching more boys than girls by a very narrow margin. According to Participant 5, “Right now the girls are actually underrepresented. I only

have two girls and three guys, there's only five kids taking it. In the past girls and guys have been kind of the equal” (p. 1).

Participant 8 (10%) did not offer gender demographic data but did however provide socioeconomic, literacy, and first generation college information. Participant 8 described advanced science students as “first generation college goers. They are coming from homes of lower social economic status. They, a majority minority, African American are also students that may possibly lack full exposure to science, and I would say have intermediate Lexile scores” (p. 1).

Furthermore, 40% of interview participants provided insight into the socioeconomic status of students participating in advanced science courses including Participant 3, Participant 6, Participant 7, and Participant 8. Participant 3 and Participant 8 described African American students participating in advanced science courses as coming from low income/socioeconomic status homes. Participant 6 described African American girls participating in advanced science courses and lower middle to middle class. Participant 7 perceived that African American students participating in advanced science courses came from better homes in comparison to students participating in non-advanced science courses. Participant 7 stated, “compared to my other physical science class, it seems like the kids who were in the chemistry, and the physics classes are kind of better off financially at home, it seems like that, but I could be wrong” (p. 1).

Theme 1: Reasons for participation. The theme reasons for participation emerged when participants were asked the following questions: Why do African American girls enroll in advanced science courses? How does this compare to other girls? Do you see enrollment patterns for African American girls in your advanced science classes? If so,

what are the trends? The subthemes tracking and college and career readiness explained teacher perceptions of why African American students participated in advanced science courses.

*1(a) Tracking.* Seven out of 10 participants (70%) discussed students being enrolled in advanced science courses due to educational tracking. Honors and magnet programs at various schools caused groups of students to travel together in advanced science and mathematics courses throughout high school. A description from participants is available in Table 8.

Table 8

*Tracking*

Participant	Description
1	The school that I've worked at has a magnet program, which requires students to take a higher number of science courses. So, in order for them to be part of that program, they would need to be in those science courses.
2	For the most part I think most of them are tracked that way. So, for instance, I have some who are now in the 10th grade who've just been on the honors track or since they began school or I have some that were top performance in their prereqs and they were selected. So, for the most part, I don't really think that anyone has like voluntarily enrolled. It's just the track that they've been on or the progress that they've made throughout school.
4	Yes, enrollment patterns are based on their achievement from middle school to high school.
5	I feel like the higher achievers are actually placed in my physics classes. I believe based off of prior science classes.
6	African American girls, there might be a bit of a skewing of the number of students taking advanced courses based on the track that they followed through school starting with elementary school because in my opinion it's not counted as an important course.
8	African American girls in my experience enroll these advanced sciences because of the actual tracking that they're on. Um, so say for instance, if they are an honor tracking, if they're on advanced, they may be a part of the actual magnet program and within that tracking, those courses, are something that is required for them to be enrolled in.

- 9 Students choose to be in magnet program. They have to apply, write an essay, and go through an interview process. So, before they can get in and they're required to have an 85 or higher in their math and science courses in middle school.

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Interview participants described tracking as the process of placing students in particular science courses based on a predetermined sequence. African American girls were placed on advanced science tracks based on participation in an honors/magnet program (See Table 7). Four out of eight participants (50%) noted that tracking began prior to coming to high school. "African American girls, there might be a bit of a skewing of the number of students taking advanced courses based on the track that they followed through school starting with elementary school" (Participant 6, p. 2). According to Participant 2, "For the most part I think most of them are tracked that way. So, for instance, I have some who are now in the 10th grade who've just been on the honors track or since they began school" (p. 2). Similarly, Participant 4 stated "Yes, enrollment patterns are based on their achievement from middle school to high school" (p. 3). Participant 9 discussed admission requirements for the magnet program. "They have to apply, write an essay, and go through an interview process. So, before they can get in and they're required to have an 85 or higher in their math and science courses in middle school" (Participant 9, p. 2).

*1(b) College and career readiness.* College and career readiness also emerged as a subtheme relating to reasons African American girls participated in advanced science courses. Seven out of 10 participants (70%) cited college and career aspirations as reasons why African American girls enrolled in advanced science courses. Teacher



rationale for relating advanced science courses to college and career readiness is explained in Table 9.

Table 9

*College and Career Readiness*

Participant	Description
1	It tends to lead to a to a degree postsecondary degree in a medical field. So, students that are interested in science as a possible career choice.
2	Hopefully by the time they decided to go to college, they'll decide to be a science major.
3	African American girls in my opinion enroll in advance science courses because many want to be or aspire to be doctors, some aspire to be pharmacists. And then you have some that would like to go off into fields of biology, forensic sciences. To pretty much make a difference, a career field that will help them make a difference in the world.
5	I feel like that class pretty much it helps to better further their education and knowledge and things that can help them in their future. So, they want to get as much experience or knowledge that they can to help them in their future careers.
7	So, I think the job possibilities in their minds are limited so they don't really know what all jobs are out there. So, they're thinking, oh, doctor, lawyer, engineer, everything is very black and white.
8	Comparing those African American girls that are on magnet tracking, some of them may have a close idea of what type of career, what they want to pursue, and they see a great opportunity for them learning that particular content in an advanced science course.
9	So, the ones that I currently have, they're enrolled all want to go in the medical field, like advanced medical degrees. They want to be doctors; I have one that wants to be a neurosurgeon. So that's the main reason why I think they take my class.

College and career readiness was described as a reason why African American girls participated in advanced science courses (see Table 8). Participant 3, Participant 5, Participant 7, and Participant 8 all agreed that African American girls enrolled in advanced science courses to gain knowledge that prepared students for future careers.

Participant 2 believed that advanced science courses caused students to aspire to major in science in college. “Hopefully by the time they decided to go to college, they’ll decide to be a science major” (Participant 2, p. 2). Participant 1 and Participant 9 mentioned both college and career as a reason for taking advanced sciences. “It tends to lead to a to a degree postsecondary degree in a medical field. So, students that are interested in science as a possible career choice” (Participant 1, p. 3), and “So the ones that I currently have, they’re enrolled all want to go in the medical field, like advanced medical degrees. They want to be doctors, I have one that wants to be a neurosurgeon” (Participant 9, p. 2).

Theme 2: Factors impacting participation. Factors impacting participation emerged as a theme when participants were asked the following questions: Do you actively recruit African American girls for your advanced science classes? Does anyone recruit such students for advanced science classes? Do these African American girls encourage other African American girls to participate in science? The subthemes that developed through close analysis of the data were recruitment strategies, peer influence, gender stereotypes, and competition with Move On When Ready (MOWR) and dual enrollment programs.

*2(a) Recruitment strategies.* Recruitment strategies emerged when participants were asked, do you actively recruit African American girls for your advanced science classes? Does anyone recruit such students for advanced science classes? Participant resources varied in reference to recruitment (See Table 10).

Table 10

*Recruitment Strategies*

Participant	Description
1	Not that I know of. From what I can tell, it's basically these are the classes that you need and then when you get to your senior year you get to choose. So sometimes they're pushed into this and sometimes they are not. The counselors push students into classes, and I would say that's directly impacted by the administration of the school.
2	Well, like I said, some of them are already on the track, but for those who aren't, maybe slipped through the cracks, or they have just shown major improvement since the last time that they were placed in a group. I do get those and I signed them up.
3	Yes, I usually do. I know sometimes I have students who say, oh, I don't want to take that course. I don't need that course. That's too hard. And you know, I explained. Do you like math? Do you like to see how we make things chemically? I'm talking about good things in physical sciences especially. From there, it's like, okay, I want to know a little more about what's going on in this class. I guess it's just all about the activities.
4	Yes, of course. Coworkers helped put them in the class. But when I talked once they got in there, I tried to influence them to go beyond. I've tried to both get them to focus on future college utilizing engineering and science.
5	Yes, I would say. Since I teach two subjects, their physical science grades, their test, and how they actually responded in that course will help me determine if I think they should go to physics or chemistry because they are advanced.
6	I actually recruit them and try to help them find career ideas. As far as the advanced science courses, those courses are set by the track that they're already on because I basically teach juniors and seniors, so they're set.
7	Anyone that takes me, especially for chemistry. If I talked to the other science teachers and they know someone who's strong enough for chemistry, I actively say you need to come to this class. Any of my girls taking chemistry are automatically put in physics.
8	I had the opportunity to, I wouldn't call it recruiting, but it was just, making sure that the kids are placed where they should be placed. I'm looking at those kid's ability and really, just really analyzing that particular kid or getting to know that particular kid, you know, maybe you need to think about this.
9	Yes, we do. Actually. They are one of our targeted subgroups when we go to the school because enrollment for girls is always

- down. So, trying to actively recruit them, trying to do things like hey you can come here and you could do this, you can be a scientist or a doctor or a surgeon or something like that. So that's one of the things we do actually actively recruit and we usually send two or three teachers from the school. We try to go in pairs to the middle schools and get the kids recruited to come into the program.
- 10 Not that I know of. I think it's kind of like, if you take it, that's great. If you're in the magnet program, you're expected to take it.

Participants 1 and 10 (20% of participants) were not aware of recruitment strategies to increase the number of African American girls taking advanced science courses. “Not that I know of. From what I can tell, it's basically these are the classes that you need and then when you get to your senior year you get to choose” (Participant 1, p. 4). Participant 10 explained “Not that I know of. I think it's kind of like, if you take it, that's great. If you're in the magnet program, you're expected to take it” (Participant 10, p. 6).

Participant 6 explained the absence of recruitment for classes but did help students develop career interests. “I actually recruit them and try to help them find career ideas. As far as the advanced science courses, those courses are set by the track that they're already on because I basically teach juniors and seniors” (Participant 6, p. 4). Similar to Participants 1 and 6, Participant 2 explained the lack of recruiting due to tracking but personally helped students that were not tracked enroll in advanced sciences. “[F]or those who aren't, maybe slipped through the cracks, or they have just shown major improvement since the last time that they were placed in a group. I do get those and I signed them up” (Participant 2, p. 5).

Participants 2, 5, 7, and 8 described recruitment as personally ensuring students are placed in the appropriate advanced science course. According to Participant 5, “Since

I teach two subjects, their physical science grades, their test, and how they actually responded in that course will help me determine if I think they should go to physics or chemistry because they are advanced” (p. 4). According to Participant 7, “If I talked to the other science teachers and they know someone who's strong enough for chemistry, I actively say you need to come to this class. Any of my girls taking chemistry are automatically put in physics” (p. 5). Participant 8 also described recruiting as “just, making sure that the kids are placed where they should be placed. I'm looking at those kid's ability and really, just really analyzing that particular kid or getting to know that particular kid” (p. 8).

Participants 3 and 4 described recruiting as encouraging students to engage in science inside and outside of the classroom. “Coworkers helped put them in the class. But when I talked once they got in there, I tried to influence them to go beyond. I've tried to both get them to focus on future college utilizing engineering and science” (Participant 4, p. 4). Likewise, Participant 3 explained “I'm talking about good things in physical sciences especially. From there, it's like, okay, I want to know a little more about what's going on in this class. I guess it's just all about the activities” (p. 4).

Participant 9 was the only participant to describe strategic recruiting efforts initiated by the school to recruit students. “So that's one of the things we do actually actively recruit and we usually send two or three teachers from the school. We try to go in pairs to the middle schools and get the kids recruited to come into the program” (Participant 9, p. 4). Participant 9 also identified African American girls as a targeted group for recruitment. Participant 9 explained, “They are one of our targeted subgroups when we go to the school because enrollment for girls is always down” (p. 4).

2(b) *Peer influence*. The influence of peers was discussed when participants were asked, do these African American girls encourage other African American girls to participate in science? Nine out of 10 participants (90%) offered thoughts related to the interview question. Participant 2 did not have any thoughts on peer influences. “That one, I'm not fully informed” (Participant 2, p. 5). Participant responses to peer influence were presented in Table 11.

Table 11

*Peer Influences*

Participant	Description
1	I've actually had students that come back after completing a science pathway, come back and actually talk to, you know, upcoming freshmen or upcoming sophomores and to try to get them to take certain classes. So, I can see that. And it's motivational for African American girls to see that others have already succeeded in that area.
2	That one, I'm not fully informed.
3	I don't think I see it with many African American girls. I think it just going back to their experience and exposure. If I don't have enough experience and exposure, then I can't sell it to the next person
4	Nope. Their primary focus is on things that have been embedded in them that have nothing to do with science nor technology. It was based on appearance and performing arts. So, does my hair look nice? Am I on this team or on the danceline?
5	Yes, I think so. They get them more involved especially in classes where some African American girls may be scared to open up and speak, but some African American girls are actually willing to help others so that they wouldn't feel that way
6	I don't see that because they're in a cluster. If they're in an advanced class, they generally stay with their group. They don't traverse outside of that group. I don't see that at all.
7	I tend to see them encouraging others to kind of take the less difficult road. They say man this class is hard. It's kind of what I see.
8	In terms of programs that are related to science I have seen it, but not in courses. You need to come and get in chemistry class, no. I haven't seen it for courses, but definitely programs related to science

- 9 So, the girls that I have seen unfortunately stay in like a little pod so I don't ever get to see them interacting with students who are outside of their group that they're with all the time anyway.
- 10 No, they say it's too hard. They just kind of smirk or laugh under their breath. I'll tell them to tell other students to take it next year, they just kind of laugh. They don't want the challenge.
- 

Two out of nine participants (22%), including Participant 1 and Participant 5, agreed that African American girls did encourage other African American girls to participate in science. Participant 1 shared experiences with former African American students coming back to encouraging current students. "I've actually had students that come back after completing a science pathway, come back and actually talk to, you know, upcoming freshmen or upcoming sophomores and to try to get them to take certain classes" (Participant 1, p. 4). Participant 1 continued to explain "it's motivational for African American girls to see that others have already succeeded in that area" (p. 4). Participant 5 explained that peer interactions of African American girls in advanced science courses helped shy students to build self-confidence. "They get them more involved especially in classes where some African American girls may be scared to open up and speak, but some African American girls are actually willing to help others so that they wouldn't feel that way" (Participant 5, p. 4).

On the other hand, the remaining seven participants (77%) did not think that African American girls specifically motivated other African American girls to participate in science. Participant 3 agreed with Participant 1 on the importance of African American girls sharing experiences with other girls but did not observe this behavior. Participant 3 stated, "I don't think I see it with many African American girls. I think it just going back to their experience and exposure. If I don't have enough experience and exposure, then I can't sell it to the next person" (p. 4).

