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Black Pearls: Examining the Science Identity Development of African American Girls in a Culturally Relevant STEM Counterspace

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Black Pearls: Examining the Science Identity Development of

African American Girls in a Culturally Relevant STEM Counterspace

A dissertation submitted in partial satisfaction of the

requirements for the degree of Doctor of Philosophy

in Education

by

Michelle Renee Smith

2016

ABSTRACT OF THE DISSERTATION

Black Pearls: Examining the Science Identity Development of

African American Girls in a Culturally Relevant STEM Counterspace

by

Michelle Renee Smith

Doctor of Philosophy in Education

University of California, Los Angeles, 2016

Professor Robert Cooper, Chair

The science community has an extensive history of exclusivity at multiple stages, including the P-20 education and professional levels. African American girls remain an underrepresented population within the STEM-fields despite their demonstrated interest and aptitude in science. Within the STEM-circuit, African American girls who once showed interest and promise in STEM, are pushed out due to negative experiences within science spaces where many are marginalized and their interests are suppressed. Critical science education scholars have called for culturally relevant pedagogical practices that honor the cultures and experiences of students of color (Emdin, 2010) and science education scholars have led the charge to examine the experiences and identity development of girls of color in science (Calabrese Barton, et al. 2012; Hanson, 2009).

This study builds on preexisting work by centering its focus on the science identity development of African American girls within a culturally relevant science counterspace. To

challenge the dominant discourse concerning their science education experiences, their identity

development is analyzed through a critical race, Black feminist theoretical lens. Through a

multiple qualitative methods design, this project illuminates the identity development of

African American girls within the counterspace by utilizing a three-dimensional model that

examines their competence, performance, and recognition in science (Carlone & Johnson,

2007). The culturally relevant curriculum employed within the counterspace allowed

participants to learn through their interests and build critical consciousness through engaging in

meaningful dialogue concerning the role of race and gender on the underrepresentation of

African American women in STEM.

The dissertation of Michelle Renee Smith is approved.

Adrienne Dixson

Megan Loeff Franke

Tyrone C. Howard

Robert Cooper, Committee Chair

University of California, Los Angeles

2016

~ Just remember the world is not a playground but a schoolroom. Life is not a holiday but an education. One eternal lesson for us all: to teach us how better we should love. ~
Barbara Jordan

To my committee, thank you for having the confidence in me to complete this project. Dr. Cooper, thank you for investing in me from the very beginning of my journey and for providing multiple opportunities for me to learn, grow, and think as an emerging scholar. Dr. Howard, thank you as well for investing so much in me, keeping me grounded, and for inviting me into the VIPS family. Dr. Franke, you have been a valuable source of encouragement and direction since our first-year RAC and the 299 series. Thank you for challenging me to push through with my plan. Dr. Dixson, my soror, thank you for taking a chance on a young scholar who sincerely admires your work. Your message to us during the research institute at AERA in Philadelphia sparked a similar zeal for my research as the message I received from Soror Cynthia Butler-McIntyre about our sisterhood in 2002.

Dr. Rury and Dr. Lisa Wolf-Wendel, I greatly appreciate the firm foundation you set for me at Kansas to pursue a PhD. Without your guidance and support, I would not have seriously considered the academy nor would I have believed that I could thrive. Mr. Wueller and Mrs. Annette Mitchell, you were significantly influential to me as an educator because you showed me what good teaching and high expectations looked like on a consistent basis.

~You don't make progress by standing on the sidelines, whimpering and complaining. You make progress by implementing ideas. ~
Shirley Chisholm

To my VIPS family, thank you for being my Los Angeles family. To my colleague and mentor, Dr. Jonli Tunstall, thank you for setting such an outstanding example for me as a scholar and professional. It was nothing short of a blessing that I was connected to such God-fearing and supportive people like you and Jerry, as He knew what obstacles that were ahead of me and VIPS was my refuge. Kathy, Whitney, Aaron & Bree, I love how our friendship has continued to grow since we have each gone on to pursue our dreams. Soror Leslie Poston, thank you for coming through for me and putting the "Ms. Poston" touch on my work. Ashley and Miguel, thank you for your support when I defended—it mattered. To Cohorts 1-11 and future VIPS cohorts, know that you represent what is possible when those committed to social justice stand up and reach back, therefore you are also expected to do the same for the next generation.

My fellow emerging scholars in the struggle from UCLA, we have been charged to carry the torch. Brian, Benny, Maritza, and Nicole, there is so much knowledge, experience, and camaraderie between us as a group. I could not have asked for a better group of friends to travel along this journey with. Doctora Nichole Garcia, yes, this summer will certainly go down in the books. Thank you for being my scholarly kindred spirit. Dr. Katina Thomas, my soror, thank you for being my mentor and my cheerleader throughout the last five years. Mr. Devin Moss, thank you for rescuing me back in Kansas—you set a high bar for grad school friends. To my cousin, Dr. Alvin Curette, thank you for being my guidance counselor.

Kansas and UCLA were perfect fits and without your direction, I could have missed out on these great institutions.

~ Is solace anywhere more comforting than that in the arms of a sister. ~
Alice Walker

There is a special group of sistas who I have grown significantly closer to over the last two years. Throughout this time, we have prayed for each other as we each endured tragedies and celebrated each through our triumphs. Thank you for inviting me in and for rooting me on. To my Delta sorors, the late Mrs. June Dickson, the Zeta Sigma Chapter, Keitha, Tara, Melody, Taisha, LaToya, and Spring '02, thank you for being an integral part of my life throughout the years, holding me accountable, and setting the example of exemplary sisterhood, scholarship, and service. *I am because we are.*

~ But can you expect teachers to revolutionize the social order for the good of the community?
Indeed, we must expect this very thing. ~
Carter G. Woodson

To my education family from Thomas, Cullen, and Spirit, each of you have taught me things that I have carried with me as an educator. Kay, thank you for being such a selfless friend and for showing so much investment in making sure I completed my dissertation. Charles King, I literally could not have done this without your support and approval. To Spann and Jamaal, thank you as well for being a part of my team and family.

~ Give light and people will find the way. ~
Ella Baker

To my STEM Girls, without you this project would have never happened. Thank you for trusting me with your learning and your opinions. From creating sugar scrubs to testing the pH of different products, your enthusiasm for learning was a light when Ms. Michelle needed it. Your futures are as bright as your light!

~Thy shoes shall be iron and brass; and as thy days, so shall thy strength be.~
Deuteronomy 33: 25 (KJV)

Lastly, to my Heavenly Father through whom all things are possible. Thank you for guiding my steps and for putting those in the Kingdom in place for me along the way. I know that it was not by happenstance. There were times when my faith was tested; however, when others, myself included, fell short of my expectations, your grace and mercy remained sufficient. Through this voyage, I have learned to trust in You and as I neared the end of this task, your servant, Pastor Remus E. Wright, reminded me that I have been blessed with a tough soul, thus I will rely on your anointing as I enter the next part of my journey.

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University of Kansas, Lawrence, KS

Certificates
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- Standard Generalist Grades EC-4 Awarded 2007
- Standard Generalist Grades 4-8 Awarded 2007

Publications

Smith, M. & Lyons, T. (2016). Postsecondary pathways. In T.C. Howard, J.D. Tunstall, & T.K. Flennaugh (Eds.), *Expanding college access for urban youth: What schools and colleges can do (pp. 115-137).* New York, NY: Teachers College Press.

INTRODUCTION
CHAPTER ONE

My Science Herstory

One of my favorite things to do when I was younger was attempting to replicate the

science demonstrations Mr. Wizard showed us on the popular Nickelodeon show *Mr. Wizard's*

World. One scene in particular has remained in my memory because it took several attempts

before I got it right. I would first fill a glass with water and cover the rim with a paper towel,

place a plate on top of the paper towel, then flip it upside down to watch the water remain in

the glass without spilling. There were a few failed attempts before I was successful, but the

feeling of accomplishment I experienced felt great—I could do what Mr. Wizard could do. In

retrospect, many of the shows and media representations that inspired my creativity,

imagination, and desire to "figure stuff out" were all male-dominated. From learning how to

draw and create with Bill Cosby on *Picture Pages* and Commander Mark on *Secret City* to

learning more about science and experimentation with Mr. Wizard and Bill Nye the Science

Guy, all of these representations of scientists and inventive people were men. The most famous

were Mr. Wizard and Bill Nye, who each fit the pervasive description of the stereotypical

scientist—white and male (Chambers, 1983; Finson, Beaver, & Cramond, 1995; Mead &

Metraux, 1975).

Although, Mr. Wizard caught my attention, my mathematician mother was the primary

"scientist" in my home. A former math teacher, my mother helped me with my science fair

projects and developed my love for mathematics. She also worked in the lab at one of the many

chemical plants in the "Golden Triangle" area of Southeast, TX. Through her, I knew that

women could do science and mathematics and therefore I could do those activities as well. However, at some point my interest in science waned and my participation in the subject became more about earning the grade I needed and less about discovery. Besides my chemistry class in 11th grade, I had very little interest in science or STEM related careers despite doing well in both math and science in high school in addition to participating in the computer applications and coding program my first two years of high school and the media technology program my 11th and 12th grade years. I did not make the connection between being relatively "good" in these subjects with any particular career and thus did not position myself as one who could take on those math and science-related roles—and neither did anyone else. For me, beyond making good grades, the relevance of these extensive, and mostly positive, experiences in STEM-related courses was lost along the way.

I know that my story is not unique, as there are countless young women whose interest in science and mathematics are stifled and whose abundant talents in these areas are left untapped. This is especially so among African American women whose race and gender have captured them in the "double-bind" (Malcom, Hall, Brown, 1976) that has often suppressed their interest and achievement, primarily in science. As a result, African American girls are often considered uninterested in science before they can actually display their interest or talent (Hanson, 2009). They are "presumed uninterested" while at the same time presumed incompetent, therefore any demonstration of talent beyond simply "making the grade" is likely to go unnoticed. The primary focus of this project does not suggest that there are no African American women whose interest did not wither along the way, no women whose talent was indeed noticed and nurtured, or none who have broken seemingly indestructible barriers

throughout the last several decades in the sciences. Nor does it imply that there have not been concerted efforts to increase the representation of women in STEM professions by multiple stakeholders. Instead, this project serves to provide insight on how we can continue to attend to potential breaks in the STEM circuit for African American girls through examining their identity development within a culturally relevant science counterspace specifically designed with their lived experiences as African American girls in mind.

Problem Statement

As the United States prepares to reposition itself as a global leader through increased scientific and technological advancement, there remains a critical shortage of domestic talent in the science, technology, engineering, and mathematics (STEM) fields (PCAST, 2010; PCAST, 2012). The Obama Administration reports, "STEM education will determine whether the United States will remain a leader among nations" (PCAST, 2010, p. vii). To fill this void, it is imperative that students become more proficient and interested in STEM careers at the K-12 and postsecondary levels, especially those from historically marginalized groups (Anderson & Kim, 2006; PCAST, 2010, 2012). However, recent National Center for Education Statistics (NCES) findings indicate that students have demonstrated marginal gains in the National Assessment of Educational Progress (NAEP) in science since 2011 with fewer than half scoring above Proficient (NCES, 2013) and students of color increasingly scoring Below Basic at each testing level (NAEP, 2009). The NAEP high school transcript study also found that a greater proportion of African American and Latino students who earned a below-standard diploma solely lacked the science requirement compared to their White and Asian/Pacific Islander counterparts (Nord et al. 2011).