Participant 4 and Participant 8 both noted that peer encouragement took place in nonacademic situations, but not in science courses. “Nope. Their primary focus is on things that have been embedded in them that have nothing to do with science nor technology. It was based on appearance and performing arts” (Participant 4, p. 4). Similarly, Participant 8 stated, “In terms of programs that are related to science I have seen it, but not in courses. You need to come and get in chemistry class, no. I haven't seen it for courses, but definitely programs related to science” (p. 8).

Participant 6 and Participant 9 described limited experiences observing African American girls encourage other girls which related back to the way students were tracked. According to Participant 6, “I don't see that because they're in a cluster. If they're in an advanced class, they generally stay with their group. They don't traverse outside of that group. I don't see that at all” (p. 4). Participant 9 stated “So, the girls that I have seen unfortunately stay in like a little pod so I don't ever get to see them interacting with students who are outside of their group that they're with all the time anyway” (p. 4).

Participant 7 and Participant 10 shared similar sentiments that African American girls discouraged other African American girls from participating in advanced sciences because advanced sciences are challenging. “I tend to see them encouraging others to kind of take the less difficult road. They say man this class is hard. It's kind of what I see” (Participant 7, p. 5). Participant 10 added, “No, they say it's too hard. They just kind of smirk or laugh under their breath. I'll tell them to tell other students to take it next year, they just kind of laugh. They don't want the challenge” (p. 7).

*2(c) Gender stereotypes.* A reoccurring subtheme of gender stereotypes was identified when participants were asked the following questions: What are your thoughts



on the preparation and readiness of African American girls to be successful in advanced science courses when compared to other populations? How do African American girls participating in advanced science courses perform compared to other groups? Do you see enrollment patterns for African American girls in your advanced science classes? If so, what are the trends? Six out of 10 participants (60%) described the abilities and interests of boys and girls in relation to stereotypical gender roles (See Table 12).

Table 12

*Gender Stereotypes*

Participant	Description
2	And the guys, I found that most times if a guy has a strong math background, he's just naturally gifted, but the girls come, you can tell that for the most part they've been prepared.
3	They [girls] connect a little more emotionally than what the male species would when it comes down to other sub groups.
4	They have put more emphasis on males being able to do more things and being smarter. I think the school system puts more emphasis on sports, and those things that focused more on the male students than female. Like in robotics we have absolutely no girls because they are not focused on it.
6	The girls tend to be more of a historically what's been traditional, like thinking in terms of males having more proficiency in math.
7	With physics especially, it's kind of understood that boys would go into physics. A lot of kids see that as like a boy class. I don't know if there is a tracking system but if given the choice between physics or going into like AP biology, environmental, something like that. Almost always they will choose the non-physics class.
8	When I was looking at AP biology, they [students] were your readers are researchers. I would say they want to really understand what it was they were doing. So, it wasn't a tug and pull. They took the initiative study. They took the initiative to ask questions more than the male groups. So, in that particular case, I'd definitely say it depends on what type of advanced science that they're in. I've noticed, those that are more mathematically inclined, they may struggle a bit because it's a little different.

Some participants discussed stereotypical gender roles society related to the participation and outcomes of African American girls in advanced science courses. According to Participant 7, “With physics especially, it's kind of understood that boys would go into physics. A lot of kids see that as like a boy class” (p. 3). Participant 2 contrasted the gifted nature of boys to the preparation and work ethic of girls in math. “And the guys, I found that most times if a guy has a strong math background, he's just naturally gifted, but the girls come, you can tell that for the most part they've been prepared” (Participant 2, p. 3). Participant 6 also discussed traditional stereotypes of boys being better in mathematics than girls. “The girls tend to be more of a historically what's been traditional, like thinking in terms of males having more proficiency in math” (Participant 6, p. 3).

Participant 4 perceived boys to be the predominant focus in education while girls were limited to stereotypical roles such as dancers. “They have put more emphasis on males being able to do more things and being smarter. I think the school system puts more emphasis on sports, and those things that focused more on the male students than female” (Participant 4, p. 2). Participant 4 also explained the lack of girls participating in robotics. “Like in robotics we have absolutely no girls because they are not focused on it” (Participant 4, p. 2).

Participant 3 commented on the emotional nature of girls compared to boys. “They [girls] connect a little more emotionally than what the males species would when it comes down to other sub groups” (Participant 3, p. 2). In relation to types of sciences, Participant 7 and 8 perceived that girls favored life sciences while boys favored physical sciences. “I don't know if there is a tracking system but if given the choice between

physics or going into like AP biology, environmental, something like that. Almost always they will choose the non-physics class” (Participant 7, p. 4). Similarly, Participant 8 explained the difference students taking AP biology and advanced sciences requiring a strong mathematics background. Participant 8 explained,

When I was looking at AP biology, they [students] were your readers are researchers. I would say they want to really understand what it was they were doing. So, it wasn't a tug and pull. They took the initiative study. They took the initiative to ask questions more than the male groups. So, in that particular case, I'd definitely say it depends on what type of advanced science that they're in. I've noticed, those that are more mathematically inclined, they may struggle a bit because it's a little different (p.2).

*2(d) Move on When Ready and dual enrollment programs.* Move on When Ready and dual enrollment programs emerged as a subtheme for factors impacting participation. The following interview questions lead to discussions about both MOWR and dual enrollment programs: Do these African American girls encourage other African American girls to participate in science? Why do African American girls enroll in advanced science courses? How does this compare to other girl students? Do you see enrollment patterns for African American girls in your advanced science classes? If so, what are the trends? What do you think is the future direction of African American girls participating in advanced science courses? Five out of 10 participants (50%) discussed college programs that allowed high school advanced science students to earn college credit (See Table 13).

Table 13

*Move On When Ready and Dual Enrollment Programs*

Participant	Description
3	I think the students who maybe do dual enrollment and some of the other programs, they get to see science on a different level beyond high school
4	Parents probably put them in advanced classes. I told them to focus on it and then to with our system, having the dual enrollment, they are trying to take advantage of that as well.
7	I don't see enrollment patterns because they are tracked and a lot of them are doing Move On When Ready now, and I think that is starting to impact our magnet program in a negative way
8	I do feel that there will be an increase in advanced science courses and the reason being is because of the different outlets that students have now. There are students that are taking science courses with Move On When Ready, or if they are at the college and career academy, they already have been exposed to advanced courses.
10	I think there is a decline in students on the high school level because a lot of students are taking Move On When Ready classes joining dual enrollment and they are actually getting college credit at the college level

Participants discussed both dual enrollment and MOWR programs during various interview questions. In reference to peer encouragement, Participant 3 stated, “I think the students who maybe do dual enrollment and some of the other programs, they get to see science on a different level beyond high school” (p. 5). Participant 4 discussed dual enrollment while explaining why African American girls enrolled in advanced science courses. “Parents probably put them in advanced classes. I told them to focus on it and then to with our system, having the dual enrollment, they are trying to take advantage of that as well” (Participant, p. 1). Participant 8 recognized MOWR as an avenue to expose students to more advanced sciences. Participant 8 stated,

I do feel that there will be an increase in advanced science courses and the reason being is because of the different outlets that students have now. There are students that are taking science courses with Move On When Ready, or if they are at the college and career academy, they already have been exposed to advanced courses (p. 9).

Participant 7 and 10 discussed the negative impact of MOWR and dual enrollment on high school advanced science enrollment numbers. “I don't see enrollment patterns because they are tracked and a lot of them are doing Move On When Ready now, and I think that is starting to impact our magnet program in a negative way” (Participant 7, p. 4). According to Participant 10, “I think there is a decline in students on the high school level because a lot of students are taking Move On When Ready classes joining dual enrollment and they are actually getting college credit at the college level” (p. 2).

Theme 3: Factors impacting readiness. Although preparation and readiness were both included in interview question 5 on the interview protocol, participants generally agreed that all students were prepared the same. “I'm not sure that there is a difference in preparation” (Participant 1, p. 2). Similarly, “I think that they are prepared just like any other student would be prepared” (Participant 7, p. 3). Student readiness however varied based on a number of factors. Factors impact readiness emerged when participants were asked the following questions: How do African American girls participating in advanced science courses perform compared to other groups? What are your thoughts on the preparation and readiness of African American girls to be successful in advanced science courses when compared to other populations? How do you support the enrollment of African American girls in your courses? What kinds of support? As a result, family

values, exposure, and a lack of foundational skills in mathematics and science developed as subthemes.

*3(a) Family values.* The impact of family values on readiness developed as a theme to explain factors that affected the participation of African American girls in advanced science courses. Five out of 10 participants (50%) described how family affected the participation and outcomes of African American girls in advanced science courses (See Table 14).

Table 14

*Impact of Family Values on Readiness*

Participant	Description
1	I'm not sure that there is a difference in preparation. There may be a difference in readiness, which I would probably put more on their home life rather than school life. If their parents weren't in a higher level field, they may not be pushed into higher level field like an advanced science and vice versa. If they have parents that were in a medical field than they may push their children to be in a higher science course
3	The lack of resources at home, maybe transportation or you know, not having parental support versus your other subgroups.
4	Most of the focus is especially being in the south, I feel like it's more family oriented. Just do enough to walk across the stage.
6	I think it stems from home environment. The value placed on STEM, placed on science isn't telling a student you need to just get your work done or listen to the teacher and you're not engaging them in science at home because there's science all around us. There is science in everything. I think it starts there and it starts in elementary grades.
8	The students participating in advanced science courses are students that are mostly first-generation college goers. They are coming from homes of lower social economic status. They, a majority minority, African American are also students that may possibly a lack full exposure to science.

The value family members placed on education had an impact on the readiness and performance in advanced science courses. Participant 1 perceived that parent

occupations affected whether or not students were encouraged to participate in advanced science. According to Participant 1, “I would probably put more on their home life rather than school life. If their parents weren't in a higher level field, they may not be pushed into higher level field like an advanced science” (p. 2). Participant 3 explained that a lack of resources and parental support to affect participation in advanced science courses.

“The lack of resources at home, maybe transportation or you know, not having parental support versus your other subgroups” (Participant 3, p. 2). Participant 4 noted low expectations based on family values. Participant 4 stated, “Most of the focus is especially being in the south, I feel like it's more family oriented. Just do enough to walk across the stage” (p. 2). Participant 6 summarized the impact of family values by stating “it stems from home environment. The value placed on STEM, placed on science isn't telling a student you need to just get your work done or listen to the teacher and you're not engaging them in science at home” (p. 3). Participant 8 also weighed in on the impact of family on African American students in advanced science courses while describing the demographics of the students enrolled in advanced science courses. Participant 8 described advanced science students as “mostly first-generation college goers. They are coming from homes of lower social economic status. They, a majority minority, African American are also students that may possibly a lack full exposure to science” (p.1).

*3(b) Exposure.* Although Participant 8 described how family dynamics impacted student exposure to science, there were varying factors that fell under the subtheme of exposure. Other discussions arose related to science exposure including the availability of public school resources, career choices, self-confidence, and educational leader support.

Four out of 10 participants (40%) discussed the importance of African American girls being exposed to advanced sciences (See Table 15).

Table 15

*Exposure*

Participant	Description
3	For your African American girls, I think sometimes there is a disadvantage and that's because of experience whereas when you have those who are Caucasian, the resources are a little more there than what it is for the African American ladies and sometimes they tend to be in the public schools. There's a lack of resources in public schools as well
5	I just think that they need to be exposed to as many different types of sciences as possible.
7	I think that if they go through it and they are exposed to these things that they've never seen before because they are a minority of a minority female and I feel like once they realize they are such a high demand, if they can just get that realization, all of a sudden their confidence will just blossom. They're like, did you know I could get a scholarship for this? Did you know I could do this? And I'm like yes, I do know that.
8	With these young ladies going into that direction, they've got to have a strong exposure base. So, I think that will deal with the powers that be making sure that we truly care about these students, and that everything we do is for them. That we make sure that we have the right individuals that are in the trenches with them. And I know it's hard to do, you know. I think that we truly focus on this subgroup everywhere I go. Anything dealing with STEM, we're always talking about the African American female because they are not so heavily represented in that field. We're going to have to do somethings as stakeholders and as people who can make changes to make sure that they are exposed to science.

Participant 3 perceived that public schools had less resources to engage students in science compared to private schools which overwhelmingly affected African American girls. According to Participant 3, “There's a lack of resources in public schools as well versus your private entities. And I think that kind of cuts the experience for the African American girls more so than anything” (p. 2). Similarly, Participant 8 recognized the



need for science teachers to be specially trained to teach students who are not exposed to science outside of public school. “They can get the training of how to use knowledge to teach students and especially teach it to students who are impoverished. You know, teaching those kids that are not going to come to you motivated, that have not been exposed to anything past public school education” (Participant 8, p. 6).

Participant 5 perceived that exposure to science courses increased future career options. Therefore, Participant 5 stated “I just think that they need to be exposed to as many different types of sciences as possible” (p. 4). Participant 7 expressed how exposure to science builds the confidence of students. “once they realize they are such a high demand, if they can just get that realization, all of a sudden their confidence will just blossom” (Participant 5, p. 5).

When asked about the future direction of African American girls participating in advanced science courses, Participant 8 communicated the importance of educational leaders and stakeholders putting the necessary practices in place to expose more African American girls to science. Participant 8 stated,

Anything dealing with STEM, we're always talking about African American females because they are not heavily represented in that field. We're going to have to do somethings as stakeholders and as people who can make changes to make sure that they are exposed to science (p. 9).

*3(c) Lack of foundational skills in math and science.* The lack of foundational skills in mathematics and science was also reflected under the theme factors impacting readiness. Six out of 10 participants (60%) shared perceptions on the lack of mathematics and science skills in Table 16.

Table 16

*Lack of Foundational Skills in Mathematics and Science*

Participant	Description
2	Not that they can't do, it's just sometimes it's kind of, it's not the best connect. So, there's sometimes a disconnect. Most of it comes from my class being heavily weighted in math. Most of the disconnect is in math.
6	But I do think historically some of the girls now are not fairing as well. They don't have a good base. They don't have a good base in math, they don't have a good base in labs skills, so they're not fairing as well, generally speaking, and that's not just the girls. The girls tend to be more of a historically what's been traditional, like thinking in terms of males having more proficiency in math. Elementary grades needs to boost their engagement with science because reading and math, you know math is a STEM course, but the engagement in everyday skills of science needs to be enforced in elementary school.
7	Yes, very much so.
8	“The young ladies were not as advanced when it actually came to the dimensional analysis, you know, the math portion of that particular course. So, there was some struggle there.
9	The girls that are in my advanced science courses have a better math and science foundation compared to other students.
10	It's like going back into teaching foundational things and bringing them up is not just diving in and going directly into a higher level class.

Research participants disclosed a significant relationship between mathematical skills and success in science classes. Three out of four physics and chemistry teachers (75%) discussed the importance of mathematics in advanced science courses. Participant 5 (25%) did not mention mathematic skills during the interview. Participant 2 discussed the struggles that African American girls had in chemistry. “Not that they can't do, it's just sometimes it's kind of, it's not the best connect. So, there's sometimes a disconnect. Most of it comes from my class being heavily weighted in math. Most of the disconnect is in math” (Participant 2, p. 3). In response to whether boys tend to be stronger

mathematics students, Participant 7 responded, “Yes, very much so” (p. 3). Participant 8 discussed the struggles African American girls had understanding dimensional analysis in chemistry classes. “The young ladies were not as advanced when it actually came to the dimensional analysis, you know, the math portion of that particular course. So, there was some struggle there” (Participant 8, p. 2).

Contrary to the rest of the participants, Participant 9 perceived mathematics and science foundational skills as a strength of African American girls enrolled in advanced science courses. Participant 9 stated “The girls that are in my advanced science courses have a better math and science foundation compared to other students” (p. 3).

In reference to the question pertaining to preparation and readiness, Participant 10 discussed the need to teach foundational skills in advanced science courses before jumping into more rigorous concepts due to the lack of adequate preparation. “It's like going back into teaching foundational things and bringing them up is not just diving in and going directly into a higher level class” (Participant 10, p. 3). Participant 6 expressed a need to improve mathematical and laboratory skills. “But I do think historically some of the girls now are not fairing as well. They don't have a good base. They don't have a good base in math, they don't have a good base in labs skills” (Participant 6, p. 3). In addition to mathematics, Participant 6 was an advocate for increased engagement in science and STEM. “Elementary grades needs to boost their engagement with science because reading and math, you know math is a STEM course, but the engagement in everyday skills of science needs to be enforced in elementary school” (Participant 6, p. 3).

*3(d) Student work ethic.* An additional theme that emerged related to student readiness was student work ethic. Seven out of 10 (70%) of participants discussed the

self-efficacy of African American girls in response to several interview questions.

Participant responses were recorded in Table 17.

Table 17

*Student Work Ethic*

Participant	Description
3	I believe that African American girls, they pretty much tend to advance a little more than the guys and that's pretty much because of the drive.
4	A lot of them are overachievers and they tend to be a little bit more open minded.
5	I think that they actually work harder than most. Dealing with politics and stuff like that, it's harder for a female plus being African American makes it even harder. So, they work harder I think than most males would.
6	They will own what they do because they are very ready. Their work ethic is better, their personal constitution for studying beyond what's asked was great. So, with students with that kind of mindset, they'll own that. They'll do well
7	I've noticed that most of the time girls especially are in two classes or groups. So, you have the ones that are really driven and they are going to do whatever it takes to succeed. For instance, I have one girl in physics right now. She made an A; she busts her behind. She's going to do what she has to do to get it done, but then you have the other girls who were just, okay, what can I do to get by? There's not really many in between, so the ones that really are driven or the ones who just want to get it done.
8	However, work ethic, engagement is different with young ladies that are in those advanced courses. They have the ability to go forth with the expectation whether it's a particular assignment, their study habits are definitely different.
9	So, my girls are like rock stars. They really are. They usually all sit together and they're extremely motivated and I think half of them are gifted so they really push themselves to do more and get their grade up. I think they usually go a little bit above the other groups, especially the boys.

Student work ethic effected the readiness of African American girls enrolled in advanced science courses. Four out of seven participants (57%) explicitly described student work ethics. Participants 5, 6, 8, and 9 discussed work ethics associated with

students participating in advanced science courses. According to Participant 5, “I think that they actually work harder than most. Dealing with politics and stuff like that, it's harder for a female plus being African American makes it even harder. So, they work harder I think than most males would” (p. 2). In reference to the readiness of a former group of students, Participant 6 said “they are very ready. Their work ethic is better, their personal constitution for studying beyond what's asked was great. So, with students with that kind of mindset, they'll own that. They'll do well” (p. 5). Participant 8 also described the work ethic of African American girls enrolled in advanced science courses.

“However, work ethic, engagement is different with young ladies that are in those advanced courses. They have the ability to go forth with the expectation whether it's a particular assignment, their study habits are definitely different” (Participant 8, p. 2). Finally, Participant 9 stated, “my girls are like rock stars. They really are. They usually all sit together and they're extremely motivated and I think half of them are gifted so they really push themselves to do more and get their grade up” (p. 2).

Three out of seven participants (43%) described student work ethic in relation to drive. Participants 3, 4, and 7 described the drive of students participating in advanced science classes. Participant 3 stated, “I believe that African American girls, they pretty much tend to advance a little more than the guys and that's pretty much because of the drive” (p. 2). Participant 4 described African American girls as “A lot of them are overachievers and they tend to be a little bit more open minded” (p. 2). According to Participant 7 “I've noticed that most of the time girls especially are in two classes or groups. So, you have the ones that are really driven and they are going to do whatever it takes to succeed” (p. 2). On the other hand, Participant 7 described students that do just

enough to get by. Participant 7 stated, “other girls who were just, okay, what can I do to get by? There's not really many in between, so the ones that really are driven or the ones who just want to get it done” (p. 2).

Theme 4: Curriculum Design. Curriculum design developed as a theme when participants were asked, tell me about the curriculum and pedagogy used to teach advanced science courses. Is it designed to meet the needs of diverse students including African American girls? Explain. Seven out of 10 participants 70% offered information regarding curriculum design (See Table 18).

Table 18

*Curriculum Design*

Participant	Description
2	We are governed by standards. We use both general and specific standards and elements to cover what we teach. So, it's no dictated way of teaching it, but it tells us what we have to make sure we cover and what we have to make sure we prepare kids on.
3	It [science curriculum] has changed over time. Science has shifted from learning about science as an inquiry or process to taking certain steps to get there. You have to dig a little deeper to make meaning for your learning.
4	The curriculum that we use is state and county based. I feel like it's at a basic level. It does not force students to put science and math together and produce something. It is just basic knowledge.
7	I use the Georgia Standards of Excellence. Across the board literacy is an issue, so the new standards force literacy into the curriculum. The characteristics of science that were with GPS are now incorporated into the standards themselves.
8	Curriculum comes from the Georgia Department of Education and then it is refined by different districts based on the vision of the district. However, there's a gap once it gets to each individual district. The resources that are provided by GADOE, I do feel that they are sufficient resources, however, not sufficient for southwest Georgia. with an advanced placement class is a little different because of course that curriculum is coming from College Board

- 9 I've contacted universities and tried to make our curriculum rather than it be like a normal high school human anatomy course to try to give them some of the components they would see in a college level anatomy course.
- 10 The AP biology curriculum is set by the College Board and basically has four big ideas and essential questions. We use cross curriculum interdisciplinary type practices in order to cover various concepts.

Participants 2, 4, 7, and 8 explained that curriculum was developed by the Georgia Department of Education and is also influenced by the local school district. Participant 8 stated, "Curriculum comes from the Georgia Department of Education and then it is refined by different districts based on the vision of the district. However, there's a gap once it gets to each individual district" (p. 4). Participant 2 explained how state standards governed instruction. "We are governed by standards. We use both general and specific standards and elements to cover what we teach. So, it's no dictated way of teaching it, but it tells us what we have to make sure we cover" (Participant 2, p. 3). According to Participant 4, "The curriculum that we use is state and county based. I feel like it's at a basic level. It does not force students to put science and math together and produce something. It is just basic knowledge" (p. 3). Participant 7 stated, "I use the Georgia Standards of Excellence. Across the board literacy is an issue, so the new standards force literacy into the curriculum. The characteristics of science that were with GPS are now incorporated into the standards themselves" (p. 3).

Participant 3 described the transition in science curriculum from inquiry based to more critical thinking. "It has changed over time. Science has shifted from learning about science as an inquiry or process to taking certain steps to get there. You have to dig a little deeper to make meaning for your learning" (Participant 3, p. 3). Participant 9 opted

to create a curriculum modeled after college classes. Participant 9 explained, “I’ve contacted universities and tried to make our curriculum rather than it be like a normal high school human anatomy course to try to give them some of the components they would see in a college level anatomy course” (p. 3). Participants 8 and 10 explained that the Advanced Placement curriculum was determined by College Board. Participant 8 stated, “with an advanced placement class is a little different because of course that curriculum is coming from College Board” (p. 4). Participant 10 concurred by explaining the Advanced Placement curriculum. “The AP biology curriculum is set by the College Board and basically has four big ideas and essential questions. We use cross curriculum interdisciplinary type practices in order to cover various concepts” (Participant 10, p. 4). Participant 8 also explained the need for highly qualified teachers in advanced sciences capable of teaching to the intent of the standards and expressed a need for additional support to help teachers become better teachers. “The resources that are provided by GADOE, I do feel that they are sufficient resources, however, not sufficient for southwest Georgia” (Participant 8, p. 4).

Theme 5: Pedagogical approaches. Similar to curriculum design, pedagogical approaches developed as a theme when participants were asked, tell me about the curriculum and pedagogy used to teach advanced science courses. Is it designed to meet the needs of diverse students including African American girls? Explain. The subthemes that developed from this were the 5E model of instruction, culturally relevant teaching, and instructional strategies.

*5(a) 5E model of instruction.* When teachers were asked about the pedagogy used to teach advanced science courses, the 5E model of instruction emerged as a subtheme.



Four out of 10 participants (40%) named the 5E Model of instruction as a pedagogical framework for instruction in advanced science courses (See Table 19).

Table 19

*5E Model of Instruction*

Participant	Description
2	we use the 5 E model
3	In the 21st century especially, students are more technologically advanced. And then also they still have those learning barriers and so I think the 5E model of differentiation and then using some assistive technology will help them.
5	So, in physics we're using the 5E model. So, it breaks things down to where we engage them first. Then we do the explore, then we do the explain, then we elaborate, then we evaluate.
7	it's [pedagogy] kind of broken down teaching science into the 5E's, which is, you know, the engage, explore, explain, elaborate, evaluate.

The 5E model of instruction was described by Participants 2, 3, 5, and 7.

Participant 2 stated, “we use the 5 E model” (p. 4) when asked about pedagogy.

Participant 3 explained, “In the 21st century especially, students are more technologically advanced. And then also they still have those learning barriers and so I think the 5E model of differentiation and then using some assistive technology will help them.” (p. 3).

So, in physics we're using the 5E model. So, it breaks things down to where we engage them first. Then we do the explore, then we do the explain, then we elaborate, then we evaluate (Participant 5, p. 3). According to Participant 7, “it's kind of broken down teaching science into the 5E's, which is, you know, the engage, explore, explain, elaborate, evaluate” (p. 3).

*5(b) Culturally Relevant Teaching.* Four out of 10 participants (40%) described culturally relevant teaching practices to ensure the success of African American girls.

The subtheme derived when participants were asked about curriculum and pedagogy, enrollment patterns, and enrollment supports for African American students enrolled in advanced science courses. Participant responses were organized in Table 20.

Table 20

*Culturally Relevant Teaching*

Participant	Description
3	as far as meeting the needs of diverse students, that 5E model, I think it kind of pushes the differentiation portion of the academic needs of your students, especially for students that may have diverse learning needs
4	Teachers who know about African American women contributions to science understand it won't be taught unless teacher are willing to tell it, to talk about it in class, you know, like Henrietta Lacks. If African American girls see their peers and role models making contributions, then they will be more willing to do it. They also must be encouraged to think they are smart enough to make a difference in STEM
5	I support you even if it's not just the content, if it's something that's going on with them because sometimes African American girls have a lot of things that could be going on with them.
8	Being an African American woman and myself who loves science, I'm just making sure that the kids see my passion. So, I feel that if more African American girls see us teaching these courses and love teaching, they will love science too. exposing them to different women in the community who were in the STEM field who are African American. They look like you that come from the same background you come from.

All participants in the study agreed that the pedagogical approaches used to teach advanced science courses were designed to meet the needs of diverse learners, including African American girls. Participant 3 elaborated on the importance of pedagogy meeting the diverse learning needs of students by stating “as far as meeting the needs of diverse students, that 5E model, I think it kind of pushes the differentiation portion of the academic needs of your students, especially for students that may have diverse learning

needs” (Participant 3, p. 3). In addition to supporting students academically in the classroom, Participant 5 discussed the importance of supporting African American girls in various situations to ensure success. “I support you even if it's not just the content, if it's something that's going on with them because sometimes African American girls have a lot of things that could be going on with them” (Participant, 5, p. 4).

Participant 4 discussed the importance of exposing African American students to STEM. “Teachers who know about African American women contributions to science understand it won't be taught unless teacher are willing to tell it, to talk about it in class, you know, like Henrietta Lacks” (Participant 4, p. 3). Participant 4 then discussed the importance of African American girls seeing other African American girls engaged in STEM. “If African American girls see their peers and role models making contributions, then they will be more willing to do it. They also must be encouraged to think they are smart enough to make a difference in STEM” (Participant 4, p. 5). Similarly, Participant 8 discussed the importance of African American girls having African American women role models in STEM fields. “[E]xposing them to different women in the community who were in the STEM field who are African American. They look like you that come from the same background you come from” (Participant 8, p. 7). Participant 8 discussed being a model of encouragement for African American girls. Furthermore, Participant 8 explained, “Being an African American woman and myself who loves science, I'm just making sure that the kids see my passion. So, I feel that if more African American girls see us teaching these courses and love teaching, they will love science too” (p. 7).

*5(c) Instructional Strategies.* Although some participants described the same instructional framework (i.e., 5E Model of instruction), the specific instructional

strategies used to teach the content varied. Nine out of 10 participants (90%) described strategies used to teach advanced science courses (See Table 21).