Due to the above outcomes and the expressed need to significantly increase the number of underrepresented STEM college graduates (PCAST, 2012), the Department of Education has increased its focus on improving STEM education nationwide (DOE, 2013). Previous research suggests that the STEM "problem" is not that underrepresented students are uninterested in science, but that more engaging teaching practices and welcoming classroom environments are necessary to *sustain* their interest and improve performance (Anderson & Kim, 2006; Hanson, 2009; Ong, Wright, Espinosa, & Orfield, 2011; PCAST, 2012). Providing a rigorous, welcoming, and engaging classroom environment are undeniably invaluable practices that may increase students' competitiveness in science, especially that of African American girls who are often marginalized within these spaces (Hanson, 2009). It is also important that we consider the impact of specific pedagogical approaches on positioning African American girls as science learners and fostering their development as they navigate the STEM circuit.

Since science is historically a primarily White male domain, both African American males *and* females risk being considered incapable of scientific excellence and are marginalized from the STEM community (Boutte, Kelly-Jackson, & Johnson, 2010; Emdin, 2010; Hanson, 2009). Due to assumptions based on race and gender, African American males and females may have shared and divergent experiences in science education. One primary example of a critical shared experience is their minimal access to schools that provide rigorous and upper-level science coursework and preparation (Anyon, 1980; Howard, 2010; Oakes, 1985; Teranishi, Allen, & Solórzano, 2004). Each gender is not immune to the effects of attending the segregated and under-resourced schools where low-income students of color are more likely to

enroll, which often limit their educational opportunities (Balfanz & Letegers, 2004; Darling-Hammond, 2013; Orfield & Lee, 2007).

Primary gender differences concerning the experiences of African American males and females in science education relate to ways they are positioned as science learners and as "'other' than the 'normal' student" (Emdin, 2010, p.2). Pringle, Brkich, Adams, West-Olatunii and Archer-Banks (2012) state, "negative positioning has the potential for deleterious effects on discourses in science and mathematics classrooms, and ultimately students' identities as learners" (p.219). African American females are presumed uninterested in science due to generalizations about women's interest in the sciences as a whole in addition to similar assumptions about the aptitude of women of color in science (Buck, Cook, Quigley, Eastwood, & Lucas, 2009; Farinde & Lewis, 2012; Hanson, 2009; Ong, Wright, Espinosa, & Orfield, 2011). These scholars assert that the issue for African American girls and other women of color does not lie in their perceived low interest in science, but in their "detrimental schooling experiences" (Farinde & Lewis, 2012, p.422) and sub-par education in science that deters them from science, and subsequently, STEM careers. Beyond the presumed lack of interest, African American girls are more likely to be diverted from upper-level science and mathematics classes and have less access to conduct hands-on science experiments (Fancsali, 2002; Farinde & Lewis, 2012), which are experiences associated with developing a strong science identity.

Recent Office for Civil Rights (CRDC, 2012) findings demonstrate that young women remain at a disadvantage to pursue STEM and/or STEM-related careers based on their enrollment in upper-level science courses and performance on AP tests in comparison to their male counterparts. The data indicate that females, of all races, are enrolled in biology courses

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at the same rate as boys and outnumber males in chemistry, but remain underrepresented in advanced level courses such as physics (CRDC, 2012). While these data may appear to demonstrate a mixed representation of females in science courses, one must note that, in some states, biology is a required course for high school completion while physics often occurs later in the science course sequence. Further, females' adequate representation in biology and underrepresentation in physics is closely paralleled to their respective representation within comparable STEM majors and careers, with women overwhelmingly majoring in the biological science as opposed to engineering and physics (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011). In addition, despite outnumbering male enrollment in AP science courses, males continue to pass AP exams at higher rates than females, which is also a trend found amongst African American males and females. These discrepancies in participation and performance are revealed through the underrepresentation of women in STEM careers, especially among African American women, notwithstanding those women who earn a STEM degree (Beede et al., 2011). Women represent nearly 50 percent of the U.S. workforce; however, they only represented approximately one-fourth of STEM careers in 2009 (Beede et al., 2011). One may presume this is due to women's underrepresentation in STEM majors; however, the data also display that women with STEM degrees are still less likely to work in STEM despite having the academic preparation to do so (Beede et al., 2011).

Despite the seemingly marginal progress to provide the types of educational environments within U.S. public schools that will foster the resilience necessary for African American girls to persist through the STEM circuit, there are efforts outside of the traditional classroom space that serve to do so. I believe that programs of this nature are undeniably

important for young girls as they develop science identities, especially in middle school, as it is a critical juncture in their career development. Providing African American girls with opportunities to engage in STEM-related activities that position them as capable learners and participants in the STEM fields is an invaluable contribution to equitable educational opportunities for girls of color in STEM. Beyond this, I believe it is uniformly important that the pedagogy and practices within these learning spaces prepare them to actively challenge the dominant narrative concerning what it means to engage and participate in science through a curriculum that honors their lived experiences as African American girls.

For this project, I developed the STEMpowerment after school program as a science counterspace grounded in culturally relevant pedagogy (Gay, 2000; Ladson-Billings, 1994, 1995a, 1995b) to explore African American girls' identity development. This counterspace stands to provide an opportunity to illuminate science identities that may potentially remain unobservable if examined within science spaces rooted in traditional practices and curricula. Without exploring such an approach to examining identity development, future well-meaning research within traditional spaces will not only reinforce the mainstream science learning experiences many African American girls encounter in their schools, but continue to solely represent science identities rooted in mainstream ideas of science identity development.

Rationale

Previous research concerning the experiences of minority women (Ong et al., 2011), and more specifically African American girls (Hanson, 2009), insists that women do no lack an interest in science, but are operating within an educational system that drains their interest and thwarts their progress within the STEM circuit. Scholars interested in the educational

experiences of African American girls in science have found that many of these young women have opportunities to participate in science-related activities outside of school, which is often in the home and supported by family members (Buck et al. 2009; Hanson, 2007, 2009). The study reveals that the young women's experiences demonstrated that they potentially "saw science as an everyday activity relevant to their world outside of school" (Buck et al., 2009, p. 400). Unfortunately, the girls did not position themselves as bearers of science knowledge and regarded their instructors and textbooks as the primary sources of knowledge (Buck et al., 2009).

Scholarship that illuminates the challenges of African American girls in the sciences are necessary for educators to adequately address areas of promise within traditional classroom settings. However, it is also important that we gain a greater understanding of the potentially affirming experiences African American girls have within and outside of the traditional science classroom that contribute to their science identities. Furthermore, there is a growing interest in implementing culturally relevant pedagogy in science classrooms (Boutte, Kelly-Jackson, & Johnson, 2010; Goldston & Nichols, 2009; Johnson, 2011; Laughter & Adams, 2012; Seiler, 2001), which serve to transform the science learning environment for students of color to one where they can engage in science that upholds their capacity to "do" science.

This study explores the science identity development of a group of African American girls participating in the STEMpowerment after school program mentioned above. Grounding the pedagogical practices in culturally relevant pedagogy is vital to this study due to the intentionality of providing a counter-learning space that will enhance their science learning experiences and build their critical consciousness as African American girls. Such an approach

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can contribute to the resilience necessary for African American girls and women to thrive in the STEM-circuit. Ultimately, this dissertation study serves to further support the notion that addressing the marginalization of African American girls in the sciences requires a multifaceted approach. This approach is not only essential when determining educational policies and "best" practices, but also within the educational scholarship used to examine the experiences of African American girls and their identity development as science students.

With this in mind, the primary foci of this study are to:

(i) expand the growing body of knowledge concerning the science identity development of African American girls in K-12 schools as they navigate the STEM circuit

(ii) provide African American girls with a science learning environment that is centered on their lived experiences and engages them in dialogue concerning the role of race and gender on African American women in STEM

(iii) determine the utility of an analytical tool used to examine African American girls' science identity development in a culturally relevant, science counterspace

Guiding Theory

The principal theories that guide this work include critical race theory and Black feminist epistemology, which guide my understanding of the intersecting roles of race and gender on African American girls' experiences as science learners. A succinct description of the function of each theory is provided below and more detailed explanations of how these theories complement each other are provided in chapter three. In addition, I present the science identity development model by Carlone and Johnson (2007), which is used to examine the girls' identity development within the culturally relevant counterspace. I am particularly interested in the utility of the model as an analytic tool to examine the science identities that emerge within the counterspace.

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Critical Race Theory

Previous research conducted on African American girls' experiences in science have, at times, employed a feminist or critical feminist lens within their studies, (Buck, et al., 2009; Hanson, 2009). While these studies acknowledge and examine the role of race and gender on African American girls' experiences through these theoretical frames, employing a race-centered theoretical frame provides an avenue to systematically examine the role racism has on their experiences. Critical race theory (CRT) offers a theoretical lens that actively confronts the role of racism in the United States, and for the purposes of this study, its role on the marginalization and experiences of African American girls and women in the STEM circuit. Further, critical race theory in education scholarship (Ladson-Billings & Tate, 1995; Solórzano, 1997) demonstrates CRT's utility as a viable framework to address racial bias in U.S. public education and allows me to co-write a counternarrative on African-American girls' educational experiences in science.

Black Feminist Epistemology

Black feminist epistemology serves to position both the participants and myself as knowledge bearers through our shared experiences as Black women, especially within the science counterspace. This theory allows critical Black female scholars to share the "collective wisdom" (Collins, 2000/2009, p. 28) of Black women through a theory that "aims to empower African-American women within the context of social injustice sustained by intersecting oppressions" (Collins, 2000/2009, p. 25-26).

Of the seven core themes of Black feminist thought denoted by Collins (2000/2009), this project primarily considers: (1) controlling images of Black women; (2) Black women and motherhood; (3) the power of self-definition; and (4) Black women's activism. These core themes allow for an analysis of African American girls' positioning as science learners and the possibilities of employing a Black feminist science approach. More importantly, it also situates African American women and girls as the primary narrators of our histories and future in science education.

Science Identity Model

This investigation utilizes the conceptual framework developed by Carlone & Johnson (2007) who problematize the relationship between racial, ethnic, and gender identities and science identity development. Within this framework, three interrelated dimensions of science identity development are identified and described, which include: (1) demonstrating competence; (2) performing scientific practices; and (3) recognition as scientists by oneself and others. As previously stated, the Carlone and Johnson (2007) served as the analytic tool I used to examine the science identity development of the African American girls in the STEMpowerment program.

Research Questions

This study explores the following research questions:

1. What is the utility of using a science identity development model to examine the science identity development of African American girls in a culturally relevant STEM after school counterspace?

2. Given the three explicit dimensions in the model, what science identities emerge among the African American girls participating in the culturally relevant STEM after school counterspace?

3. How do African American girls perceive the role of race and gender on the participation and success of women of color in STEM?

The first research question serves to consider the usefulness of the initial Carlone and Johnson (2007) science identity development model originally used to examine the experiences of "successful" women of color in science. I begin with assessing its utility primarily due to the sample, which includes African American girls who are still navigating the STEM circuit in comparison to the women of color who successfully reached their career and educational goals in the Carlone and Johnson (2007) study. Further, I am also interested in its function as an analytic tool employed to examine identity development within a culturally relevant STEM counterspace. I contend that this model, with its three interrelated dimensions and focus on the influence of race, ethnicity, and gender, will serve as a viable model to examine their identity development within a culturally relevant space that addresses race and gender within the curriculum.

The second question seeks to uncover the various types of science identities that emerge from the study using the initial conceptual model developed by Carlone and Johnson (2007). Drawing from literature that suggests that there are varied science school identities among girls who are associated with a positive identification with science (Brickhouse, Lowery, & Schultz, 2000), I seek to reveal the varied identities that may emerge within the culturally relevant counterspace. Further, I contend that science identities are influence by the context in which students engage in science learning. The third question seeks to illuminate how the girls recognize the influence race and gender on their experiences in STEM and potential challenges

they may undergo within the circuit based on their race and gender. More importantly, this question also reveals the girls' stance on the influence of race and gender on the underrepresentation of African American women in STEM.