Table 21

*Instructional Strategies*

Participant	Description
1	Hands-on labs and project based learning.
2	it's depending on what I have, lecture just to or mini lecture to prepare them for college. I do at group activities, I do individual activity, so it's just. So, it's just a mixture.
3	just kind of, I guess sparking the interest, sparking the interest and making science learning more meaningful to kind of help them gain that push or that love for science like I have.
4	My pedagogy is based on my history of teaching and what captures the students' attention and if I can get them to think beyond what's in the room, then I could advance them a little bit further.
5	Students need to understand and do a lot of things hands-on so that they can be able to explore and explain later on why was it so important.
6	I use energy flow as a capstone idea and students have to connect everything that we talk about to it. I am very much a constructivist teacher so I give them a problem and guide them to solve it.
8	So, with the pedagogy, definitely incorporating three dimensional classrooms, making sure that in planning and practice that teachers are promoting the students to use science and engineering practices and materials that are cross cutting.
9	Teaching style, assignments, and lab practicums mimic those at the local colleges.
10	it is driven a lot by inquiry labs and also models, via handouts and things that allows students to do more interpretation and data analysis.

Participants 3 and 4 implemented engagement activities to get the attention of students and create interest in the content. Participant 3 explained the strategy used to engage students in science as “sparking the interest and making science learning more meaningful to help them gain that push or that love for science like I have” (p. 4).

According to Participant 4, “My pedagogy is based on my history of teaching and what

captures the students' attention and if I can get them to think beyond what's in the room, then I could advance them a little bit further” (p. 3).

Hands-on activities and laboratory exercises were expressed by Participants 1, 5, and 10. Participant 5 explained “Students need to understand and do a lot of things hands-on so that they can be able to explore and explain later on why was it so important” (p. 3). Participant 1 used “Hands-on labs and project based learning” (p. 3) to engage students in advanced science courses. According to Participant 10, “it is driven a lot by inquiry labs and also models, via handouts and things that allows students to do more interpretation and data analysis” (p. 4).

Other participants had varying strategies. Participant 6 chose to employ a constructivist theory of teaching and learning. “I use energy flow as a capstone idea and students have to connect everything that we talk about to it. I am very much a constructivist teacher so I give them a problem and guide them to solve it” (Participant 6, p. 3). Participant 2 explained “it's depending on what I have, lecture just to or mini lecture to prepare them for college. I do at group activities, I do individual activity, so it's just a mixture” (p. 3). Finally, Participant 9 explained how college practices influenced pedagogy used to teach advanced science courses. “Teaching style, assignments, and lab practicums mimic those at the local colleges” (p. 3). Finally, Participant 8 explained the importance of teaching advanced sciences using the three-dimensional learning as prescribed by the Next Generation Science Standards. “So, with the pedagogy, definitely incorporating three dimensional classrooms, making sure that in planning and practice that teachers are promoting the students to use science and engineering practices and materials that are cross cutting” (p. 5).

Theme 6: Student outcomes. The theme student outcomes developed as a result of participants answering the questions, what do you think is the future direction of African American girls participating in advanced science courses and do you have any data to support student outcomes of African American girls participating in advanced science courses? The subthemes that developed from this were college expectations and career choices.

*6(a) Postsecondary expectations.* Four out of 10 participants (40%) discussed postsecondary expectations and/or personal experiences with African American girls participating in advanced science courses. The commentary from interviews was organized in Table 22.

Table 22

*Postsecondary Expectations*

Participant	Description
3	I see them pretty much leading preferably in our science majors and science careers and then also coming back to help out others. I think our African American girls are on the rise.
4	Hopefully, those students who didn't pursue STEM in the beginning, may be willing to go and pursue it in college.
8	There are a couple of students, there's one that is at Spelman now and she's graduating with her bachelor's degree and she'll be going into the medical college I think it is Meharry.
9	I know students who have stayed in the program and who have taken advanced science courses who went through and they're in medical school or in nursing school.

Participants 3, 4, 8, and 9 described expectations and/or personal experiences with African American girls enrolled in advanced science courses. According to Participant 3, "I see them pretty much leading preferably in our science majors and science careers and then also coming back to help out others. I think our African American girls are on the

rise” (p. 5). Participant 4 added, “Hopefully, those students who didn't pursue STEM in the beginning, may be willing to go and pursue it in college” (p. 5). Participant 8 discussed former students that were pursuing science related postsecondary degrees. “There are a couple of students, there's one that is at Spelman now and she's graduating with her bachelor's degree and she'll be going into the medical college I think it is Meharry” (Participant 8, p. 10).

*6(b) Career Choices.* When participants were talking about the future direction of African American girls enrolled in advanced science courses, seven out of 10 participants (70%) discussed career choices (See Table 23). Popular career choices for students enrolled included medical fields, military, and STEM related fields.

Table 23

*Career Choices*

Participant	Description
1	I can see them going into medical fields, engineering fields. If they take an advanced placement like environmental science, and I can see them going into a science based field as a career choice.
2	they want to leave for medical fields. Nurses and doctors or physician assistants. So, I do feel like once they decided and they enjoyed their science classes and they continue to move on, I feel like a lot of them are leaning towards medical fields.
5	I believe the number of girls participating is going to increase because of the different career paths available. I have had some students asking me what sciences they need in order to be a nurse. Some of them what to be engineers, some of them want to be chemists or work as lab techs.
6	have gone on to be exemplary in their pursuit of a medical career in STEM careers and they have come back and told me about how AP environmental science helped to intrigue them even to different areas than they were intending in science.
7	Quite a few go to the military and they actually score really well on the ASVAB so they get to choose their branch. Some want to be electrical engineers and because of robotics they've realized that they can.

- 8 We will begin to see more African American young girls, in high school taking these courses because they know what they want in their future to pursue careers that are heavily science integrated. For example, one of my former students just completed her pharmacy degree.<sup>9</sup>
- 10 I feel like they're going to be able to sustain and go on with whatever their career options are because they're being exposed to information that they need to be successful.

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Participant 1 stated, “I can see them going into medical fields, engineering fields. If they take an advanced placement like environmental science, and I can see them going into a science based field as a career choice” (p. 4). Participant 2 described potential career options for African American students enrolled in advanced science courses. “Nurses and doctors or physician assistants. So, I do feel like once they decided and they enjoyed their science classes and they continue to move on, I feel like a lot of them are leaning towards medical fields” (Participant 2, p. 5). Participant 5 discussed an increase in girls enrolling in advanced science courses due to various career choices. “I have had some students asking me what sciences they need in order to be a nurse. Some of them what to be engineers, some of them want to be chemists or work as lab techs” (Participant 5, p. 5). Participant 8 responded similar to Participant 5 by stating, “We will begin to see more African American young girls, in high school taking these courses because they know what they want in their future to pursue careers that are heavily science integrated. For example, one of my former students just completed her pharmacy degree” (p. 9). Participant 6 described students as “exemplary in their pursuit of a medical career in STEM careers and they have come back and told me about how AP environmental science helped to intrigue them even to different areas than they were intending in science” (p. 2). According to Participant 7, “Quite a few go to the military and they



actually score really well on the ASVAB so they get to choose their branch. Some want to be electrical engineers and because of robotics they've realized that they can” (p. 6). Participant 10 summarized by saying “I feel like they're going to be able to sustain and go on with whatever their career options are because they're being exposed to information that they need to be successful” (p. 8).

## Research Question 2

Race demographic data collected from participants were used to answer the following research question: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? Responses from African American teachers were compared to responses from Caucasian teachers to determine if teacher perceptions of African American girls varied depending on the race of the teacher. Based on the information collected, teacher perceptions of the participation and outcomes of African American girls did not vary based on the race of the teacher.

## Data Analysis

### Organization of Data Analysis

The six themes described in the findings section were analyzed to explain the answers to the two research questions: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses and, is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? After the researcher analyzed the data, the information was synthesized and organized into four big ideas: curriculum and instruction of advanced

science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses. The information was explained using narrative descriptions in the interpretation of the results section.

### Interpretation of Results

Response to research question 1. Based on the findings, the results were described and interpreted to determine trends and patterns in the data. The researcher analyzed the data and organized the findings into four big ideas in order to answer research question 1, what are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? The four big ideas were curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

*Curriculum and instruction of advanced science courses.* The curriculum used to teach advanced sciences was determined by both the state department of education and the local school district. Participants 2, 4, 7, and 8 explained that the Georgia Department of Education mandated the implementation of the Georgia Standards of Excellence while the local school district designed a curriculum used to teach the standards. Advanced placement teachers explained that the curriculum used to teach Advanced Placement courses was outlined by the College Board, which was a nationally used curriculum. Participants 8 and 10 both stated that the curriculum came from College Board while

Participant 10 further described the curriculum as being broken down into four big ideas and essential questions.

The 5E Model of instruction was commonly used as a pedagogical framework for instruction in advanced science courses. Participant 7 explained the 5E model as “*engage, explore, explain, elaborate, evaluate*” (p. 3). Additionally, Participant 8 discussed “*incorporating three dimensional classrooms*” (p. 5) when describing the pedagogy used to teach advanced science courses which encompassed disciplinary core ideas, cross cutting concepts, and science and engineering practices.

The instructional strategies used by the participants varied based on teacher choice and recommendations prescribed at each school. Participants 1, 5, 9, and 10 used hands-on activities, including project based learning and laboratory exercises, to engage students in advanced science courses. “The curriculum and pedagogy of the advanced courses tend to lead more to a hands-on lab based exploration than the lower level science courses but it doesn’t have to be that way” (Participant 1, p. 3). Participant 6 was a self-proclaimed “*constructivist teacher*” (p. 3) which was described as teaching through problem solving and critical thinking.

*Barriers for African American girls participating in advanced science courses.*

After the themes were analyzed, the researcher discovered that 8 out of 16 subthemes, including tracking, lack of recruitment, competition with MOWR, family values, exposure, lack of foundational skills in mathematics and science, gender stereotypes, and peer influences, were identified as barriers for African American girls participating in advanced science courses. The following section explained barriers preventing African American girls from participating in high school advanced sciences.

The majority of participants explained that tracking was a major reason why African American students participated in advanced science courses. Students were placed on academic tracks prior to entering high school which determined whether or not students would be exposed to advanced courses. Participant 6 explained that tracks were determined as early as elementary school and students remained on that track through high school.

African American girl participation in advanced science courses was also influenced by the availability of magnet programs. High schools that offered STEM related magnet programs offered advanced science courses to students including African American girls as a part of the course sequence. Participant 9 explained the application process that included an essay and formal interview as well as a minimum grade point average in mathematics and science to participate in the magnet program. The requirements associated with participating in magnet programs offered one explanation of the limited number of students participating in advanced science courses.

Academic tracking of students based on ability exposed some students, including African American girls, to advanced science courses. However, the practice of tracking limited access of advanced sciences to the general population of students that were not tracked as advanced, honors, gifted, or magnet program students. High School teachers in the approved district taught six classes, but the majority of the teachers only taught one or two advanced science courses. For example, Participants 2 and 3 both described teaching two advanced science courses. Participant 10 also explained “even right now the girls are actually underrepresented. I only have like two and the guys, there's only five kids taking it” (p. 1). Therefore, the majority of high school students in the district were not exposed

to advanced science courses.

One out of 10 participants (10%) described strategic recruitment as a means to get African American girls enrolled in advanced science courses. Participant 9 described the process of teachers going to middle schools to get solicit student participation for a magnet program with a heavy emphasis in advanced science and mathematics courses. Participant 9 described African American girls as “one of our targeted subgroups” (p. 3). The other participants described the lack of strategic recruitment of African American girls or explained personal strategies of motivating students already enrolled to remain in advanced sciences. Therefore, many African American girls were not informed about advanced science courses due to the lack of recruitment strategies.

Half of the participants discussed Move On When Ready and dual enrollment programs as a means to expose students to advanced sciences. According to Participant 8 “There are students that are taking science courses with Move On When Ready, or if they are at the college and career academy, they already have been exposed to advanced courses” (p. 9). Although the availability of Move On When Ready and dual enrollment courses actually increased the number of high school students taking college science courses, some teachers felt the Move On When Ready and dual enrollment programs actually decreased the number of students enrolled in high school advanced science courses. Participant 7 stated “a lot of them are doing Move On When Ready now, and I think that is starting to impact our magnet program in a negative way” (p. 4). Participant 10 explained the competition between Advanced Placement courses and Move On When Ready. “Why am I going to take AP biology when I don't know if I'm going to get three

or better on the test? I'm going to go to college for free and I know I'm going to get credit" (Participant 10, p. 7).

Five out of 10 participants described how the home environment of African American girls, including the educational and economical background of the parents, influenced student participation. The majority of the students in the school district came from low socioeconomic backgrounds. "They are coming from homes of lower social economic status" (Participant 8, p. 1). Participants 4 and 6 discussed the impact that family had on the success of African American girls and the lack of value placed on science. Participant 4 explained the lack of participation of African American girls in science and STEM activities. "Especially being in the south, I feel like it's more family oriented (p. 2) and went on to say, "Their primary focus is on things that have been embedded in them that have nothing to do with science nor technology" (p. 4). Participant 6 stated, "I think it stems from home environment. The value placed on STEM, placed on science" (p. 3). Participant 3 described "The lack of resources at home, maybe transportation or you know, not having parental support" (p. 2). In summary, teachers perceived that many African American girls were not participating in advanced sciences because science was not valued at home and parents did not support students in science and STEM related endeavors.

Participants 3, 5, 7, and 8 discussed the importance of exposing students to science. Participant 3 discussed African American girls lacking exposure to advanced sciences due to the lack of resources provided by public schools. Participant 8 summed up the idea of a lack of exposure to science by stating, "We're going to have to do

some things as stakeholders and as people who can make changes to make sure that they are exposed to science” (p. 9).

A strong background in mathematics and science was described by participants as an important skill in physical sciences, such as chemistry and physics, as well as Advanced Placement courses. Unfortunately, Participants 2, 6, 7, and 8 described deficits in mathematics rather than a strong foundation. In reference to chemistry, Participant 8 stated, “The young ladies were not as advanced when it actually came to the dimensional analysis, you know, the math portion of that particular course” (p. 2), and Participant 2 expressed, “Most of the disconnect is in math” (p. 3). Advanced Placement teachers also noticed the lack of foundational skills. According to Participant 6, “They don't have a good base in math, they don't have a good base in labs skills” (p. 3). Participant 10 also described the need to build the foundational knowledge of students before getting into the content required by the Advanced Placement curriculum. The lack of foundational skills required to be successful in advanced science courses resulted in students electing not to take the courses.

The lack of a strong foundation in mathematics lead to the next finding, which was gender stereotypes. Overall, participants perceived boys to be stronger in mathematics than girls. “The girls tend to be more of a historically what's been traditional, like thinking in terms of males having more proficiency in math” (Participant 6, p. 3). This idea asserted a common gender stereotype concerning boys being better math students than girls. The shared idea of male supremacy by teachers and students may have made African American girls apprehensive about participating in advanced sciences involving mathematics. Participant 7 stated, “if given the choice between

physics or going into like AP biology, environmental, something like that. Almost always they will choose the non-physics class” (p. 4).

Some participants observed African American girls discouraging other African American girls to participate in advanced science courses. According to Participant 7, “I tend to see them encouraging others to kind of take the less difficult road” (p. 5), and Participant 10 stated, “No, they say it’s too hard” (p. 7). The discouragement of African American girls by other African American girls was another reason that African American girls did not participate in advanced sciences.

*Motivations for African American girls participating in advanced science courses.*

Another reason that students decided to participate in advanced science courses included college and career aspirations. Advanced science teachers perceived that African American girls participated in advanced science courses because of aspirations to work in a STEM or medical field. Participants 1, 3, and 9 specifically described the desires of students enrolled in advanced science to pursue degrees and careers in medicine while Participants 2, 5, 7, and 8 discussed the importance of advanced sciences in helping students to pursue desired degree or career interests related to STEM.

Another factor that determined participation was student work ethic. The work ethic of African American girls participating in advanced science courses was dependent on student drive as well as the self-efficacy of the students. Participant 9 stated, “they have that little bit of extra drive” (p. 2). According to Participant 6, “Their work ethic is better, their personal constitution for studying beyond what’s asked was great. So, with students with that kind of mindset, they’ll own that” (p. 5). Participant 5 expressed the idea that double marginalization of African American girls increased student drive to be



successful. “I think that they actually work harder than most. Dealing with politics and stuff like that, it's harder for a female plus being African American makes it even harder” (Participant 5, p. 2). Participant 7 also noted the double marginalization of African American girls by stating, “they are a minority of a minority female and I feel like once they realize they are such a high demand, if they can just get that realization, all of a sudden their confidence will just blossom.” (Participant 7, p. 5).

Some participants acknowledged the importance of recognizing the culture of students while engaging African American girls in advanced science courses. Culturally relevant teaching was a means of accommodating the diverse needs of students. Participant 4 discussed the importance of educating African American girls on the contributions that African American women have made in the areas of mathematics and science. According to Participant 4, “The closest advertisement of African American women being in STEM lately was the movie *Hidden Figures* recognizing the black women that worked at NASA” (p. 3). Furthermore, “Teachers who know about African American women contributions to science understand it won't be taught unless teacher are willing to tell it, to talk about it in class, you know, like *Henrietta Lacks*” (Participant 4, p. 3). Participants 4 and 8 both discussed the importance of African American girl role models, and Participant 5 discussed the importance supporting African American girls with needs unrelated to the content. Teachers who utilized culturally responsive teaching strategies were better equipped to respond the needs of African American girls enrolled in advanced science courses.

*Expected outcomes of African American girls participating in advanced science courses.* In summary, participants perceived that African American girls participating in

advanced science courses would major in a STEM field in college and eventually pursuing STEM or medical related occupations. Participant 3 stated, “I see them pretty much leading preferably in our science majors and science careers and then also coming back to help out others” (p. 5), and Participant 4 added, “Hopefully, those students who didn't pursue STEM in the beginning, may be willing to go and pursue it in college” (p. 5). According to Participant 9, “they have a good understanding of what they want to do career-wise, they know that they want to be a doctor. So, they've made that their goal and they know this course is just one of their steps they have to take” (p. 2).

Participants also expressed the role teachers played in preparing students to be successful in college. Participant 5 explained, “I try to reach the college level so that they are actually prepared” (p. 3). Participant 10 support students by “providing them with the resources they need to make them more prepared and ready to perform well on these various tests” (p. 3). According to Participant 4, “I tried to influence them to go beyond. I've tried to both get them to focus on future college utilizing engineering and science” (p. 4). Participant 9 ensured the curriculum mimicked the curriculum students were exposed to in college. “I've contacted universities and tried to make our curriculum rather than it be like a normal high school human anatomy course to try to give them some of the components they would see in a college level anatomy course” (Participant 9, p. 3). Therefore, the actions of the teachers were intentional to prepare students for college and science related careers.

Participants overall were unable to provide data to support the outcomes of African American girls who formally participated in advanced science courses. However, some participants shared examples of former students coming back and sharing

information on successes with both teachers and current students. According to Participant 8, “There are a couple of students, there's one that is at Spelman now and she's graduating with her bachelor's degree and she'll be going into the medical college I think it is Meharry” (p. 10). Participant 1 stated, “I've actually had students that come back after completing a science pathway, come back and actually talk to, you know, upcoming freshmen or upcoming sophomores and to try to get them to take certain classes” (p. 4).

In conclusion, teachers perceived students participating in advanced science courses to have the ability to be successful in science education and careers with proper supports. Participant 10 explained,

With these young ladies going into that direction, they've got to have a strong exposure base. So, I think that will deal with the powers that be making sure that we truly care about these students, and that everything we do is for them. That we make sure that we have the right individuals that are in the trenches with them. And I know it's hard to do, you know. I think that we truly focus on this subgroup everywhere I go. Anything dealing with STEM, we're always talking about the African American female because they are not so heavily represented in that field. We're going to have to do somethings as stakeholders and as people who can make changes to make sure that they are exposed to science. (p. 9)

Response to research question 2. The researcher did not collect enough information from participants to determine if there was a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses. The participants did not respond to the illicit

questions with sufficient comments to answer research question 2. Furthermore, the researcher did not push participants to provide answers. The researcher did find that African American participants appeared to be more conscious of the importance of culturally relevant teaching and exposing students to examples of positive African American women in STEM fields. “If African American girls see their peers and role models making contributions, then they will be more willing to do it. They also must be encouraged to think they are smart enough to make a difference in STEM” (Participant 4, p. 5). Participant 5 described the importance of “exposing them to different women in the community who were in the STEM field who are African American. They look like you that come from the same background you come from” (Participant 8, p. 7).

There was a contrast in some views of African American teachers compared to Caucasian teachers. For example, one Caucasian participant described family impact on the preparation and readiness of students as something that impacted all students, not just African American girls. This perspective modeled a colorblind ideology. On the other hand, an African American participant expressed that poverty in public schools affected African American students more because Caucasian students were more likely to attend private schools with more funding. That participant had more of a critical ideology of race. These examples show that there may be a difference in thinking when comparing and contrasting African American teachers. However, this information does not definitively prove that race places a role in expectations of student performances and outcomes. Teachers of all races had high expectations for student success in advanced sciences.

## Summary

The findings and an interpretation of the results were presented in Chapter IV. The results were linked to each research question to offer insight into the participation and outcomes of African American girls participating in high school advanced science courses. A qualitative descriptive study was conducted with 10 participants who had at least two years of experience teaching high school advanced science courses to African American girls. A semi-structured interview protocol was developed to guide the interview process and answer the research questions. The researcher conducted face-to-face interviews with participants and documented the findings and interpreted the results.

Summary tables followed by a narrative were consistently used to summarize the information collected for each participant. Thematic analysis was used to organize the findings into themes for each research question. The following themes were presented for research question 1: reasons for participation, factors impacting participation, factors impacting readiness, curriculum design, pedagogical approaches, and student outcomes. The researcher did not find a relationship between teacher race and teacher perceptions to answer research question 2, and, therefore, no themes emerged.

Finally, the researcher synthesized and organized the findings into four big ideas to explain the participation and outcomes of African American girls participating in advanced science courses. The four big ideas included the following: curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating

in advanced science courses. The researcher presented the trends and patterns in the data in a narrative form.

## CHAPTER V

### DISCUSSION

#### Summary of the Study

African American girls were underrepresented in STEM education and careers in the United States (Archer et al., 2015; Charleston, Adserias, et al., 2014; O'Brien et al., 2015; Pinder & Blackwell, 2013). Increased diversity in the STEM work force improved the economy and allowed the United States to compete internationally (Charleston, Adserias, et al., 2014; Stipanovic & Woo, 2017). Science was found to be an important foundational skill necessary to succeed in STEM related fields (Archer et al., 2015; Young, Feille, et al., 2017). The science disposition of African American girls influenced future participation in STEM (Young, Ero-Tolliver, et al., 2017; Young, Feille, et al., 2017). In a study conducted by Archer et al. (2015), African American girls were found to have less aspirations to pursue science. As a result, the researcher conducted a historical review of social injustices towards African American girls in education based on gender and race and also explored the curriculum and pedagogy used to teach science to African American girls.

Discrimination against African American women in education dated back to the early 17th century during the time of slavery. African Americans were considered property and prohibited from being educated (Levine & Levine, 2014; Mazama & Lundy, 2013). Although the Emancipation Proclamation decreed the freedom of slaves in 1863 (Aiken et al., 2013; Rogers, 2013), African Americans realized the difference between freedom and equality particularly in education (Kerrison, 2015; Levine & Levine, 2014;

Mazama & Lundy, 2013). The Plessy versus Ferguson court case of 1896 legalized racial segregation by determining “separate but equal” was constitutional. The Brown versus Board of Education of Topeka decision of 1954, overturned the Plessy versus Ferguson court decision and ended segregation in public schools (Aiken et al., 2013; Levine & Levine, 2014). In addition to racial discrimination, African American women faced gender discrimination. The women’s movement first began in England and made its way to the United States in response to men dominance and women oppression (Parpart et al., 2000; Reid, 2013). However, some women’s rights groups did not advocate for African American women, and therefore the National Association of Colored Women was established in 1896 (Aiken et al., 2013). In the 21st century, campaigns, such as #BlackGirlMagic, existed to celebrate African American women in spite of the double marginalization they received (Joseph et al., 2017). Historical discrimination and racial and gender stereotypes affected the science identity and self-efficacy of African American girls participating in science courses (Archer et al., 2015; Young, Ero-Tolliver, et al., 2017).

Curriculum was generally designed to be race neutral and emphasized colorblindness rather than multiculturalism (Aragón et al., 2017; Rector-Aranda, 2016). Science, in particular, was perceived to be a colorblind course, but racism and sexism contributed to the participation of African American girls in science (Codrington, 2014; Joseph et al., 2017). According to Farinde and Lewis (2012), culturally responsive science teaching practices increased the number of African American girls pursuing STEM fields by teaching African American girls to disregard societal stereotypes of inferiority based on gender and race (Codrington, 2014; Farinde & Lewis, 2012). The



Framework for K-12 Science Education Next Generation Science Standards were designed to address inquiry and equity for diverse students in science education (Asowayan et al., 2017; Ghattas & Carver, 2017). The 5E model of instruction derived from constructivism aided in student understanding of science in a multicultural environment (Ghattas & Carver, 2017; Rodriguez et al., 2019). In addition to culturally responsive teaching practices, researchers suggested student-centered instructional practices, such as hands-on laboratory exercises and enrichment programs, to promote science education (Alexander & Hermann, 2016; Baker, 2013).

The current study concentrated on the gap in the literature exploring the experiences of African American girls in high school advanced science courses. The purpose of the current study was to explore teacher perceptions of the participation and outcomes of African American girls participating in advanced science courses. Black Feminism Thought and Critical Race Theory were used as a lens to study literature and answer research questions related to the participation and outcomes of advanced science courses. The researcher designed a study to answer the following research question: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses. Furthermore, in an effort to determine whether or not a relationship existed between the race of advanced science teachers and the participation and outcomes of African American girls, the researcher posed the following research question: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

The researcher conducted a qualitative descriptive study, and the instrumentation included a semi-structured interview. The researcher obtained permission to conduct the study from the superintendent and the high school principals. Next, the researcher contacted 16 high school advanced science teachers with at least two years of experience teaching advanced science courses in the approved school district through email and solicited participation in semi-structured interviews, which was a 63% response rate. Ten advanced science teachers provided informed consent to serve as participants in the study. Interviews were scheduled and recorded on an electronic device. Temi was used to translate the interviews and the transcriptions were uploaded into NVIVO 12 Pro. The data were presented, analyzed, and organized in Chapter IV.

#### Analysis of Research Findings

Summary tables and narrative descriptions were used to summarize the findings. Thematic analysis was used to organize the findings related to research question 1: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses? The following themes emerged: reasons for participation, factors impacting participation, factors impacting readiness, curriculum design, pedagogical approaches, and student outcomes. The reasons that African American girls participated in advanced science courses were tracking as well as college and career readiness. Factors impacting the participation of African American girls in advanced science courses included recruitment strategies, peer influences, gender stereotypes, and Move on When Ready and dual enrollment programs. The curriculum of advanced sciences was designed by state agencies and refined by the local school district. The pedagogy used to teach advanced sciences varied by teacher.

Some common practices shared by some participants included culturally relevant teaching practices and the 5E model of instruction. In addition to pedagogy selections being culturally biased, pedagogy choices were also regionally biased. Finally, the participants communicated student outcomes to be college and careers related to STEM or medicine.

Then, the researcher analyzed and synthesized the findings and organized the information into big ideas. The researcher reported the big ideas in a narrative form. The following big ideas emerged: curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

The approved school district implemented a curriculum created by the Georgia Department of Education, which was guided by the Georgia Standards of Excellence. The curriculum was further refined by the local school district leaders to meet the needs of the teachers and students in the district. Advanced Placement teachers used a national curriculum designed by The College Board. The 5E model of instruction was commonly communicated as the framework used to guide instruction by emphasizing a series of phases, which helped students master the content. The five phases of the 5E model included engagement, exploration, explanation, elaboration, evaluation. Individual teachers decided which pedagogical approaches were the best fit for advanced science students. Some of the instructional strategies that participants used included hands-on activities, such as laboratory exercises and project-based learning.

The researcher found several barriers affecting the participation of African Americans in advanced science courses. Academic tracking was reported as a major reason why African American girls participated in advanced science courses. Unfortunately, very few students were placed in advanced science courses, so access to exposure to advanced sciences were limited. Participants reported a lack of strategic recruitment strategies at the various schools. Participants that taught Advanced Placement courses explained how the opportunity to enroll in the Move on When Ready and dual Enrollment programs decreased the number of students opting to participate in Advanced Placement courses. Participants also discussed how family values, which was impacted by the socioeconomic status and education of parents, influenced the expectations of students to participate in advanced sciences. African American girls also lacked exposure to advanced sciences due to the lack of resources invested and the lack of emphasis placed on advanced sciences and STEM related fields. Participants perceived that many African American girls lacked the foundational skills in mathematics and science, which were instrumental to teaching advanced sciences. Some participants also affirmed a common gender stereotype of boys being stronger mathematics students than girls, which ultimately affected the science disposition of girls in physical sciences. Moreover, participants saw African American girls discourage other African American girls from participating in advanced science courses.