Conclusion

The preceding offers a description of the problem concerning African American girls' experiences in science and preparation for STEM careers. Here, I present a study that examines African American girls' science identity development as participants in the culturally relevant after school program STEMpowerment. However, before I continue, I must call attention to my use of specific terms within the document that may have interchangeable terms, more specifically my use of African American, culturally relevant pedagogy, and STEM circuit. While I have labored over the use of African American or Black within this study for a great length of time, I have elected to use both Black and African American throughout the text. This was done to authentically represent myself and the language I use to designate people of African descent in the United States, namely those who represent families who descend from African slaves who were involuntarily brought to the United States centuries ago. A variety of texts use one or the other or both for their own reasons; however, for the sake of authenticity, I choose to use them interchangeably in this text.

I use the term "STEM circuit" instead of "STEM pipeline" in response to an invitation by scholars in STEM-education to employ a more appropriate label that represents multiple pathways within the STEM "pipeline" that students may take (Adelman, 2006; Museus et al. 2011). The STEM circuit is defined as, "a system of the multiple and varying educational pathways from science and math education in elementary schools to completion of terminal

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STEM degrees" (Museus et al., 2011, p. 9). Finally, I use culturally relevant pedagogy

throughout the study, although I primarily draw from literature that uses the terms "culturally

relevant" or "culturally responsive" in their work (Gay, 2000; Ladson-Billings, 1994, 1995a,

1995b). While Gay (2000) suggests that the terms are often used interchangeably, I have

elected to use the term culturally relevant in this study given the explicit focus on building

students' critical consciousness within the curriculum (Ladson-Billings, 1994; 1995a, 1995b).

The following chapter provides literature concerning the state of African American

women in STEM, which includes their performance, participation, and experiences as pre-

professionals. This chapter also offers a discussion of the literature focused on culturally

relevant pedagogy, especially within science spaces, which is used as the pedagogical

foundation of the STEMpowerment program in addition to Black feminist and feminist science

pedagogy. These three approaches collectively represent the pedagogical approach within

STEMpowerment that I refer to as Black Feminist Science Pedagogy. Chapter Three provides a

more thorough explanation of the theories that guide this study in addition to the science

identity development model I use as an analytic tool to examine the girls' identity development

within the counterspace in addition to assessing its utility within that space. Chapter Four

includes the methodological approach for the study, which describes the theories guiding my

approach and the rationale for relying on this approach. Chapter Four also includes a detailed

explanation of the STEMpowerment after school program, the sample, and the modes of data

collection and analyses that led to the findings provided in the subsequent chapter. Chapter

Five delivers the findings of the study relative to the research questions, which is followed by

the discussion chapter, which examines the major findings of the study relative not only to the

research questions but also the theoretical framework and the pedagogical underpinnings of

the program. Within this final chapter, I also discuss implications for future scholarly research

and practice, as it relates to current educators and pre-service educator programs.

CHAPTER TWO
LITERATURE REVIEW

While the overall quality of education in urban schools requires attention, a particular

focus on improving science education is warranted due to our country's reliance on scientific

and technological advances to maintain its global standing (DOE, 2013; PCAST, 2010). The

Department of Education strives to increase the number of STEM college graduates, yet must

do so through a public educational system that has not provided equitable science education

experiences and opportunities to historically underrepresented students (Museus, et al. 2011;

Tate, 2001). The Department of Education (DOE) argues that to reach this goal, it is vital that

historically underrepresented students in the STEM fields (i.e. students of color, women, first-

generation college students, those of varied abilities, etc.) are represented in this increase. To

significantly increase STEM graduates, the Department of Education has turned its attention on

improving K-12 science education nationwide through education initiatives focused primarily on

the training and development of current and future STEM educators. Collectively these

initiatives are expected to

> …identify and implement effective approaches for improving STEM teaching and
> learning; facilitate the dissemination and adoption of effective STEM instructional
> practices nationwide; and promote STEM education experiences that prioritize hands-
> on learning to increase student engagement, interest, and achievement in the STEM
> fields. (DOE, 2013, p. 2)

This statement signifies an interest in determining the pedagogical practices that will not only

better prepare students to compete for STEM careers, but also gain greater interest among

these students in doing so. The initiatives appear to be open to multiple approaches that will

improve science and mathematics education; however, it is doubtful that approaches deemed

"effective" would significantly deviate from the mainstream STEM pedagogy that has relegated African American girls to the margins in science education. When determining "effective" approaches, it is important to consider *for whom* these approaches are most effective. Should STEM initiatives continue to search for approaches that are inherently mainstream, science education will merely inherit new approaches that will garner the same outcomes as before. It is similar to putting a new coat of paint on a dilapidated house. It may appear refurbished and improved, but it remains uninhabitable because the foundation and structure remain unaddressed. With this in mind, it is essential that the science education community broadens its scope when determining effective practices. This is especially so considering the need to increase the representation of historically marginalized groups in STEM such as girls of color.

This investigation focuses on the science identity development of African American girls within a culturally relevant STEM counterspace as I posit that such an instructional approach is necessary within science education to develop academically prepared and resilient Black girls for STEM careers. I believe this approach is well suited to foster identities in ways not only connected to achievement in science, but that allow girls to confidently engage in science as Black females in a male dominated field. I will begin by describing the state of Black girls in science by providing relevant literature focused on their experiences in K-12 science. The following sections then present literature that expound on the pedagogical approach used within the STEMpowerment program, which is grounded is culturally relevant pedagogy and is also informed by Black feminist and feminist science pedagogy. As previously stated, I refer to this combined approach as Black Feminist Science Pedagogy.

African American Girls' Experiences in Science Education

In Chapter One, I introduced issues related to African American girls' achievement in science and representation in advanced level science courses, which impact their preparedness for and overall representation in STEM majors and careers. In this section, I focus more attention on their experiences in K-12 science learning environments. There is a growing body of literature examining the experiences of girls of color, and more specifically, Black girls in K-12 science education, that examines factors influencing their attitudes toward science, challenges to and propellants of their success in science classrooms, and identity development within science spaces (Brickhouse et al., 2000; Buck, et al., 2009; Calabrese Barton et al., 2012; Hanson, 2007, 2009). In their examination of how four African American girls construct "school science identities" in schools, Brickhouse et al. (2000) found that each of the four girls denoted in the study identified with science, did not feel disconnected from science, and were confident in their science abilities. Despite this, the authors observed that the girls with more socially accepted school behaviors had positive interactions with instructors, and those who did not adopt the "good student" identity suffered "political consequences" (p. 456). They explain,

> …the two girls who take on easily recognizable social roles for girls and bring with them the usual experiences and talents of girls are also the ones who have the fewest difficulties in constructing successful school science identities. Whereas all four of these girls constructed positive identification with science, schools and teachers do not respond to these identities in value-neutral ways. (p. 456)

Their findings illustrate the various ways Black girls engage with and identify as science students, which demonstrate that there is no one science identity linked to one's interest and ability to achieve in science. On the other hand, the study illuminates the influence of the socially constructed idea of a "good" science student has on educators' narrow behavioral

expectations within science classes, which may hinder Black girls' opportunities in science. The authors conclude that the girls, "could benefit from a curriculum that permitted more diversity in the ways students might engage in and use science content" (p.456). Similar findings were presented in the Calabrese Barton et al. (2012) study, which revealed incongruence between one student's engagement in science work and her teacher's expectations of a "good" science student. The study revealed that the student's tendency to delve deeply into the learning, which was revealed through her explanations, was not positively recognized by the instructor as the speed in which students complete an assignment and provide correct answers at the expense of deeper knowledge was honored by the instructor (Calabrese Barton et al. 2012).

Hanson (2009) offered a comprehensive examination of Black girls' experiences in science using the National Educational Longitudinal Study (NELS) and her Knowledge Networks web survey. The author focused on topics such as the participants' attitudes toward science, the influence of educators on their experiences, and the role of Black families and peers. The study uncovered that Black girls were more likely to have positive attitudes toward science in comparison to their White, female counterparts in 8th grade, however, they reported less interest as they progressed in high school. Despite having an interest in science, Hanson (2009) revealed that Black girls recognized race as a potential barrier to their success in science and had discouraging experiences in school science. She also identified multiple concerns for Black girls' poor experiences in school science such as feeling isolated, having their confidence in science challenged, and being systematically steered away from the subject.

Despite their reported poor experiences in school science, Hanson (2007, 2009) sheds light on the role of family and friends on Black girls' science attitudes and experiences. Based on

her findings, the author argues that the Black family and community may serve as an, "important source of agency in this realm" (Hanson, 2009, p. 91). Findings also suggest that Black girls receive most of their encouragement from other Black women in their families. Peer relations are more complex, with students sharing that their peers were less interested in science and provided very little support for their pursuit of science achievement. In contrast, there were a limited number of respondents who denoted having friends and peers who were interested in science. Those who reported having friends interested in science also reported receiving support from those friends as well.

Together, these findings demonstrate the various influences that may interrupt or propel African American girls to construct science identities leading to potential science success and careers in STEM. This literature demonstrates the significance of creating more supportive science learning spaces where teachers affirm Black girls' capabilities in science similarly to how the students are encouraged by their families and friends with likeminded interests. Furthermore, it is vital that these science learning communities implement pedagogical practices that foster science identity development that poises Black girls to become self-assured in their engagement in science classrooms and are successful. The following segments focus on the pedagogical approach I believe will provide African American girls with science learning experiences that uncover various identities that are paralleled to success in science and interest in science, which I refer to as Black Feminist Science Pedagogy.

Creating Culturally Relevant, Black Feminist Science Counterspaces

Moses and Cobb (2000) argue in *Radical Equations*, "In today's world, economic access and full citizenship depend crucially on math and science literacies" (p.5). The authors used industrialism as an example of how advances in science and technology created new jobs that displaced people of color who did not have the mathematical and science skills to fill them. The authors also referenced schools that inadequately prepared students of color for these positions and posed that, "Industrial technology created schools that educated an elite to run society" (Moses & Cobb, 2000, p. 11). Unfortunately, historically marginalized groups were not considered a part of this "elite" group of students. This notion is also comparable to the differences between the four types of schools described in Anyon's (1980) text, which she argues prepared students for careers akin to their current economic and social positions.

Tate (2001) expands on these ideas by making the case for declaring science education as a civil rights issue and urges scholars to redirect their attention from shared physical space (i.e. segregation) to shared opportunities to learn. Calabrese Barton (2002) later calls attention to the increased focus on science education through a similar social-justice lens to better understand science education and urban students' "visions of science, success in science, and participation in science" (p. 17). Emdin (2010) also argues that many science educators are beginning to address science education for urban students through a social-justice lens and suggests that, "urban settings have proven to be sites in which much needed change in access and exposure to science should begin" (p. 1).

In the case of science educational opportunities for African American girls, I posit that implementing pedagogical approaches rooted and centered in the students' cultures, histories,

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and funds of knowledge can influence their science identities in ways mainstream approaches do not achieve. As I previously stated, the pedagogical approach used in this study, Black feminist science pedagogy, is significantly grounded in culturally relevant pedagogy, Black feminist pedagogy, and feminist science pedagogy. I begin with the historical underpinnings of culturally relevant pedagogy, as the call for curricula that honors Black students' cultural histories in an effort to expand social opportunities is not a recent phenomenon among Black educators and scholars. I then describe the core themes of culturally relevant pedagogy before focusing attention on the growing body of research examining the use of culturally relevant practices in science classrooms. Lastly, I introduce Black feminist pedagogy and feminist science pedagogy and explain how these interrelated approaches collectively inform Black feminist science pedagogy.