On the other hand, the researcher found factors that motivated African American girls to participate in advanced science courses. Participants perceived that African American girls were motivated to participate in advanced science courses due to personal aspirations to pursue degrees and careers in a STEM or medical field. Therefore, African

American girls who were eager to achieve personal goals exhibited a work ethic characterized by drive and self-efficacy. Finally, some participants motivated African American girls in advanced science courses by implementing culturally relevant teaching practices.

Participants expected African American girls to major in a STEM field in college and pursue a STEM or medical related occupation. Some participants prepared students for college by mimicking college instructional practices. Overall, participants predicted that African American girls would have positive outcomes when properly supported and motivated.

The researcher compared race data of the research participants to answer research question 2: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses? The researcher was unable to determine a significant relationship between the race of teachers and the perceived participation and outcomes of African American girls in advanced sciences. The researcher did not ask questions directly related to perceptions based on race because the researcher felt the participant answers would not be honest. According to the interview responses collected, the researcher found that all participants had high expectations for student success.

The researcher did find some variations in the mindsets of teachers based on race and appropriate instructional strategies. For example, African American teachers were more likely to implement culturally responsible teaching practices. The researcher also compared the critical race ideologies communicated by African American participants and colorblind ideologies communicated by Caucasian participants. African American

women teachers appeared to be conscious of a personal responsibility to assist African American girls in being successful in advanced sciences. The appeared consciousness of African American teachers did not imply that Caucasian teachers had lower expectations for the participation and outcomes of African American girls. In fact, all participants expressed high expectations for African American girls participating in advanced sciences.

### Discussion of Research Findings

African American girls were a double marginalized group of people due to sex and race. Race and gender were often discussed separately, but limited data explored the intersectionality of race and gender on the performance of African American girls in science (Charleston, Adserias, et al., 2014; Ricks, 2014). The researcher used semi-structured interviews to gain insight into how advanced science teachers perceived the participation and outcomes of African American girls participating in advanced science courses. In addition to analyzing teacher perceptions of the participation and outcomes of African American girls, the research considered how the data connected to the conceptual frameworks used to frame the study. Critical Race Theory and Black Feminism Thought were used in an integrated approach to explore the unique experiences of African American girls enrolled in advanced science courses (Alexander & Hermann, 2016; Charleston, George, et al., 2014; Delgado & Stefancic, 2012; Ricks, 2014).

According to the Critical Race Theory, race was a social issue that negatively affected education (Collins, 2018; Smith-Maddox & Solórzano, 2002). Critical race theorists rejected oppression and encouraged liberation regarding race, gender, and class (Solórzano & Yosso, 2002). Participants in the study similarly described the impact that

race, gender, and socioeconomic status played in the access of African American girls to an advanced science in high school, which ultimately impacted participation and outcomes. The researcher compared the Critical Race Theory to earlier critical theories of Paulo Freire. Freire also advocated for pedagogy that liberated oppressed people (Beckett, 2013; Freire, 1970; Gottesman, 2010). However, critics of Freirean pedagogy argued that Paulo's theory did not adequately address both gender and race (Beckett, 2013; Lac, 2017). In addition to Critical Race Theory, the researcher also used Black Feminist Thought as an instructional framework because Black Feminist Thought addressed issues specific to African American women and girls related to race, gender, and class while promoting social justice (Charleston, George, et al., 2014; Collins, 2000; Love 2016).

The raw data were coded and the findings were organized into themes and subthemes. Next, the researcher analyzed the findings and organized the information into four big ideas. The big ideas that emerged were curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

Research Question 1: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?

Curriculum and instruction of advanced science courses. Participants explained that the curriculum for most advanced sciences were determined by the state department

of education and the school district leaders and required the use of specific standards to guide instruction. The exceptions were Advanced Placement courses, which were governed by the nationally recognized organization College Board. Researchers found that race influenced curriculum design by pushing politically correct content and a colorblind ideology of thinking (Aragón et al., 2017; Pinder & Blackwell, 2014; Rector-Aranda, 2016). According to Codrington (2014) and Joseph et al. (2017), science was particularly viewed as an objective subject matter, which caused teachers to approach science education through a colorblind lens. Participant 4 eluded to a colorblind science curriculum when explaining the responsibility of teachers that are aware of positive influences of African American women in STEM to share knowledge with students, which otherwise would not be taught in school. Participant 4 shared examples of influential African American women, which included the women in the movie, *Hidden Figures*, and Henrietta Lacks. This ideology served as an endorsement of multiculturalism in science education curriculum and culturally responsive teaching. Culturally inclusive curriculum practices helped to shift the stereotypical narrative about African American girls and promote unity among all students (Aragón et al., 2017; Pinder & Blackwell, 2014).

Participant 6 was a self-described constructivist teacher, which was developed by Vygotsky in 1978. Social constructivism helped to explain science in a diverse learning environment (Ghattas & Carver, 2017). Forty percent of participants discussed the use of the 5E Model as the instructional framework used to teach advanced sciences. The 5E model also derived from the concept of constructivism (Pangestika & Prasetyo, 2018). Participants 1, 5, and 10 used hands-on activities to engage advanced science students.



The use of hands-on activities was consistent with studies conducted by Alexander and Hermann (2016) and Baker (2013).

Participant 8 stated that the resources provided by the Georgia Department of Education were effective, but not sufficient enough to support teachers in the participating district. Participant 8 went on to discuss the importance of filling teacher positions with highly qualified teachers in advanced science courses and supporting teachers who were not highly qualified through teaching the content. This perspective was consistent with Stipanovic and Woo (2017) who found that students from low socioeconomic backgrounds had fewer highly qualified teachers.

Barriers for African American girls participating in advanced science courses. The following section explained barriers preventing African American girls from participating in high school advanced sciences. Fifty percent of the findings that emerged were related to barriers hindering the participation of African American girls in advanced science courses. The following themes and subthemes were determined to serve as barriers: tracking, lack of recruitment strategies, competition with Move On When Ready and dual enrollment programs, family values, exposure, lack of foundational skills in mathematics and science, gender stereotypes, and peer influences.

Seventy percent of participants agreed that tracking was a primary reason that African American girls enrolled in advanced science courses. Academic tracks were preconceived notions of student ability to be successful in certain courses. Participants also described having a limited number of students participating in advanced science courses compared to the overall number of students being taught. The limited number of students participating in advanced sciences was consistent with Miller (2018) who argued

that academic tracking confined most African American students to vocational and lower academic tracks, which limited advanced academic opportunities. Once African American students were labeled as low achievers, the tracked students were unable to take rigorous science and mathematics courses (Farinde & Lewis, 2012; Miller, 2018). Similarly, while African American girls were underrepresented in advanced science courses and enrichment programs (Adams et al., 2014; Archer et al., 2015; Young, Feille, et al., 2017), African Americans generally were overrepresented in special education programs (Ghattas & Carver, 2017).

The lack of strategic recruiting practices also served as a barrier for African American girls participating in advanced science courses. Participants either were unclear on recruitment strategies being used or admitted to the absence of recruitment strategies. Young, Ero-Tolliver, et al. (2017) discussed the importance of concerted efforts being made to recruit African American girls to participate in advanced sciences because of the potential African Americans have to occupy STEM occupations. The researcher did not find specific recruitment and retention strategies in the literature to increase the number of African American girls participating in advanced science courses.

Dual enrollment courses provided students with the opportunity to be exposed to college level science courses in high school. Stipanovic and Woo (2017) found limited opportunities to participate in dual enrollment programs for students from low socioeconomic students. According to Participant 8, the majority of the students in the school district under study came from low socioeconomic homes, which would indicate limited participation. Furthermore, participants who taught Advanced Placement courses argued that Move On When Ready and dual enrollment programs decreased the number

of students taking Advanced Placement courses in high school. Participant 10 explained that students were guaranteed college credit for passing a dual enrollment course. On the contrary, students in Advanced Placement courses were required to score a qualifying score on an exit exam to receive credit.

Pinder and Blackwell (2014) explained that STEM participation among African American girls and women was impacted by social, familial, financial, and motivational considerations. Participants in the current study described the impact of family values on the participation of African American girls in advanced science courses. Family values often derived from the education, occupation, and socioeconomic status of the parents. Participants 3, 4, 6, and 8 described the lack of parental support to motivate and engage students in science at school as well as home. According to Stipanovic and Woo (2017), parental involvement influenced STEM participation of African American girls. Contrarily, studies conducted by Archer et al. (2015) and Young, Feille, et al. (2017) did not confirm that the absence of parental support affected STEM participation. Participant 1 explained the relationship between home environment and student readiness, as well as how parental education affected enrollment in advanced science courses. Participant 6 explained that the value placed on STEM and science started at home.

In addition to family values, Pinder and Blackwell (2014) stated that social interactions influenced STEM participation. Social interactions included regular interactions with peers and teachers at school that helped to develop the science identity of African American girls (Pinder & Blackwell, 2014). Approximately 22% of participants agreed that African American girls positively influenced each other while the remaining 77% of participants disagreed. The majority of participants did not observe

African American girls encouraging other African American girls in science courses. Participants 7 and 10 explained that African American girls typically discouraged peers to take advanced sciences because of the difficulty of the subjects. In a study conducted by Archer et al. (2015), students perceived science to be a difficult subject that was most suitable for intelligent students. Students in the study also measured intelligence by class, gender, and race. Furthermore, Stereotypes of what a scientist should be along with social and historical factors discouraged African American students from thinking science was for African American students (Archer et al., 2015). Similarly, Participant 4 expressed that African American girls needed to be encouraged to believe that African American girls could be successful STEM learners.

The National Women's Law Center (2014) determined that the lack of exposure to STEM courses along with gender and racial stereotypes were reasons that African American girls and women did not participate in STEM related fields. Participant 3 discussed the lack of resources provided by the public school system to engage African American girls in advanced sciences when compared to private schools. The lack of resources was consistent with Stipanovic and Woo (2017) and Young, Feille, et al. (2017) who determined that the lack of academic resources overwhelmingly affected African American students due to race and socioeconomic status.

Participant 7 discussed the career readiness of African American girls, which also related to the lack of exposure to various career options. Participant 7 stated that students were unaware of the various job options associated with science education outside of traditional occupations. Similarly, Archer et al. (2015) reported that African American

students had limited knowledge of science careers other than science teachers, medical doctors, and research scientists.

Participant 8 also stressed the importance of educational leaders supporting the exposure of African American girls in science and STEM. Codrington (2014) explained that culturally responsive teaching practices were not nationally mandated; however, it was the responsibility of teachers and administrators to implement culturally responsive teaching practices on the local level. Participant 4 discussed the importance of teachers teaching students about the contributions African American woman in STEM because representation was not written into the curriculum.

Participants discussed the importance of having a strong foundation in both mathematics and science. Science was an important foundational skill for STEM careers (Archer et al., 2015; Young, Feille, et al., 2017). The researcher did not present literature related to the importance of mathematics as a foundational skill because the scope of the research was limited to science. However, the physical science, chemistry, and physics teachers communicated that mathematics was embedded into the science curricula. Participants 2, 4, and 8 discussed African American girls struggling with the mathematics portion of Chemistry. Participant 8, particularly, described the struggle African Americans faced in the dimensional analysis unit. Researchers found that African American girls were less represented in physical sciences compared to life sciences (Archer et al. 2015; Young, Feille, et al., 2017). A study conducted by Young, Feille, et al. (2017) found that African American girls achieved the highest in life science, followed by physical science, and then earth science on the National Assessment of Educational Progress. Participant 7 also reported that when given an option, African

American girls preferred to participate in life sciences, such as Advanced Placement biology or environmental science, rather than physics.

The discussion of the lack of foundational skills in mathematics raised awareness of gender stereotypes. Some participants asserted the common gender stereotype that boys were stronger mathematics students than girls Baker (2013) explained that girls were discouraged from taking masculine courses, such as chemistry, and Bernard and Dudek (2017) found that students perceived scientists to be Caucasian men. Baker (2013) found that student-centered instructional strategies help to narrow the achievement gap between girls and boys enrolled in high school physical sciences. Participant 3 stated that girls connected more emotionally in comparison to boys. Baker (2013) also suggested a curriculum that appealed to the emotional nature of girls. According to Rector-Aranda (2016), the educational system could either maintain stereotypes or challenge stereotypes as a social injustice. Maria Stewart, a pioneer of the Black feminism movement, encouraged African American women to dismiss socially constructed stereotypes and construct a positive sense of identity, which was strongly encouraged by Black Feminist Thought theorists (Collins, 2000).

Motivations for African American girls participating in advanced science courses. The researcher determined that many students were motivated to participate in advanced sciences based on college and career aspirations. Participants perceived African American girls in advanced science courses to be primarily interested in medicine and STEM related fields. Similarly, Szelényi et al. (2013) explained that participating in STEM related high school courses determined STEM career outcomes. Participants also perceived African American girls who were successful in advanced science courses were

driven and possessed a high degree of self-efficacy. According to Ghattas and Carver (2017) and Young, Ero-Tolliver, et al. (2017), African American girls with a positive science disposition, which was defined by having an interest, identity, utility, and self-efficacy for science, were more likely to participate in advanced science courses in high school. Studies conducted by Young, Feille, et al. (2017) and Archer et al. (2015) also highlighted the importance of self-efficacy and a positive science disposition. Many of the recruitment strategies identified by participants were not specific strategies of recruitment, but motivational strategies used to encourage and retain students participating in advanced science programs. Some examples included participants giving motivational speeches to encourage student participation, engaging students in career exploration, and providing positive role models to encourage African American girls enrolled in advanced science courses. Finally, some participants motivated African American girls by exposing students to other African American girls and women that made a difference in science, STEM, or medicine. This exposure included former students pursuing degrees, industry professionals, and teacher mentors. Exposing African American girls to other African American girls and women who served as role models was a culturally responsive teaching practice used to meet the specific needs of African American girls. This practice was consistent with Critical Race Theory and Black Feminist Thought.

Expected outcomes of African American girls participating in advanced science courses. Participants thought that African American girls participating in advanced science courses would be prepared to pursue a degree and/or occupation in STEM or medical fields. This finding was similar to studies conducted by Young, Ero-Tolliver, et

al. (2017) and Young, Feille, et al. (2017) who explained that African Americans had the ability to be successful in science as well as STEM when proper supports were provided.

Research Question 2: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

The researcher did not identify a relationship between race and teacher perceptions of African American girls participating in advanced science courses. This finding went against the Critical Race Theory, which centered race and racism in all aspects of research. This finding was also contrary to a study conducted by Joseph et al. (2017) who found that Caucasian teachers who were unaccustomed to African American culture, held negative stereotypical perceptions of African American students. The researcher did not ask participants if the race of the teacher would affect perceptions because the researcher anticipated the responses would be untrustworthy. However, the researcher found that some African American women participants could personally relate to the experiences of African American girls in advanced sciences and therefore were conscious of the role teachers played in ensuring the success of African American girls in advanced science courses. Similarly, African American women teachers appeared more likely to implement culturally responsive practices to promote science education, which was recommended by Codrington (2014). On the other hand, Caucasian participants were not able to personally identify with the experiences of African American girls and communicated a desire to help all students to be successful. Although Caucasian participants could not personally identify with the experiences of African American girls, this finding did not mean that race played a role in how teachers felt about the



participation and outcomes of African American students enrolled in advanced science courses. Every participant communicated high expectations of African American girls participating in advanced sciences to be successful.

### Conclusions

Research Question 1: What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?

- The researcher identified several barriers that affected the participation of African American girls in advanced science courses. Some barriers were created by teachers.
- Students perceived barriers that affected the participation of African American girls in advanced science courses.
- Teachers did not do anything to reduce barriers.

Research Question 2: Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

- There was no relationship between the race of teachers and teacher perceptions regarding the participations of African American girls in advanced courses. The researcher assumed that asking participants directly if race affected how teachers felt about the participation and outcomes of African American students would have resulted in an issue of trustworthiness. African American teachers acknowledged the experiences of African American girls and shared personal stories, which appeared to be absent when interviewing Caucasian teachers. All

participants expressed similar expectations of African American girls participating in advanced science courses, which generally included college and careers in STEM and medical fields.

### Implications

The researcher added to the field of curriculum studies by studying teacher perceptions related to the participation and outcomes of African American girls in high school advanced science courses. High school advanced science teachers were selected as participants to describe the experiences of African American girls because of the frequent interactions that advanced science teachers had with African American girls enrolled in advanced science courses. Although studies existed related to the participation of African American girls in science, the researcher was unable to find a previous study that focused specifically on the perceptions of high school science teachers. According to Szelényi et al. (2013), a relationship existed between girls taking STEM related high school courses and student outcomes in STEM related careers. Similarly, the science disposition, which included the science identify, utility, self-efficacy, and interest of African American girls, also influenced future STEM participation (Young, Ero-Tolliver, et al., 2017; Young, Feille, et al., 2017). The current study filled a gap in the research regarding advanced science teacher perspectives on African American girls and was supported by several researchers in the literature review.

The study had important implications for science teachers. Although science curriculum was perceived to be objective, discriminatory practices regarding race and gender influenced the success of African American girls (Codrington, 2014; Joseph et al., 2017). Teachers described the curriculum and pedagogy used to teach advanced science

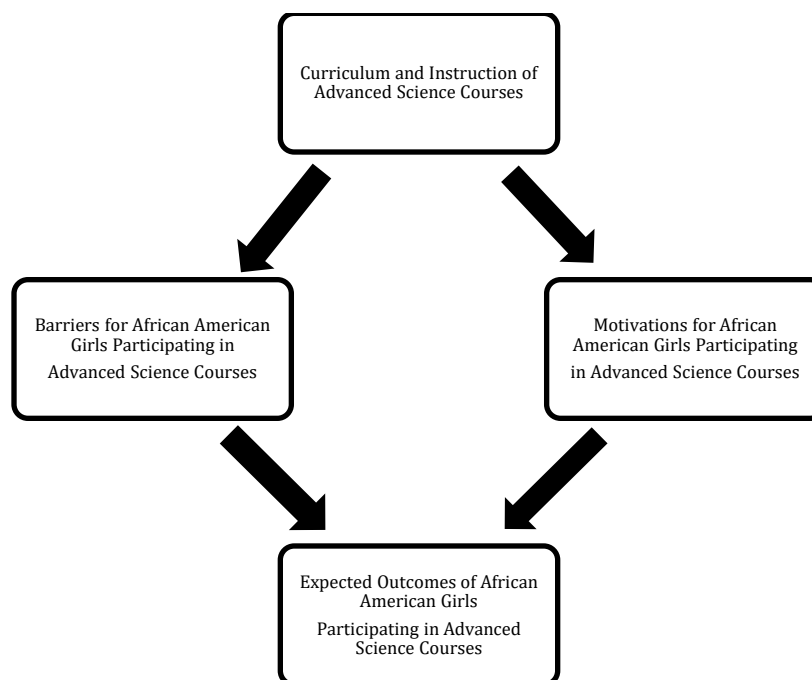
courses and explained perceptions about the participation and outcomes of African American girls. The researcher was able to identify barriers and motivating factors that affected the participation and outcomes of African American girls in advanced science courses. Based on all of the barriers hindering the progress of African American girls in relation to advanced sciences, the researcher suggested addressing the barriers to increase student participation in high school advanced sciences. Science teachers were able to use the information to inform instructional practices and supports best suited to increase the number of African American girls participating in advanced science courses, which subsequently increased the number of African American girls pursuing STEM or medical related college degrees and careers. This change began with a conscious effort to implement culturally responsive teaching practices, to increase scientific competency and mathematics skills imbedded in science, and to be aware of implicit gender and racial stereotypes that blocked the participation in advanced sciences. An emphasis on advanced sciences as well as integrating 21st century skills in the classroom prepared students for STEM careers. Science instruction that emphasized research-based and evidence-based practices also improved collaboration, creativity, critical thinking, science literacy, and digital literacy. All of the aforementioned skills were 21st century skills necessary for STEM jobs of the future. Administrators and educational stakeholders were able to use the information presented in the study to influence curriculum and educational policies in an effort to address the needs of diverse students, including African American girls. The researcher suggested removing barriers that blocked participation by mandating multiculturalism in the curriculum, increasing systematic recruiting efforts, offering opportunities for all students to be exposed to engaging

science activities, and reforming tracking practices. Additionally, parents were able to use this study to understand the importance of continued education outside of the classroom, and the role of families in influencing the scientific disposition of African American girls. The researcher suggested engaging students in science at home, summer programs, and enrichment activities as well as celebrating students for participating in rigorous sciences.

In the United States, STEM occupations were growing exponentially; however, there were not enough qualified people to fill the positions (Alexander & Hermann, 2016; Stipanovic & Woo, 2017; Vilorio, 2014). STEM fields lacked diversity and African American girls were particularly underrepresented in mathematics, engineering, and physical sciences (Archer et al., 2015; CEOSE, 2016; Young, Feille, et al., 2017). The researcher chose to focus on advanced science education because scientific competency and dispositions impacted STEM careers (Archer et al., 2015; Young, Feille, et al., 2017). Therefore, this study was also useful to employers interested in increasing diversity in occupations requiring exposure to information and skills taught in advanced science courses.

### Research Framework

Poole's Conceptual Framework (see Figure 1) depicted a relationship between advanced science courses, science teachers, and African American girls. Once the study was concluded, the researcher observed a relationship between the curriculum and instruction used to teach advanced science courses and motivations and barriers associated with the participation in advanced science courses, which influenced perceived outcomes. The conceptual framework was revised to reflect the relationship revealed to the researcher at the conclusion of the study (see Figure 7).



*Figure 7. Research Framework*

The six original themes that emerged from the findings included the following: reasons for participation, factors impacting participation, factors impacting readiness, curriculum design, pedagogical approaches, and student outcomes. The themes and subthemes were further analyzed and organized into four big ideas that included the following: curriculum and instruction of advanced science courses, barriers for African American girls participating in advanced science courses, motivations for African American girls participating in advanced science courses, and expected outcomes of African American girls participating in advanced science courses.

Barriers included tracking, lack of recruitment strategies, competition with Move On When Ready and dual enrollment programs, family values, exposure, lack of foundational skills in mathematics and science, gender stereotypes, and peer influences. On the other hand, motivations included college and career readiness, student work ethics, and culturally relevant teaching practices. Finally, the curriculum and instructional

practices in conjunction with student barriers and motivations influenced student outcomes. Advanced science teachers generally perceived participants in advanced science courses to have a desire to pursue advanced education and careers in STEM or medical related fields.

### Limitations

As stated in Chapter I, the researcher perceived potential limitations to be the use of teachers as participants instead of students, the focus on science as a foundational skill for STEM careers, and transferability. Teachers were able to offer a unique perception regarding the preparation and outcomes of African American girls participating in advanced science courses. However, the researcher did not continue to ask probing questions to get responses related to the relationship between the race of teachers and teacher perceptions. Therefore, the researcher was not able to collect much information to establish a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses.

The researcher was also concerned about focusing on science as a foundational skill to STEM participation while disregarding the integrated nature of science, technology, engineering, and mathematics. According to Archer et al. (2015) and Young, Feille, et al. (2017), science was considered to be an important foundational skill for STEM participation. The researcher also found out in the process of data collection that mathematics skills were embedded in science curriculum, which was an example of STEM. Therefore, an emphasis on science was no longer a limitation. A close examination of science was needed to gain an understanding of skills needed in STEM fields.

The researcher perceived an issue with generalizing the results. The research was limited to one school district in Georgia and the population was small. Criterion sampling, a type of purposeful sampling, was used to identify the 16 potential participants with experience teaching advanced sciences to African American girls. According to Miles and Huberman (1994), 8 to 14 participants were needed to conduct interviews in qualitative research. The researcher was able to recruit 10 participants, which represented a 63% response rate of eligible participants. The participants were limited to seven African American women teachers and three Caucasian women teachers. Although the study can be transferred to a different setting, the results would vary based on the demographic information of the participants and students.

The researcher designed a semi-structured interview protocol to answer questions related to the participation and outcomes of African American girls in advanced science courses. The researcher was an African American woman with experience teaching high school science to African American girls. In an effort to reduce researcher bias, the researcher maintained a reflexive journal throughout the research process to increase trustworthiness.

## Recommendations

### Recommendations for Using the Data

The majority of the students in the school district studied were African American. Therefore, this study provided valuable information to district leaders as well as school personnel. The researcher suggested the following recommendations:

1. The researcher recommended a district and school leadership briefing of barriers and motivating factors impacting the participation of African American girls in advanced

sciences. The participants revealed several factors, which specifically hindered African American girls from engaging in advanced science and were out of the control of teachers. Action should be taken by district leaders and school administrators to engage in both goal setting and solution seeking processes to increase the number of African American girls participating in advanced science courses.

2. The researcher recommended that district leaders support school level professional learning to increase teacher knowledge of culturally responsive teaching practices. The participants discussed using a variety of strategies to engage students in science based on teacher preference. Professional learning to improve instructional practices would support not only African American girls, but all students.

3. The research can be used by district leaders to study the alignment of the science curriculum from kindergarten to Grade 12 in order to identify learning gaps. This study would provide insight into why high school students lacked foundational skills in mathematics and science necessary to participate in advanced science courses.

4. The researcher recommended that district leaders support after-school enrichment programs and field trips to increase student exposure to science outside of the classroom through real-world experiences. The district would also provide training to help parents teach children to connect science to everyday activities.

#### Replicating the Results

The researcher recommended the following changes for replicating the results:

1. Cultural bias as well as regional bias affected teacher perceptions. The researcher recommended conducting the study in a different region with more diverse students and teachers. The district under study consisted of majority African American students and



teachers, and experiences of African American girls were common. The results of the study would vary in a different region. The researcher would like to know how teachers of various races perceive the participation and outcomes of African American girls in a school district where African American girls were the minority.

2. The researcher recommended using a mixed method approach, which consisted of a semi-structured interview and a survey. A previously tested survey would be added as an instrument to produce more data regarding the impact of teacher race on the participation and outcome African American girls. The researcher was unable to gather much information from the semi-structured interview about the impact of teacher race on the participation of African American girls in advanced science courses. The researcher recommends the use of a survey which will be sent to a large number of participants to produce statistically significant data to answer the research question.

#### Future Research

Additional references (Appendix H) were provided to support future research related to the current study. The researcher recommended the following studies for future research:

1. Conducting a study to answer the following research question: What are the perceptions of African American girl undergraduate STEM majors regarding the impact of high school advanced science courses on college and career aspirations? This study is a follow-up study using college students who participated in high school advanced science courses in the approved district. The researcher will study whether or not the experiences of African American girls in high school advanced science courses impacted college and career choices.

2. Conducting a study to answer the following research question: To what extent is there a relationship between teacher credentials and proficient science scores on the Georgia Milestone Assessment? The researcher recommends exploring characteristics and credentials of science teachers who produce a large number of proficient students on the physical science and biology Georgia Milestones Assessment System. The researcher recommended looking at Georgia Milestones Assessment System data of teachers in Georgia and identifying characteristics, such as degree level, degree area, years of experience, race, and gender of science teachers who perform well, to produce recommendations for improving statewide assessment scores through teacher preparation.
3. Conducting a study to answer the following research question: Is there a relationship between strategic recruitment efforts for STEM programs in elementary and middle schools and high school STEM participation? The researcher recommended studying strategic recruitment efforts on both the elementary and middle school level to investigate whether those efforts have an effect on STEM participation in high school.

#### Dissemination

The superintendent in the approved district requested that the researcher share the results of the study. Therefore, the researcher planned to email a completed copy of the dissertation to the superintendent. Then, the researcher would set up a meeting to share results with the superintendent as requested. Subsequently, a district presentation was planned for district leaders, including the superintendent's cabinet, science content coordinators, and school board members.

The National Science Teacher Association (NSTA) sponsored annual conferences and professional development sessions to help improve teaching and learning in science.

Therefore, the researcher planned to sign up to present the results of the study at a STEM conference sponsored by the NSTA.

The researcher planned to contact ProQuest at [disspub@proquest.com](mailto:disspub@proquest.com) in order to receive more information about publishing the dissertation on ProQuest to increase the visibility of the work. Furthermore, the researcher planned to write two articles related to the study and go through the peer review process to have the research articles published. The researcher planned to submit the research articles to the *Cultural Studies of Science Education* journal using the web address: <http://www.editorialmanager.com/csse/>. *Cultural Studies of Science Education* investigated science education as a diverse social and cultural phenomenon. The researcher also planned to submit journal articles to the *Journal of STEM Teacher Education* at <http://www.jstemed.org/>. The *Journal of STEM Teacher Education* was a peer reviewed journal article that published high quality articles related to STEM education.