Historical Underpinnings of Culturally Relevant Pedagogy

Public education in the United States has progressed significantly in terms of diversity, with the proportion of students of color attending public schools growing each year (Aud, et al., 2013). Despite this diversity, the curricula and pedagogical practices used to educate African American students are merely nominal alterations of the pedagogy that has historically benefited White students, as Caucasian American culture is greatly represented in the curricula. Having undergone over a century of deculturalization in public schools (Spring, 1994/2010; Woodson, 1933/2005), African American students have had few opportunities to see their culture positively represented in the curriculum, especially within textbooks (Gay, 2000; McCarthy, 1990; Woodson, 1933/2005). These representations are mainly romanticized

accounts of slavery and surface-level descriptions of prominent African American leaders such as Frederick Douglass, Martin Luther King, Jr., and Rosa Parks (McCarthy, 1990). Traditional instructional practices, in addition to curricula, have historically steered African American students to the margins of achievement in U.S. public schools (Delpit, 1995; Ladson-Billings, 1994, 1995b; Woodson, 1933/2005). This is especially so within science, as it is mistakenly labeled a neutral subject void of cultural influence and bias (Laughter & Adams, 2012). With this in mind, a more profound change in how we approach science education is warranted and an overhaul of how we educate African American girls is necessary.

The longstanding argument to include more Afrocentric and culturally inclusive pedagogy to better educate African American students and sustain their culture has been discussed by numerous scholars (Asante, 1991; Delpit, 1995, 2012; Henry, 1994; Howard, 2010; Howard & Terry, 2011; Ladson-Billings, 1994, 1995a, 1995b; Lee, 1992; Lee, Lomotey, & Shujaa, 1990; Woodson, 1933/2005). Furthermore, it is important to understand the history of African American schooling (Anderson, 1988; Perry, 2003) and ways a potentially liberating education transformed into a system of indoctrination (Spring, 1994/2000). Anderson's (1988) historical record of early African American education uncovered that African American leaders initially considered formal education as, "a means to liberation and freedom" (p.17) as opposed to an attempt to adopt White values. This is especially so, given few White children were being formally educated in the south during the late 19th century. Instead, Anderson (1988) shares a different account of African American education's goals during this period,

> …the prevailing philosophies of black education and the subjects taught in black schools were not geared to reproduce the caste distinctions or the racially segmented labor force desired…Rather, it reflected their belief that education could help raise the freed

people to an appreciation of their historic responsibility to develop a better society…
(p.28)

In reference to the classical curriculum Black educators developed, Anderson (1988) argued that Black students were "provid[ed] access to the best intellectual traditions of their era and the best means to understanding their own historical development and sociological uniqueness" (p.29). Despite competing education models such as the Hampton-Tuskegee model that sought to instruct Black educators to train the next generation of politically disenfranchised agricultural and industrial laborers, there remained schools that preserved a liberal curriculum (Anderson, 1988). However, with considerable support from those who believed African American education should serve the needs of a growing industrial economy and the much later onset of compulsory education, the maintenance of African American education for social freedom and leadership diminished over time.

Today, nearly 150 years since the introduction of the Hampton-Tuskegee model, social justice educators continue to stress the importance of pedagogy and curricula that are emancipatory in nature. Expanding on the multicultural education movement, educators are challenged to take a more action-oriented approach towards incorporating the lived experiences and *funds of knowledge* (Moll, Amanti, Neff, & Gonzalez, 1992) of students of color in the classroom, especially in urban school contexts. Examples include critical pedagogy (Camangian, 2013; Duncan Andrade & Morrell, 2008), decolonizing pedagogy (Tejeda, Espinoza & Gutierrez, 2002), and culturally relevant pedagogy (Gay, 2000, 2002; Ladson Billings, 1994 1995a, 1995b) which is described in greater detail in the following section.

Core Themes of Culturally Relevant Pedagogy

Culturally relevant pedagogy declares a need for effective pedagogy centered on the

cultural histories and experiential knowledge of historically marginalized students of color by

> "using the cultural knowledge, prior experiences, frames of reference, and performance
> styles of ethnically diverse student[s] to make learning encounters more relevant to and
> effective for them. It teaches *to and through* the strengths of these students. It is
> culturally *validating and affirming*" (Gay, 2000, p.29).

In her groundbreaking research, Gloria Ladson-Billings (1994, 1995a, 1995b) identified: (1)

academic success; (2) the development and maintenance of cultural competence; and (3)

developing critical consciousness, as the three main criteria for culturally relevant pedagogy.

According to Ladson-Billings (1995b), educators using culturally relevant pedagogy will

"produce students who can achieve academically, produce students who can demonstrate

cultural competence, and develop students who can both understand and critique the existing

order" (p.474). Through her research of educators who were considered effective and fruitful

teachers of African American students, Ladson-Billings found that their practices affirmed

students' heritage and cultural knowledge by integrating their lived experiences into the

curriculum. Further, these teachers had high academic expectations of their students and did

not oppose addressing social inequities throughout their curricula.

Gay later described culturally responsive pedagogy as one that includes practices that,

"simultaneously develops, along with academic achievement, social consciousness and critique,

cultural affirmation, competence and exchange; community building and personal connections;

individual self-worth and abilities; and an ethic of caring" (Gay, 2002, p.43). Howard (2010) and

Howard & Terry (2011) also offer a comprehensive analysis of culturally responsive pedagogy.

They reveal that culturally relevant pedagogy collectively serves to remove deficit-based

ideologies of students of color, challenge mainstream practices as normative, and build critical

consciousness and sociopolitical development, which, "reflects an ongoing commitment to

challenging injustice, and disrupting inequities and oppression of any groups of people"

(Howard & Terry, 2011, p. 348). Keeping these explanations in mind, culturally relevant

pedagogy goes beyond changing teaching practices in a surface-level manner. Instead, it

requires educators to be intentional in their pedagogical practices and the potential effects

these practices have on their students' achievement.

In association with these ideas, the five guiding themes of *culturally responsive*

pedagogy identified by Gay (2002) charge educators to: (1) develop a knowledge base about

cultural diversity; (2) develop a culturally relevant curriculum; (3) demonstrate caring and build

learning communities; (4) communicate with ethnically diverse students; and (5) respond to

ethnic diversity. Although there are some distinctions between the earlier writings of culturally

relevant and culturally *responsive* pedagogy, Gay (2000) argues that these terms can and are

often used interchangeably. As I stated in Chapter One, I have elected to use the term culturally

relevant pedagogy within this text. I will now concentrate on the significance of developing a

culturally relevant curriculum (Gay, 2000), fostering and maintaining cultural competence, and

building students' critical consciousness (Ladson-Billings, 1995a, 1995b) through culturally

relevant pedagogy since these tenets are the cornerstone of the STEMpowerment program's

curriculum.

To effectively develop and maintain students' cultural competence, having a strong

knowledge base about students of color is critical to implementing culturally relevant pedagogy

(Gay, 2000, 2002). Woodson (1933/2005) best explains this when he states that to best educate

the Black student, educators must, "find out exactly what his background is today, what his possibilities are, and how to begin with him as he is and make him a better individual of the kind that he is" (p.97). In addition, it is important that this knowledge acquisition is not based on a deficit-minded understanding of African American students, their history, and their culture (Gay, 2000; Howard, 2010; Howard & Terry, 2011). As stated above, traditional curricula have provided limited representations of people of color, thus educators must learn more "*explicit knowledge* about cultural diversity" (Gay, 2002, p. 107). Building this knowledge is considered essential to meet the needs of culturally diverse students; however, knowledge without implementation is futile. This cultural knowledge must manifest itself within the curriculum (Delpit, 2012; Gay 2000, 2002; Howard, 2010; Howard & Terry, 2011; Ladson Billings 1994, 1995a, 1995b). Ladson-Billings (1995a) asserts that students' culture must serve as "a vehicle for learning" within culturally relevant classrooms (p.161)

Developing a culturally relevant curriculum disrupts the longstanding use of Eurocentric-only curricula in public schools, which has led to, "largely imitation resulting in the enslavement of the mind" (Woodson, 1933/2005, p.87) for African American students. Gay (2000) explains the utility of culturally relevant pedagogy in empowering students of color through knowledge that is, "accessible to students and connected to their lives and experiences outside of school" (p. 111). Gay (2000) argues that ethnic and cultural representation in the curriculum serve to expose the stereotypical images and ethnic biases found in textbooks, literature, and mass media and replaces these with versions of their own cultural "truths."

Gay (2000) and Lee, Lomotey, and Shujaa (1990) demonstrate that efforts to incorporate the culture of other historically oppressed groups into the curriculum had a positive

effect on students' interest and performance in multiple subject areas. Lee, et al. (1990) and

Lee's (1992) scholarship on Afrocentric-centered schools also offer important examples and

explanations of how African American students' ethnic heritage can serve as the *foundation* for

curricula and pedagogy in contrast to being rendered a supplement. Collectively the authors

display the possibility, value, and necessity of designing curricula rooted in one's ethnic culture.

In addition, this curriculum development is not limited to social studies, literature, and the fine

arts, but also mathematics (Moses & Cobb, 2000; Tate, 1995; Terry, 2010) and science (Boutte,

Kelly-Jackson & Johnson, 2010; Emdin, 2010; Farinde & Lewis, 2012; Goldston & Nichols, 2009;

Laughter & Adams, 2012; Lee, 1992; Lee et al., 1990). Despite its use within mathematics and

science, many continue to presume cultural relevance as too difficult and/or unnecessary to

root in these respective subjects. The following displays how culturally relevant pedagogy is

implemented in science classrooms in ways that challenge these assumptions. Further, these

studies demonstrate the continued determination to provide an engaging and meaningful

science classroom environment for African American students that will garner their increased

academic achievement and interest in science. This is especially important when considering

the outcomes of African American girls in science and their continuous exclusion from greater

opportunities for success.

Culturally Relevant Science

Welner and Carter (2013) state, "In a pluralistic and democratic society, schools must

respond to students' actual needs, build on their unique strengths, be culturally responsive and

provide the opportunities necessary to give every student a fair chance at academic success"

(p.5). Although there remains a general belief that science is detached from cultural influence, science education cannot continue to offer traditionalist science instruction that alienates African American girls. Culturally relevant science serves to position students as capable science learners and challenges deficit positions about their contributions to science.

Although literature focused on incorporating culturally relevant pedagogy in science appears to be a recent focus among scholars, Lee et al. (1990) described ways to incorporate African culture in science units nearly three decades ago. This was in response to an overwhelming focus on the arts and humanities in ethnic-based curricula at the time. The authors explained how Afrocentricity, African American culture, and African American history were used in architecture, aeronautics, and computer science units within the study. Through these units, students not only mastered the necessary scientific content, but were also introduced to each unit's relationship to their cultural heritage and African American role models within each field. Lee's (1992) later work presented conceptual diagrams of scientific inquiry that were grounded in the African ideology of interconnectedness. Lee et al. (1990) explained that a more African-centered curriculum will, "legitimize African stores of knowledge, idealize community service, and impart a worldview in which Africans master technology and support cultural continuity while promoting critical consciousness" (p.53).

A growing body of literature focuses on culturally relevant pedagogy in science spaces that accentuate the culture and heritage of students of color through traditional and contemporary African American cultural knowledge (Boutte et al.; Emdin, 2010; Farinde & Lewis, 2012; Goldston & Nichols, 2009; Laughter & Adams, 2012). Incorporating culturally relevant pedagogy in science classrooms is believed to, "[recognize] that there is a wide range

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of scientific skills and ways of knowing that people display in their lived experiences within diverse communities" (Boutte, et al., 2010, p. 2). The importance of these studies is their implementation of culturally relevant pedagogy in urban school environments that often serve African American, low-income, and future first-generation college students. These studies represent what can be achieved in the urban school to nurture science talent among African American students.

Boutte et al. (2010) displayed ways a culturally relevant science educator modified an existing curriculum with aspects of African American culture and the students' experiential knowledge. For example, when the educator used a cell analogy lesson to help students learn about cell structure, organelle functions, and content vocabulary, some students paralleled these to the structure and functions within the Black church. The importance and influence of the African American church and the educational experiences of African American students is referenced in other studies as well (Goldston & Nichols, 2009; Ladson-Billings & Henry, 1990). Another unit in the study drew connections between the integumentary body-system (i.e. hair, skin, nails) and the history of Black hair care in America, which also included the influence of Madame C. J. Walker (Boutte et al., 2010). In addition, a similar science unit on Black hair referenced by Delpit (2012) focused on "the mathematics of black hair design" (p. 21) and the science related to the ingredients used to create Black hair products.

Seiler (2001) offers a significant addition to incorporating the funds of knowledge and everyday experiences of African American males in science through her work in a Philadelphia high school. Through their interactions, she and the students were able to draw connections between science and their favorite sports, musical instruments, health-related issues, topics

related to the hair product industry, and cellular phones. In addition, the students' interest in learning science flourished as they started to hold each other accountable regarding their commitment to learning the subject. Seiler explains that the young men were adamant that newcomers to their group were as serious about science as they were before gaining acceptance.

The linkage of hip-hop culture and science is studied by Emdin (2010), who argues, "Focusing on hip-hop in the science curriculum requires acceptance of the notion that hip-hop can be used to connect students to science" (p. 9). Emdin (2010) bridges the gap between the stereotypical "hip-hop student" and the "science student" who are presumed as dichotomous beings. Further, his scholarship demonstrates ways science teachers can draw from artists who have used scientific knowledge in their lyrics (i.e. The GZA, Wu-Tang Clan) to teach scientific concepts and in turn encourage students to incorporate science into their own lyrics to demonstrate their understanding of these concepts. I have used similar strategies to reinforce science content using Erykah Badu's "Orange Moon" (Badu, 2000, track 10). In the song, the artist refers to herself as an orange moon "reflecting the light from the sun," (Badu, 2000, track 10), which reinforced students understanding of stars emitting light and other celestial bodies (i.e. planets and moons) reflecting this light.

Together these examinations demonstrate the possibilities that arise when aspects of African American students' culture and experiential knowledge are incorporated into the science classroom. The studies displayed how students can demonstrate their understanding of scientific concepts through culturally relevant assessments as well. These assessments challenge the notion that there is one way to demonstrate one's aptitude in science and a

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single or predominant example of how a "scientist" should socially perform to be recognized as a "good" science student. In the case of African American girls, incorporating their culture and issues concerning their lives into their curriculum challenges the notion that science is divorced from their everyday lived experiences or that their home lives have little to offer the science community. Thus centering the science curriculum on their lived experiences and interests repositions them from their "othered" status within science education (Emdin, 2010). Ultimately, science education as it currently stands will not bring African American girls equitable opportunities if their communities' histories, stores of knowledge, and contributions remain unacknowledged and unwelcomed in the curriculum.

Black Feminist Pedagogy

As a female, African American science educator, Black feminist pedagogy is reflective of the pedagogical approach I constantly strive to implement in the classroom. Additionally, Black feminist pedagogy is aligned with the appeal to use a culturally relevant pedagogy that will build a culture of care in the classroom and a push towards advancing students' propensity to critique the systems in which they navigate (Ladson-Billings 1994; 1995a, 1995b). This is especially important for African American girls who will navigate other science spaces that reinforce mainstream ways of learning and the socially constructed behaviors expected of "real" scientists.

Early literature theorizing a Black feminist pedagogy suggests that it "is not merely concerned with the principle of instruction of Black women by Black women and about Black women" (Omolade, 1987, p.32). Instead, Black feminist pedagogy encompasses the pedagogical

traditions of African American educators who have demonstrated excellence in teaching African American youth (Ladson-Billings, 1994). While the culturally relevant curriculum content developed for this study is vital, Ladson-Billings (1994) argues that its *implementation* is of utmost importance. It is evident that the practices in Black feminist pedagogy overlap with culturally relevant pedagogy and I will visit the themes that influence my interpretation of what I consider *Black feminist science pedagogy*. These themes represent the Black feminist pedagogical practices that will contribute to the science learning community of the STEMpowerment program and include: (1) demonstrating an ethic of care and (2) the political nature of Black feminist pedagogy.

I draw from multiple examples in the literature that refer to demonstrating an ethic of care within Black feminist pedagogy such as developing authentic relationships with students, creating familial learning environments, and taking on the role of "othermothers" in the classroom (Beauboeuf-Lafontant, 2002; Dixson, 2003; Foster, 1993; Ladson-Billings, 1994; Omolade, 1987). Foster's (1993) analysis of "connectedness" (p. 104) offers insight into ways African American female teachers develop "appropriate relationships between themselves, the students, families and communities they serve" (p. 104). This aspect of care extends to creating the caring relationships between teachers and an individual student often described in the care literature (Noddings, 1992). Connectedness recognizes the interrelated bonds among the students, teachers, and the surrounding community they reside.

Connectedness also acknowledges the shared cultural histories between female African American teachers and their African American pupils by recognizing that they share lives as marginalized people in U.S. society (Omolade, 1987). This is consistent with creating a familial

learning environment or "learning community" within the classroom space as well. Ladson-Billings (1994) contends that teachers should create more fluid teacher-student relationships, which positions students to exhibit their abilities to learn *and* lead in the class. This is congruent with the ideals of traditional African American schooling that sought to train the next generation of African American leaders (Anderson, 1988). Furthermore, creating familial spaces aligns with Afrocentric values of communalism as opposed to individualism, thus students are not solely responsible for themselves, but share responsibilities with their peers as members of an extended family (Ladson-Billings, 1994).

The concept of "othermothers" illuminated by Collins (2000/2009) in her analysis of Black feminist epistemology references the history of African American women taking on maternal roles within the community, especially as teachers. Beauboeuf-Lafontant (2002) declares that, "othermothering is germane to education because teaching in the African-American community, as in other ethnic groups, has been dominated by women since the turn of the 20th century" (p. 77). The teacher as "othermother" refers to their historical adoption of maternal roles or service as "surrogate parents" (Dixson, 2003, p.230) in the classroom. This assumes the othermother role greatly contributes to building a fictive-kinship within the familial learning environment (Beauboeuf-Lafontant, 2002; Collins, 2000/2009; Delpit, 1995; Dixson, 2003; Foster, 1993).

Given the political nature of Black feminist pedagogy (Dixson, 2003), it is not farfetched to suggest that there has been a Black feminist pedagogy before there were formal African American, female educators in the traditional education system. Contemporary African American female educators taking on the responsibility to instruct African American children as

a conduit for racial uplift is founded in enslaved Africans' taking the risk to teach each other to read and write in the quest for freedom (Anderson, 1988; Perry, 2003). African American education, even in its rudimentary form, has always represented a political act towards gaining freedom (Anderson, 1988). In Dixson's (2003) exploration of Black women's pedagogy, the author found that the participants demonstrated various acts of political involvement leading toward more equitable education of their students. Furthermore, they considered their call to teaching more of a responsibility and an act of "public service" (Dixson, 2003). This represents African American women's commitment to do much more than teach because they enjoy the profession, seek personal fulfillment, or because they "like" children. Instead they do so as an act of fulfilling their "civic duty" to advance opportunities for African American children and the African American community. This act represents far more than the aforementioned reasons too often associated with women's work as educators. Black feminist pedagogy reveals that many educate as an act of love for and commitment to the African American community.

Concerning the role of social and systemic barriers intended to impede African American girls' success in science, it is also important to explore the politics of challenging the dominant pedagogy in science education or having "political clarity" (Beauboef-Lafontant, 2002, p.77). The authors describe the "political clarity" of African American female teachers' as the ability to, "see racism and other systemic injustice as simultaneously social *and* education problems" (p.77). The author goes on to argue that these teachers also, "demonstrate a keen awareness of their power and responsibility as adults to contest the societal stereotypes imposed on children" (p.77). I posit that for African American girls engaging in a science counterspace, Black feminist pedagogy must involve guiding students to recognize and challenge stereotypes

about their abilities as well as the systemic injustices within the sciences. This line of thinking relates to Ladson-Billings's (1994) argument for students' gaining critical consciousness within a culturally relevant classroom.

Feminist Science Pedagogy

Calabrese Barton's (1998) examination of feminist science pedagogy presents an example of how feminist science educators can utilize their pedagogy in science classrooms. In her examination of her own practices in a college-level introductory chemistry course, the author pushed her students to critique Western, patriarchal notions of science learning and practices. By challenging the dominant pedagogy of science and guiding her students to critically think about the practice of science as opposed to solely focusing on content acquirement, her students showed a connection to and demonstrated achievement in science unlike some students in traditional science learning spaces. Furthermore, she challenged the norm that science is an inherently unattainable subject to grasp if one was not a "science" person by redefining both what it means to be a scientist and the general practice of the subject.

Black feminist science pedagogy is an amalgamation of the central tenets and pedagogical practices found within culturally relevant, Black feminist, and feminist science pedagogies. While there are distinct essential elements found among each, these approaches are interrelated and complement each other. Thus, Black feminist science pedagogy represents a means to challenge traditional science learning through the intersection of the aforementioned social justice oriented pedagogical approaches.

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What follows in Chapter Three is the theoretical framework used to examine the identity development of the African American girls in the STEMpowerment program, including the science identity development model used as a tool to analyze the STEMpowerment participants' identity development followed by an explanation of critical race theory and Black feminist epistemology, which serve as the guiding theories for this study.

CHAPTER THREE
Theoretical Framework

Introduction

Three theories undergird this work: science identity development, critical race theory, and Black feminist epistemology. In Chapter Two, I provided an extensive explanation of the utility of employing Black feminist science pedagogy within the science learning space. I will begin this chapter by introducing science identity development literature followed by a more descriptive explanation of the framework I will use to examine the African American girls' identity development within the culturally relevant STEM counterspace. I will follow my description of the science identity model by concentrating on the theories I used to examine their identities—critical race theory and Black feminist epistemology.

Science Identity Development

There is an array of literature that focuses on the science attitudes of marginalized groups, such as students of color and women in particular, that specifically examines gender differences in attitudes (Baker & Leary, 1995; Catsambis, 1995; Jones, Howe, Rua, 2000; Zacharia & Calabrese Barton, 2004). Among this research, recent focus specifically concerns African American girls (Buck et al., 2009; Farinde & Lewis, 2012; Hanson, 2007, 2009; Pringle et al., 2012). Within science education research, there are increasingly more studies employing science identities as an analytic tool to understand a range of topics concerning students' learning experiences, participation, and success in science (Brickhouse, et al., 2000; Brickhouse & Potter, 2001, Brown, 2004; Brown, Reveles, & Kelly, 2005; Carlone & Johnson, 2007; Cobb, 2004; Tan & Calabrese Barton, 2008). Although there are science identity studies focused on

students of color and women as collective groups, much like the body of research examining attitudes and experiences, there is scant research solely on women of color (Carlone & Johnson, 2007; Elmesky & Seiler, 2007; Johnson, 2001, 2006; Tan & Calabrese Barton, 2008) or specifically African American girls and/or women (Brickhouse et al., 2000). Among this body of research centered on race and gender, there are studies that reveal that African American girls must adhere to cultural norms within traditional science classrooms to be fully accepted into the science community, especially by their teachers (Brickhouse et al., 2000; Brickhouse & Potter, 2001).

As I referenced in Chapter One, I posit that science identities are influenced by the context in which students engage in science. Given this, I take a sociocultural approach to examine the science identity development of African Americans participating in the STEMpowerment counterspace, as this approach "emphasizes the role of classroom communities and an understanding of the development over time of the unique social relationships and microcultures that characterize these communities" (Lemke, 2000, p. 305). Drawing from this perspective, I contend that students' science identities are constructed as they navigate different learning communities and may exhibit select identities relative to that space (Tan & Calabrese Barton, 2008). Below I briefly describe studies that examine the science identities constructed by girls of color within various science spaces. These studies reveal the influence the community in which they engage in science has on their identity construction within these spaces.