### Concluding Thoughts

African American girls were significantly underrepresented in STEM and science education and careers. African American girls were capable of participating in advanced science courses, but unfortunately several barriers kept the number of girls participating in advanced science courses from increasing. Many African American girls engaged in advanced sciences possessed a high level of self-efficacy to pursue desired STEM or medical related degrees and careers in spite of the barriers. However, educational leaders, teachers, and stakeholders should acknowledge the diverse needs of African American girls and take action to support and encourage more African American girls to participate in advanced science courses. Increased diversity in science education not only promotes

educational equity but will increase the number of uniquely qualified applicants to fill science related jobs of the future. Therefore, the researcher chose to continue research on the topic in hopes of having an impact on the number of African American girls who participate in advanced sciences in the future.

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APPENDICES

APPENDIX A  
SEMI-STRUCTURED INTERVIEW PROTOCOL

Date: \_\_\_\_\_

Place: \_\_\_\_\_

Interviewer: Shanica Cherie Poole

Interviewee/Participant Number: \_\_\_\_\_

Introduction:

Thank you for agreeing to participate in this semi-structured interview which is a necessary step for successful completion of my dissertation. African American girls are underrepresented in STEM education and fields. Research has shown a connection between the participation in advanced science courses and student aspirations to pursue STEM degrees and careers. The purpose of the current study is to explore perspectives of high school advanced science teachers on the participation and outcomes of African American girls that you have taught.

Instructions:

I will read each question aloud and would like to hear your open and honest responses. I will take notes on this document as well as record for quality assurance. It is important that information discussed during the interview be kept confidential to protect your privacy. Your identity will be protected and the audio recording will be destroyed upon successful completion of my dissertation. Your responses will be transcribed and



available for you to review prior to the analysis of the data collected. This session will last approximately 30 minutes to an hour. Do you have any questions before we begin?

Semi-Structured Interview Protocol Questions:

1. Describe the advanced science courses that you teach in which African American girls participate.
2. Describe the demographics of the students participating in your high school advanced science course(s)?
3. Why do African American girls enroll in advanced science courses? How does this compare to other girl students?
4. How do African American girls participating in advanced science courses perform compared to other groups?
5. What are your thoughts on the preparation and readiness of African American girls to be successful in advanced science courses when compared to other populations?

6. Tell me about the curriculum and pedagogy used to teach advanced science courses. Is it designed to meet the needs of diverse students including African American girls? Explain.

7. Do you see enrollment patterns for African American girls in your advanced science classes? If so, what are the trends?

8. How do you support the enrollment of African American girls in your courses? What kinds of support?

9. Do you actively recruit African American girls for your advanced science classes? Does anyone recruit such students for advanced science classes?

10. Do these African American girls encourage other African American girls to participate in science?

11. What do you think is the future direction of African American girls participating in advanced science courses?

12. Do you have any data to support student outcomes of African American girls participating in advanced science courses?

- Is there anything I haven't asked that you would like to share?
- Do you have any questions, comments, or concerns related to the current study?
- Thank you for participating in the interview process. It is my hope that the information collected will be used to add to the body of literature related to experiences of African American girls in advanced science courses.

APPENDIX B  
INFORMED CONSENT FORM



**Informed  
Consent Form**

You are being asked to participate in a research project conducted by Shanica Poole, a student in the Department of Counseling, Foundations and Leadership at Columbus State University. This study is being supervised by Dr. Christopher Garretson.

**I. Purpose:**

The purpose of this project is to explore teacher perceptions of the participation and outcomes of African American girls enrolled in high school advanced science courses.

**II. Procedures:**

Teachers that meet specific criteria to participate will be contacted through email by the researcher. Teachers will be informed that participation in the study is completely voluntary. There is a possibility that data collected will be used in future research projects.

**Individual Face-to-Face Interview Procedures:**

Individual interviews will be conducted after school hours at a location and time designated by the participant. An electronic device will be used to record interviews. An interview protocol will be used to semi-structure the interview process. Interviews will last approximately 30 minutes to an hour. The researcher will email interview transcripts

to participants the week following each interview to verify the accuracy of the information collected.

### III. Possible Risks or Discomforts:

There are minimal risks associated with the participation in the current study. The researcher will keep all responses confidential and individual schools and teachers will not be identified. In the event that an individual's responses are disclosed, participants will be notified promptly. To alleviate discomfort, the participants may withdraw informed consent before, during, or after the interviews are complete. Participants will also have the opportunity to review interview transcripts to ensure the responses accurately represent the perceptions of the participants. The researcher will stress the importance of keeping the interviews confidential to protect the privacy of participants.

### IV. Potential Benefits:

Participants do not directly benefit from participating in the study. However, the research may potentially benefit educators at various levels, and adds to the existing body of research on the subject matter.

### V. Costs and Compensation:

There are no costs associated with participation in the study, and participants will not be compensated for participating in semi-structured interviews.

### VI. Confidentiality:

Participant information collected during the study will be kept confidential. The researcher will take the following steps to ensure confidentiality: (1) Information that could identify the district, school, or teacher will not be reported. (2) Information will be collected and analyzed on a password protected device. (3) Identifying information

collected during the study will be shredded or deleted a year after the research study is complete.

VII. Withdrawal:

Your participation in this research study is voluntary. You may withdraw from the study at any time, and your withdrawal will not involve penalty or loss of benefits.

For additional information about this research project, you may contact the Principal Investigator, Shanica Poole at [REDACTED] or poole\_shanica@columbusstate.edu. If you have questions about your rights as a research participant, you may contact Columbus State University Institutional Review Board at irb@columbusstate.edu.

I have read this informed consent form. If I had any questions, they have been answered. By signing this form, I agree to participate in this research project. I am 18 years of age or older.

---

Signature of Participant

---

Date

## APPENDIX C

## REQUEST TO SUPERINTENDENT CONSENT TO CONDUCT STUDY

**Subject: Request to Conduct Dissertation Study**

Dear Mr. Dyer,

My name is Shanica Poole, and I am a doctoral student in the Department of Counseling, Foundations and Leadership at Columbus State University. My supervising faculty is Dr. Christopher Garretson. I am conducting a qualitative descriptive study about the participation and outcomes of African American girls enrolled in high school advanced science courses.

I will be conducting this study using the following research questions:

1. What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?
2. Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

The Columbus State University Institutional Review Board insures that research projects involving human subjects follow federal regulations.

I am requesting permission to conduct semi-structured interviews with high school advanced science teachers in the Dougherty County School System. Teachers selected to participate in the study should have at least two years of experience teaching high school advanced science courses to African American girls. Advanced science courses include chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, honors human anatomy, and any other science deemed appropriate by the principal at each high school. A sample size of 10 teachers is desired. Teachers that meet the criteria will be recruited to participate via email. A mutually agreeable date, time, and location will be setup to conduct each interview which will last between 30 minutes to an hour. Teachers will participate in participant/member checks by reviewing the transcripts of interviews for accuracy.

The researcher will ensure:

1. Participants will have access to the interview protocol and informed consent form prior to the interview, and be made aware of the right to withdraw permission to participate in the study at any time.
2. Information will be kept confidential and personal information will be omitted from the dissertation.

3. Information will be used exclusively for the purpose of completing the dissertation in partial fulfillment of the requirements for the degree of Doctor of Education which is submitted to the faculty of Columbus State University
4. Students will not be used as participants in the current study.

If you are willing to allow me to conduct my study in the Dougherty County School District, please sign and return this letter to me on district letterhead. Please let me know if you have any questions regarding this study.

My telephone contact information is [REDACTED] and my email is poole\_shanica@columbusstate.edu.

Thank you for your time and consideration.

Sincerely,

Shanica Poole

Shanica Poole  
 Doctoral Student  
 Columbus State University

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I, \_\_\_\_\_, give permission for Shanica Poole to conduct a  
 (Print Name)  
 research study in the Dougherty County School District with high school science teachers.

Signature of Superintendent/Designee: \_\_\_\_\_

Date: \_\_\_\_\_



## APPENDIX D

## SUPERINTENDENT LETTER OF COOPERATION

August 13, 2018

Ms. Shanica Poole  
Doctoral Student  
Columbus State University

Dear Ms. Poole:

Please accept this correspondence as indication of my approval of your request, dated July 26, 2018, to conduct a qualitative descriptive study regarding the participation and outcomes of African American girls enrolled in high school advanced science courses

I wish you much success with your study, and I look forward to reviewing the results. Do not hesitate to contact me at [REDACTED] or [REDACTED] if I can be of further assistance.

Sincerely,

[REDACTED]  
[REDACTED]  
Superintendent

## APPENDIX E

## REQUEST TO SCHOOL PRINCIPALS FOR CONSENT TO CONDUCT STUDY

**Subject: Request to conduct dissertation study**

Good afternoon,

My name is Shanica Poole, and I am a doctoral student in the Department of Counseling, Foundations and Leadership at Columbus State University. My supervising faculty is Dr. Christopher Garretson. I am conducting a qualitative descriptive study about the participation and outcomes of African American girls enrolled in high school advanced science courses.

I will be conducting this study using the following research questions:

1. What are the perceptions of selected high school science teachers regarding the participation and outcomes of African American girls in advanced science courses?
2. Is there a relationship between the race of teachers and teacher perceptions regarding the participation and outcomes of African American girls in advanced science courses?

The Columbus State University Institutional Review Board insures that research projects involving human subjects follow federal regulations.

I am requesting permission to email high school advanced science teachers at your school and conduct semi-structured interviews with these teachers after school hours. Teachers selected to participate in the study should have at least two years of experience teaching high school advanced science courses to African American girls. Advanced Science courses include chemistry, physics, Advanced Placement biology, Advanced Placement environmental science, honors biology, honors human anatomy, and any other science deemed appropriate by the principal. A sample size of 10 teachers is desired. Teachers that meet the criteria will be recruited to participate via email. A mutually agreeable date, time, and location will be setup to conduct each interview which will last between 30 minutes to an hour during the months of September and November 2018. Teachers will participate in participant/member checks by reviewing the transcripts of interviews for accuracy.

The researcher will ensure:

1. Participants will have access to the interview protocol and informed consent form prior to the interview, and be made aware of the right to withdraw permission to participate in the study at any time.

2. Information will be kept confidential and personal information will be omitted from the dissertation.
3. Information will be used exclusively for the purpose of completing the dissertation in partial fulfillment of the requirements for the degree of Doctor of Education which is submitted to the faculty of Columbus State University
4. Students will not be used as participants in the current study.

If you are willing to allow me to conduct my study at your school, please sign and return this letter to me via email or in person. Please let me know if you have any questions regarding this study.

My telephone contact information is [REDACTED] and my email is poole\_shanica@columbusstate.edu.

Thank you for your time and consideration.

Sincerely,

Shanica Poole

Shanica Poole  
 Doctoral Student  
 Columbus State University

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 I, \_\_\_\_\_, give permission for Shanica Poole to conduct a  
 (Print Name)  
 research study at \_\_\_\_\_ High School.

\_\_\_\_\_  
 (Signature of Principal)

\_\_\_\_\_  
 (Date)

## APPENDIX F

## SCIENCE TEACHER RECRUITMENT LETTER FOR INTERVIEWS

**Subject: Perceptions of Science Teachers Needed**

Dear Science Teacher,

My name is Shanica Poole, and I am a doctoral student in the Department of Counseling, Foundations and Leadership at Columbus State University. My supervising faculty is Dr. Christopher Garretson. I am conducting a qualitative descriptive study about the participation and outcomes of African American girls enrolled in high school advanced science courses.

I am emailing you to see if you would be willing to participate in a research study.

To collect data for this study, I will be conducting individual face-to-face interviews after school hours. The time and location for the interviews will be at your convenience. Interviews will last approximately 30 minutes to an hour and will consist of questions related to your perceptions of the participation and outcomes of African American girls enrolled in high school advanced science courses. Information collected will be kept confidential and will not be directly linked to you. I have attached a copy of the informed consent form as well as the interview protocol questions for you to review.

If you are willing to participate in this research study, please reply to this email and include the following information:

Name:

Telephone number:

Preferred Date(s):

Preferred Time (after school hours):

Preferred Location:

If the researcher is unable to accommodate your preferred date, time, and location, you will be contacted by email or phone to discuss different options that are convenient for you.

If you are willing to participate in the study, the informed consent form will be signed prior to beginning the interview.

Please feel free to email me at poole\_shanica@columbusstate.edu or call me at [REDACTED] if you have questions.

Thank you for your time, consideration, and participation.

Sincerely,

Shanica Poole

Shanica Poole  
Doctoral Student  
Columbus State University

## APPENDIX G

## INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

Exempt Approval Protocol 19-010 Inbox x Print Share

**CSU IRB** <irb@columbusstate.edu>  
to me, Christopher, CSU, Institutional ▾ Oct 16, 2018, 11:57 AM Star Reply More

Institutional Review Board  
Columbus State University

Date: 10/16/18  
Protocol Number: 19-010  
Protocol Title: Examining Perceptions of High School Science Teachers Regarding the Participation and Outcomes of African American Girls in Advanced Science Courses  
Principal Investigator: Shanica Poole  
Co-Principal Investigator: Christopher Garretson

Dear Shanica Poole:

The Columbus State University Institutional Review Board or representative(s) has reviewed your research proposal identified above. It has been determined that the project is classified as exempt under 45 CFR 46.101(b) of the federal regulations and has been approved. You may begin your research project immediately.

Please note any changes to the protocol must be submitted in writing to the IRB before implementing the change(s). Any adverse events, unexpected problems, and/or incidents that involve risks to participants and/or others must be reported to the Institutional Review Board at [irb@columbusstate.edu](mailto:irb@columbusstate.edu) or (706) 507-8634.

If you have further questions, please feel free to contact the IRB.

Sincerely,

Amber Dees, IRB Coordinator  
Institutional Review Board  
Columbus State University

**\*\* Please note that the IRB is closed during holidays, breaks, or other times when the IRB faculty or staff are not available. Visit the IRB Scheduled Meetings page on the IRB website for a list of upcoming closures. \*\***

## APPENDIX H

## ADDITIONAL REFERENCES

The researcher read several journal articles that were not used in the current study. However, the additional references listed below would be informative for future research related to the topic.

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