Tan and Calabrese Barton's (2008) study on the science identities of girls residing and attending schools in "urban" neighborhoods focuses primarily on the role of the "community of

practice" and the "identities-in-practice" they construct as they navigate these spaces (p.48). In terms of the science classroom, the authors argue that social structures within the science-learning environment inform students' identities in practice. In addition, they suggest that students exhibit distinctive science identities within different "figured-worlds" such as when they engage in small and large groups, give oral presentations, and participate in non-classroom science environments. Within their study, the authors found that through the girls' individual identities-in-practice, they exert their agency as "border-crossers" between their lived and cultural experiences and the science classroom.

The authors conclude:

> We believe that when the girls experience success in science class when participating through the perspectives of identities-in-practices. Identities-in-practice as a lens opens up and reveals the girls' interests in science and displays their agency in engaging with science meaningfully on their own terms in ways that cannot be surfaced through traditional commodified, testing instrument. (Tan & Calabrese Barton, 2008, p. 69)

Elmesky & Seiler (2007) also contend that science identities are influenced by the social structures within the classroom that can either be accepting or disapproving of behaviors misaligned with those traditionally expected of "scientists." The authors focused primarily on the role of students integrating the cultural disposition of movement expressiveness within the science classroom to build solidarity with fellow students as members of their science classroom community. They also demonstrate ways students can reconstruct science identities without discarding their identities as African American youth. The authors denote the tension between engaging in this form of border-crossing within science communities-of-practice with instructors whose ideas of science classroom practices and behaviors are not aligned with students' cultural dispositions. This cultural mismatch results in isolating students and

reinforces dichotomous representations of what it means to be a "good" science student, which then demotes students as "others" within the space (Elmesky & Seiler, 2007).

Studies such as these demonstrate that a deeper understanding of how African American girls are positioned as scientists within socially constructed spaces, such as the science classroom, are warranted. Here, there are multiple factors that impact students' science identities, namely the pedagogical practices of the instructors within these spaces and beliefs about what behaviors are representative of a "good" science student. Essentially, instructors serve as gatekeepers within the science class by determining the norms and practices that students must follow to become recognized as positive contributors within their classroom communities. Below I link these ideas to the science identity model that will guide my analysis of the African American girls' identity development within the culturally relevant, STEM counterspace.

Science Identity Development Analytic Tool

This study employs the initial Carlone and Johnson (2007) science identity model used to analyze the role of race, gender, and class on the science identities women of color in science fields, which they argue is "a connection hinted at, but not made explicit, in previous literature" (p.1191). The researchers describe a person with a "strong science identity" (p. 1190) as someone who is

> ...competent; she demonstrates meaningful knowledge and understanding of science content and is motivated to understand the world scientifically. She also has the requisite skills to perform for others her competence with scientific practices (e.g., uses of scientific tools, fluency with all forms of scientific talk and ways of acting, and interacting in various formal and informal scientific settings). Further, she recognized herself, and gets recognized by others, as a "science person." (p.1190)

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In addition to these ideas, the authors rely on Gee's (1999, 2000-1) theory of identity, which considers the social construction of identity. Gee shares that, "being recognized as a certain 'kind of person' in a given context," reflects one's identity and that "all people have multiple identities connected not to their 'internal states' but to their performances in society" (2000-1, p.99). In reference to the importance of considering social constructs on science career choice, Lewis (2003) argues that previous literature on the underrepresentation of African Americans in the sciences often does not consider the social process involved with choosing science as a career. He suggests, "An aspiring scientist relies on the judgment and invitation of practicing scientists throughout every phase of the educational and career process," (Lewis, 2003, p.371). Collectively, these ideas support the notion that developing a science identity is not an internalized phenomenon that happens within an individual without influence from multiple variables, in this case, social interactions within science learning communities.

Within their longitudinal study of 15 undergraduate women of color who majored in STEM subjects and later pursued science-related careers, Carlone and Johnson (2007) identified three "interrelated dimensions" of science identity within their initial conceptual model that include: (1) *performance* of science, (2) *recognition* as a scientist, and (3) *competence* as a scientist. What follows is an explanation of each dimension within the model.

Competence

Competence in science is described as having "knowledge and understanding of science content" (Carlone & Johnson, p. 1191) or what is often described within the K-12 educational system as having "content knowledge" or "content mastery" based on the prescribed science

objectives adopted by the state. While it may appear rather easy to determine whether a

student has content mastery, often this knowledge is determined by standardized assessments

that provide mere snapshots of student learning, and thus, are not necessarily an ideal measure

of science competence. In addition, when examining science identities, competence in a

specific science discipline such as chemistry, may not imply that a student will garner the same

level of understanding within the biological sciences. Nonetheless, engaging in meaningful

scientific inquiry and project based learning provides opportunities to observe students'

content and science process competence.   Furthermore, drawing from the interdisciplinary

focus on STEM education, students can demonstrate their processing skills in addition to

content knowledge in multiple subjects through lessons that integrate more than one STEM

discipline (Vasquez, Sneider, Comer, 2013).

Performance

Performance of science does not refer to one's academic performance in the sciences,

but rather one's social performance as a scientist of "relevant scientific practices" (Carlone &

Johnson, p. 1191). These practices include, but are not limited to, using the language of the

discipline to sound "science like" (p.1191) and successfully using science tools so that others

may recognize one as a scientist. This idea of a "performance" of a science identity is also

related to research that suggests that we offer a "corporate image" of oneself within different

contexts. It is argued that as identities are developed, people construct a corporate image,

which is described as an observable representation of physical appearance, attitudes, and

behaviors that relies on society, or the community in which one operates to accept and validate

(Hesse-Biber, Livingston, Ramirez, & Johnson, 2010; Luhtanen & Crocker, 1992). Garcia and

Crocker (2004) further point out that while validation of one's corporate image can produce

positive outcomes such as self-pride, the opposite may result in shame and humiliation.

This image most often symbolizes who you *present* yourself to be and as a result, others make

assumptions about your character and abilities based on this representation. Based on these

assumptions, it is necessary that this image be compatible with the social norms within a

particular space or career path for someone's acceptance within that community. In terms of

African American girls in science, the long-standing idea of what a "scientist" looks and acts like

is in constant conflict related not only to their race and gender as African American women, but

also the misunderstood or stereotyped perceptions of African American girls' behaviors and

cognitive abilities within learning spaces.

This particular dimension is closely aligned with the aforementioned literature

concerning the social structures that influence science identities. Brickhouse et al., (2000)

details how the African American girls in their study sometimes adjusted their science identities

depending on the audience (i.e. teacher, peers, parents). Studies that describe students'

border-crossing within these science spaces also beg the question of what happens when

students' identities are positively acknowledged within science classrooms. I argue that there is

room for multiple acceptable performances of scientific practices when science educators place

a greater value on varied identities within communities of practice. Therefore, there includes a

range of performances that are more inclusive of the diverse population of African American

girls navigating science spaces, which reassigns our girls from "other" to significant contributors

within science.

Recognition

Using a grounded theory approach, Carlone and Johnson (2007) found that the
"recognition" domain primarily influenced the women's science identities. These findings led
them to significantly tease out this particular domain in their analysis, which focused primarily
on the, "dual focus on both the agency of those striving to build a science identity and the
constraints on that process due to the structures within which that identity is being
constructed" (p. 1211). Regarding the constraints of being recognized as scientists, the authors
share that women of color, especially darker-skinned Black women in the study, negatively
experience the following normative expectations.

> It is much easier to get recognized as a scientist if your ways of talking, looking, acting,
> and interacting align with historical and prototypical notions of science. This, of course,
> makes it more likely that members of the discipline will keep reproducing members who
> look, talk, act, think, and interact like they do. (p. 1207).

Although recognition was a significant factor for women in the Carlone and Johnson (2007)
study, I contend that the accompanying dimensions the authors considered in their initial
model are equally vital for analyzing the identity development of the young women in this
study. Considering the model was used to understand the science identities of women who
have already successfully navigated through various milestones of their science careers, the
performance and competence dimensions may have been well developed at that point of their
trajectories, which may explain why they were not considered as influential. Given the young
girls within this study are still gaining competence in science and beginning to "perform" as
scientists, it is important to consider these two dimensions, which is why the model is used in
its entirety to examine their identity development including the role of race, ethnicity, and
gender.

Critical Race, Black Feminist Lens

The previous section focused primarily on science identity development research and the model I will use to analyze the girls' identities within the culturally relevant STEM counterspace. I use critical race theory (CRT) and Black feminist epistemology as the theoretical frame to examine American African girls' science identities. I begin by offering a historical explanation of critical race theory and its utility for analyzing educational issues followed by denoting the central tenets of CRT that predominantly guide this study. The section thereafter discusses Black feminist epistemology and the core ideas that are emphasized within the study.

Critical Race Theory

The overall enrollment of students in U.S. public schools has become increasingly more diverse over the past several decades with more students of color enrolling each year. The National Center for Education Statistics (NCES) reports that in 2011, U.S. public schools enrolled approximately 49.5 million students and of these pupils, 48 percent were students of color (Aud et al., 2013). Enrollment data demonstrate that from 1995 onward U.S. public schools have witnessed a steady decline of White students and an overall increase of students of color and these trends are projected to persist with students of color outnumbering the number of White students by 2016 (Aud et al., 2013).

While these data suggest that U.S. public schools are becoming more diverse, this diversity has not resulted in increased access to equitable educational opportunities for students of color or access to schools with diverse student populations. Orfield (2001) explains, "Although the diversity of our students has increased by order of magnitude since mid-century,

most of our children are growing up in separate societies and schools" (p. 17). This separation

has resulted in many students of color attending under resourced schools, which has influenced

their underrepresentation in selective postsecondary institutions (Teranishi, Allen, & Solórzano,

2004). This resegregation along with the deculturalization and denial of an equitable education

for students of color (Spring, 1994/2010) creates the persistent opportunity gaps between

racial groups (Welner & Carter, 2013) and the use of mainstream pedagogy void of cultural

relevancy (Asante, 1991; Delpit, 1995, 2012; Gay, 2000, 2002; Howard, 2009, 2010; Howard &

Terry, 2011; Ladson-Billings, 1994, 1995a, 1995b) collectively work to maintain the educational

stratification by race that has plagued our nation.

Recent scholarship suggests that race has minimized its influence on the educational

outcomes of students of color in comparison to socioeconomic status (Reardon, 2011). In

contrast, many scholars are steadfast in their belief that race influences the educational

experiences, opportunities, and outcomes of students of color in public schools and

postsecondary education (Allen, 1992; Howard, 2010; Ladson-Billings, 1998, 1999; Ladson-

Billings & Tate, 1995; Solórzano, Meja, & Yosso, 2000; Teranishi, Allen, & Solórzano, 2004).

Ladson-Billings and Tate (1995) proclaimed that race remained "untheorized" not due to a void

in research analyzing the affect race has on social inequity, but that, "the intellectual salience of

this theorizing has not been systematically employed in the analysis of educational inequality"

(p.50). Education scholars such as Gloria Ladson-Billings and William Tate (1995) and Daniel

Solórzano (1997) have answered this charge by producing groundbreaking educational

scholarship rooted in the theoretical underpinnings of critical race theory (CRT). The use of CRT

in education has undoubtedly offered a theoretical lens to understand, analyze, and unmask

the role of race and racism in U.S. public education and has gained momentum in its twenty years in educational scholarship.

Below, I describe how this framework is fundamental to analyzing the role of race in U.S. public education. I will first describe the origins of and central tenets that guide CRT followed by an explanation of its utility within educational scholarship. Scholars who have significantly contributed to developing CRT and CRT in education are referenced throughout.

Critical Race Theory (CRT) originated from a movement of legal scholarship, critical legal studies (CLS), which focused on ways power structures drive social, and cultural inequality within our capitalistic society. This scholarship serves as a 'critique to legal order' (Trubek, 1984, p.577) that, "challenges the ideas that a legal order exists in any society" (p. 577). Critical legal studies scholarship is rooted in Gramsci's theory of hegemony, as it relates to class structures, to, "describe the continued legitimacy of oppressive structures in American society" (Ladson-Billings, 1998, p.10). Critical race theory scholars offer the racial analysis that is lacking in CLS scholarship. Bell (1995) explains that CRT is, "a call for a change of perspective, specifically, a demand that racial problems be viewed from the perspective of minority groups, rather than a white perspective" (pp. 906-907).

There are five central tenets of critical race theory scholarship, they include: (1) the permanence of racism in U.S. society (Bell, 1992, 1995); (2) the theory of Whiteness as property (Harris, 1995); (3) the use of counterstorytelling and its use of experiential knowledge (Bell, 1995; Delgado, 1989; Solorzano & Yosso, 2002); (4) the critique of liberalism as the dominant ideology (Decuir & Dixson, 2004; Ladson-Billings, 1998; Solorzano, 1997); and (5) the concept of interest convergence (Bell, 1980). The first, and arguably the most essential tenet that drives

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this work, is the recognition that racism is a normal and permanent structure interwoven into the fabric of U.S. society (Bell, 1992). Given this conviction, critical race theory scholars labor to "[unmask] and [expose] racism in its various permutations" (Ladson-Billings, 1998, p.11).

Counterstorytelling challenges the master narrative that aids to sustain the subordinate position of the oppressed through its continued reinforcement of racialized stereotypes about people of color and their experiences (Bell, 1995; Delgado, 1989; Solórzano et al., ; Solórzano & Yosso, 2002). Delgado, (1989) provides an excellent examination of the role of counterstories in collectively fighting injustice.

He states,

> Stories humanize us. They emphasize our differences in ways that can ultimately bring us closer together. They allow us to see how the world looks from behind someone else's spectacles. They challenge us to wipe off our own lenses and ask, "Could I have been overlooking something all along?" (p.2440)

Decuir & Dixson (2004) later reinforce that the master narrative is understood through the eyes of and told with the voices of the privileged, thus relegating the voices of the oppressed to the margins (Bell, 1995; Delgado, 1989; Solórzano & Yosso, 2002). Therefore, the counterstory is a mechanism used to decenter dominant voices and rewrite the narrative from historically silenced perspectives.

The following tenets (i.e. Whiteness as property, interest convergence, and critique of liberalism) are largely interrelated, as they uncover the role of White privilege in sustaining inequality and assert that seemingly progressive stances promoting equality clandestinely preserve this privilege. Whiteness as property is understood as the intersection of race and the traditional ideas regarding property and property rights based on historical legal theorists such as John Locke, Thomas Jefferson, and James Madison (Harris, 1993). The author identifies four

"property functions of whiteness" which include rights of disposition, rights to use and enjoyment, reputation and status property, and the absolute right to exclude (Harris, 1993). These rights traditionally assigned to what many may consider physical property (i.e. land, purchased goods, etc.) are now converted to rights and privileges exclusively reserved for the dominant group's actual being.

Interest convergence, another fundamental principle of CRT, is best described as a means by which the dominant group preserves its status by only allowing slight endeavors toward equality if and only if their privilege is not endangered or they are positioned to benefit from what becomes of the effort (Bell, 1980). Bell (1980) uses the landmark civil rights case Brown v. Board of Education (1954) to describe the role of interest convergence in maintaining racial stratification in U.S. public education. By exposing the negative "unintended" outcomes of the ruling on the African American community and the underlying need for the country to morally reinvent itself for diplomatic reasons at the time, Bell demonstrates that the ruling was less about ending segregation, but rather for the United States to maintain a powerful global position (Bell, 1980). Accordingly, interest convergence serves as a concealed apparatus to preserve the dominant group's property rights to Whiteness and the privileges it provides.

Finally, CRT scholars critique the three primary notions of liberalism: colorblindness, neutrality of law, and incremental change (Bell, 1995; Decuir & Dixson, 2004). The rejection of colorblindness is often the emphasis of critical race work as it also critiques and rejects laws that are race-neutral. CRT scholars argue that colorblindness fails to acknowledge racism, inequity, and oppression based on race and allows many to ignore the negative effects of

current and historical racism (Decuir & Dixson, 2004). The authors go on to state, "adopting a colorblind ideology does not eliminate the possibility that racism and racist acts will persist" (p. 29). Therefore, colorblindness permits individuals to remain ignorant about the social inequality that aids in maintaining positions of privilege, which is a property right of Whiteness, thus addressing injustice is deemed unnecessary and ignored entirely.

Critical Race Theory in Education

Critical race theory has proven to be a theory with transdisciplinary functions, as scholars have applied this framework within disciplines such as education (Ladson-Billings, 1998; Ladson-Billings & Tate, 1995; Solórzano, 1997). Given that public education is directly affected by federal, state, and local laws and has served as a representation of the civil rights struggle for people of color in the U.S., employing CRT in educational research is both meaningful and necessary. In their revolutionary article, Ladson-Billings and Tate (1995) first introduced the efficacy of CRT in education by illuminating aspects of race-based educational inequality by using CRT as an analytic framework. Ladson-Billings (1998) later demonstrated how CRT can be applied to examine specific aspects of education including curriculum, instruction, assessment, school funding, and desegregation. Ladson-Billings and Tate (1995) critiqued the function of multicultural education during that time and called attention to practices that were reduced to, "less than scholarly pursuits of the fundamentally different conceptions of knowledge or social justice" (p. 62). They went on to parallel multicultural education, as it was, with the liberalism CRT scholars rejected. In contrast to reinforcing the status quo, Ladson-Billings and Tate (1995) explained, "critical race theory in education, like its

antecedent in legal scholarship, is a radical critique of both the status quo and the purported

reforms" (p. 62).

Solórzano (1997) also contributed to the expansion of critical race theory in education

and identified tenets that he found most useful for educational scholarship. They include: (1)

the centrality of race and racism; (2) the challenge to dominant ideology; (3) the commitment

to social justice; (4) the centrality of experiential knowledge; and (5) the transdisciplinary

perspective of the work (Solórzano, 1997). Moving beyond the development of a critical race

theory of education, Solórzano & Yosso (2002) have also advanced the scholarship by

conceptualizing critical race methodology in education.

Black Feminist Epistemology

Black feminist epistemology or "thought" includes a growing body of theoretical,

artistic, and other works that have long served to embody Black women's standpoint. Black

feminist epistemology also advocates for the careful consideration of the intersecting roles of

race, gender, and class within the feminist movement and scholarship (Brewer, 1999; Collins,

1986, 2000/2009; Higginbothom, 1992; hooks, 1984; Hull, Scott, & Smith, 1982). In bell hooks'

Feminist Theory: From Margin to Center (1984), she explains that the traditional or "petty

bourgeois" feminist movement and feminist theory development primarily focused on women

gaining equal status with men; however, hooks argues that this presumes that *all* men have

equal rights that women, as a collective, should fight to attain. This line of thinking, she argues,

does not consider the intersecting role of race and class that, "in conjunction, with sexism,

determine the extent to which an individual will be discriminated against, exploited, and

oppressed" (p.19). With this in mind, Black feminism works towards eradicating all forms of

oppression that have served to disenfranchise historically marginalized groups, as our liberation

as African American women is codependent on the liberation of all those in subjugation (hooks,

1984). She goes on to highlight that while African American women were invited to share their

personal experiences within the feminist movement, they were not considered intellectual

contributors to the theorization of feminist theory. Collins (1986) points out that due to African

American women's marginalization, many resorted to sharing our standpoint through non-

academic means of resistance through literature, music, etc. Through the multiple means by

which Black women share our standpoint, Collins (2000/2009) recognizes those who contribute

to Black feminist thought as intellectuals notwithstanding one's social class, educational

background. Doing so acknowledges the interconnectedness among Black women and our

propensity to contribute to and practice Black feminist thought. Although many prominent

African American women have historically spoken out for our inclusion and adequate

representation within the feminist movements through various means, there is a growing body

of academic literature that has served to further develop and theorize Black feminist thought

(hooks, 1984; Collins, 2000/2009).

Within this study, I primarily draw from the ideas shared by Patricia Hill Collins's text,

Black Feminist Thought (2000/2009) as well as works that contribute to the core themes as they

relate to examinations of African American women's experiences. According to the author,

despite our experiential differences, the everyday lived experiences of Black women from a

variety of social class and educational backgrounds continue to inform our theoretical analysis

of Black feminist thought and practices (Collins, 2000/2009). This autonomy of thought

provides Black women with the agency to "set the record straight" by interpreting our own experiences as opposed to having them interpreted for us, as this positions us to collectively serve as keepers and producers of knowledge concerning our existence (Collins, 2000/2009).

The knowledge presented in this study will be produced by and acquired from young African American women in an effort to develop an understanding of their experiences during a critical point in their science identity development. Collins (1986) indicates that Black feminist thought does not primarily aim to educate others about our experiences, but to educate each other as African American women, thus this work is more about educating each other about the science identity development of African American girls and the girls learning from each other's perspectives as it is about educating the masses. Furthermore, Collins (2000/2009) contends that such work preserves Black women's autonomy in interpreting and sharing our experiences in addition to taking ownership of defining ourselves as Black women.

In an earlier work, Collins (1986) described three key themes within *Black Feminist Thought*: (1) the meaning of self-definition and self-valuation; (2) the interlocking nature of oppression; and (3) the importance of Black women's culture. A more expanded work unveiled additional core themes were developed, bringing the total to seven. They include: (1) Work, Family, and Black Women's Oppression; (2) Controlling Images of Black Women; (3) the Power of Self-Definition; (4) Sexual Politics of Black Women; (5) Black Women's Love Relationships; (6) Black Women and Motherhood; and (7) Black Women's Activism (Collins, 2000/2009). Below, I will focus particular attention on the controlling images of Black women, Black women and motherhood, the power of self-definition, and Black women's activism.

Controlling Images of Black Womanhood

As explained above, African American women have constantly fought to have their

voices heard and recognized as primary authors of our experiences. After enduring the

dehumanization of slavery, the once physical destruction of African American women's power

through slavery has since been replaced and maintained with stereotypical, controlling images

that psychologically dehumanize us. These images, then, portray African American women in

ways that are counter to Western ideas of White femininity, and since these images are almost

always presented in a negative manner, they give others the presumed privilege to continue

the dehumanization and oppression of African American women. Collins (2000/2009) further

explains, "These controlling images are designed to make racism, sexism, poverty, and other

forms of social injustice appear to be natural, normal, and inevitable parts of everyday life"

(p. 77).

The primary and longstanding controlling images that have served to objectify and

subjugate Black women include the mammy, Jezebel, matriarch, and welfare mother (Collins,

2000/2009). The mammy, described as the "faithful, obedient domestic servant" (p. 80) and

often portrayed as the desexualized housekeeper/maid in texts and film, is, essentially, an

"emancipated" house slave. She is considered the quintessential Black woman in the eyes of

her oppressor because she has seemingly internalized and accepted her subservient position

and walks a fine line as an authority figure within the white family as the "surrogate mother in

blackface devoted to the development of a white family" (p. 81).

Historical and contemporary media images of the mammy include, but are not limited to

Hattie McDaniel's character "Mammy" in *Gone with the Wind* (Selznick & Fleming, 1939), the

protagonist in *Imitation of Life* (1934, 1959), and, most recently, Viola Davis's co-protagonist character portrayed in *The Help* (Stockett, 2009). These media representations did much more than represent this controlling image, but also signify the limited employment opportunities for African American women post-emancipation *including* acting roles.

Opposite the mammy is the matriarch or Sapphire who is often depicted as the strong, smart-mouthed, male castrating, head of household within African American homes (Collins, 2000/2009). This image depicts African American women as uncontrollable and therefore unappealing in the eyes of the oppressor because the matriarch is everything the mammy is not—at least not within the white household. More than a controlling image of African American women, the matriarch cannot exist without the controlling image of the "weak" or absent African American father, which further perpetuates negative perceptions of the African American family. Early deficit centered research concerning the African American family imposed the image of the African American mother as a working woman who neglected her motherly duties, thus her family suffered from her inability to live up to the mammy image expected of her by the dominant society (Moynihan, 1965). Collins (2000/2009) goes on to explain that this image also places the blame of African American children's failure on the African American mother, which redirects society's attention from the oppressive forces that aid in creating these circumstances.

The next controlling image is the welfare mother or "welfare queen" who is often depicted as the unemployed, unwed, and welfare-dependent African American who lack the work-ethic require to financially provide for her children (Collins, 2000/2009). Decades after this image emerged, African American single mothers have continued to be unfairly

stereotyped as "welfare queens" whose main goal in life is to bear children in hopes of

receiving public assistance (Collins, 2000/2009; Handler & Hasenfeld, 2007). In many ways, she

is the perceived "lazy" version of the matriarch who is incapable of properly raising her family

due to the limited aid from her children's father or fathers and her unwillingness to work. Like

the matriarch image, this image also serves to strip both African American women and men of

their roles as satisfactory parents due to the presumed absence of the father and the "laziness"

of the mother. Gilliam (1999) suggests that the welfare queen narrative script is now "common

knowledge," (p. 5) which has only been enriched by a disproportional percentage of media

images of African American women in poverty (Gilens, 1996).

Finally, the Jezebel is the hyper-sexualized image of the African woman who is often

portrayed as sexually aggressive (Collins, 2000/2009). Historically, the Jezebel image has been

used to justify White masters' sexual abuse of enslaved African women, which is notably

represented by the children that slave women bore for their masters (Collins, 2000/2009).

Often the Jezebel was dehumanized and reduced to a "breeder" within the slave plantation;

however, romanticized portrayals of the Jezebel are found in movie depictions that present

these assaults as mutualistic affairs. With these accounts, the hate and mistreatment towards

the enslaved African woman by her White mistress is maintained, thus the Jezebel represents a

more direct threat to White womanhood due to the Jezebel's seductive influence on the

mistress's husband. On the surface, the Jezebel appears as the opposing image of the mammy;

however, Collins (2000/2009) argues that these two images work in concert for the

continuation of economic manipulation of African American women's work.

Collectively, these images do much more than misrepresent Black women, but also place limits on the perception of who Black women *can* be in terms of our places in the workforce, home, and society at large. Controlling images also manage a sufficient job of placing African American women in categorical boxes that suggest that if we are not one of these images, we must be another. When considering our underrepresentation, it is crucial to understand how controlling images of Black women may serve to thwart young Black girls' progression within the STEM circuit, especially while they are in school.

Due to the controlling images of African American girls in schools, they are likely considered the "other" within the science classrooms, less they choose to "pass" in an effort to adhere to the expected behaviors of future scientists or are silenced within these spaces (Fordham, 1993). Collins (2000/2009) described "silence" as an act of resistance for many African American women; however, I argue that within the science classroom environment, young African American girls walk a fine line between being *silenced* and being silent as an act of resistance within these spaces. In his examination of perceptions of African American girls in classroom environments, Morris (2007) found that some were considered overly assertive by their instructors, and paralleled a perceived "adultification" of Black girls to the "overly aggressive and dominant" matriarch (p. 503). He asserts, "the adultification of Black girls can lead to a perception of them as aggressively feminist, which can justify restriction of their inquisitiveness and assertiveness in classrooms" (p.503). This poses a dilemma for young African American girls within science classes, as the behavioral characteristics of White maleness is often paralleled with success in science. With young African American girls' assertiveness constantly being suppressed in an effort to make them more "ladylike," they may

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lose opportunities to share their aptitude to take leadership roles in the science class, verbally argue their theories, or demonstrate the range of the scientific abilities they possess.

These controlling images of African American girls in schools separate them from viable consideration as abled scientists and are important to the study given the role of race and gender on the underrepresentation of African American women in STEM addressed within the STEM counterspace. Furthermore, due to the culturally relevant curriculum as part of the Black feminist science pedagogy implemented within the STEMpowerment program, African American girls are urged to be themselves in the counterspace, which may be in opposition to the behavioral expectations held within the traditional science space. They are encouraged to use their voices in the space as opposed to having them silenced. Further, positioning the girls as capable scientists within the space serves as an act to resist the stereotypes forced onto young African American girls based on these controlling images and challenges the notion that some of the behaviors represented within the images should be considered negative to begin with (Collins, 2000/2009).

Black Women and Motherhood

Within this particular theme, I draw primarily from Collins (2000/2009) explanation of the role of influential Black women that assist in raising and supporting Black children, which she refers to as bloodmothers and othermothers. As the name implies, bloodmothers represent the biological mother while othermothers represent those women who have historically assisted bloodmothers in the responsibilities involved with caring for their children. I call attention to the role of both mothers and othermothers, as the women that may provide

support for young African American girls through their educational trajectory, may include, but are not limited to their mothers, aunts, sisters, cousins, teachers, and neighbors. Collins (2000/2009) asserts that these "women-centered networks" are representative of the Afrocentric practices of communal child-care that places a significant value on members of the community's rights and responsibilities related to caring for and raising African American children.

Power of Self-Definition

As described in the previous section, African American women have constantly fought against the controlling images put in place to justify continuous efforts to subjugate us within U.S. society. In opposition to these attempts, Collins (2000/2009) asserts that African American women have resisted these controlling images through self-definition and self-valuation. This core theme of Black feminist thought functions to aid in examining ways African American women evaluate, critique, and confront the negative stereotypes others have used to define our womanhood. The author insists that the process of self-definition and self-valuation allows us to define and value our behaviors for ourselves in an effort to challenge the negative stereotypes associated with them. These stereotypes are not challenged by replacing negative images with those acceptable by the dominant society, but are better confronted when we place the power to define ourselves into our own hands through action and resistance. The author argues that African American women have historically resisted controlling images, which challenges the indication that we have collectively accepted our oppression.

She explains,

> U.S. Black women's ideas and actions force a rethinking of the concept of hegemony, the notion that Black women's objectification as the Other is so complete that we become willing participants in our own oppression. Most African-American women simply do not define ourselves as mammies, matriarchs, welfare mothers, mules, or sexually denigrated women. The matrix of domination in which these controlling images are embedded is much less cohesive or uniform than imagined. (p.109).

Through denial of society's definitions of African American womanhood that have been imposed on us, via multiple avenues of resistance, African American women have challenged the Master Narrator by "question[ing] not only what has been said about African-American women but the credibility and the intentions of those possessing the power to define" (Collins, 2000/2009, p. 125). Thus, by positioning African American women as the sole credible definers of their womanhood, Black women push against the prescribed role of the objectified Other and reclaim our humanity.

African American women's demand for respect, self-love, and self-reliance within a society whose modus operandi to suppress us relies on the unrelenting process of devaluing African American women via controlling images serves as essential action towards self-valuation (Collins, 2000/2009). Likewise, understanding the collective culture of African American women aids the self-definition and self-valuation process. This focus on interpersonal relationships between African American women dating back to their enslavement brings forth the notion that we are interconnected and must work together to survive (Collins, 1986). Although there is a need for the collective to labor together towards eradicating efforts to suppress African American women as a group, Collins (2000/2009) argues that the self-defining and self-valuation process is one that is an individual process aside from receiving assistance

from other Black women as "the power to save the self lies within the self" (p. 130). By persisting in the journey toward self-definition African American women are changed, and this change is empowering.

Black Women's Activism

Lastly, Black women's activism illuminates the different strategies African American women have enacted for resistance and transformation. Collins (2000/2009) notes that Black women's activism is often illustrated by focusing primarily on overt acts of resistance such as serving in political organizations and other forms of community organizing; however, everyday activism on behalf of our communities and African American women are frequently overlooked. More importantly, the author goes on to highlight ways that Black women's activism manifests through a commitment to educational attainment within the African American community. Historically, education was regarded as a means to intellectual emancipation, even as African Americans were still physically enslaved. The appeal to learn emphasizes the inherent longing for education among the African American community, thus suggesting that the longing to acquire knowledge is something inherently African American or more specifically, inherently African (Anderson, 1998). More importantly, the contribution of Black female educators and the Black mothers who relentlessly encouraged their children to become educated represents the focus on education as a conduit to group survival and racial uplift (Collins, 2000/2009)

This focus on education is important for this study as African American girls' persistence in the U.S. educational system, despite the roadblocks designed to inhibit their success, represents acts of resistance among our youth. Furthermore, positioning themselves as capable

scientists challenges the dominant narrative depicting their collective ability to perform in these spaces. Thus, it is critical to frame participation in this science learning environment where African American girls create a "safe space" or counterspace where they support one another, hold each other accountable, build self-reliance, engage in dialogue regarding our positioning in the sciences, and are empowered to transform the educational institutions they will soon navigate as a form of Black women's activism (Collins, 2000/2009).

Intersectionality

Constructing a theoretical framework grounded in CRT and Black feminist epistemology requires additional attention toward the theory of intersectionality. This is especially so considering such an approach is interwoven throughout Black feminist scholarship (Collins, 2000/2009). Further, as identified in the third research question, I am particularly interested in the girls' perception of the influence of race *and* gender on their experiences in STEM and the underrepresentation of African American women in STEM-related careers.

Intersectionality as an analytic tool expands the examination of the structure and influence of power on those in subordinate positions by challenging the single-axis method of analyzing the complexities of inequality (Cho, Crenshaw, & McCall, 2013; Collins &Bilge, 2016; Crenshaw, 1989). By moving away from focusing solely on one axis of social division (i.e. race, gender, or class, etc.) an intersectional approach provides a "gathering place for open-ended investigations of the overlapping and conflicting dynamics of race, gender, class, sexuality, nation, and other inequalities" (Cho, Crenshaw, & McCall, p. 788). Within the legal community, Intersectionality grew from critical legal and critical race theory scholarship (Carbado, 2013) by

feminists of color who recognized the paradox of Black women being both too similar to and different from their Black male and White female counterparts within anti-discrimination law (Carbado, 2013; Cho, Crenshaw, & McCall, 2013). While the term *intersectionality* was formally introduced in Kimberlé Crenshaw's groundbreaking Black feminist, legal scholarship (1989, 1991); intersectionality has a significant history grounded in the intellectual works among feminists of color (Collins & Bilge, 2016).

Lastly, intersectionality has functioned as an analytic tool that is employed across multiple disciplines and is noted as a particularly useful tool to examine the schooling experiences of girls of color that lead to their underrepresentation in the STEM fields (Collins & Bilge, 2016). The authors posit that policy-makers and stakeholders should move away from addressing the issue concerning the underrepresentation of populations within STEM through "either/or" pipelines focused on race or gender as it renders girls of color as sub-categories within each pipeline. They state, "This shift would focus increased attention on barriers to science that girls of color face, many of which are the same barriers that confront boys. Both groups meet similar barriers, but experience them differently" (Collins & Bilge, 2016, p. 176). Keeping this in mind, it is vital to consider intersectionality in my analysis, and do so particularly when examining the girls' perception of their experiences as African American females in STEM and how they perceive the influence of race and gender on the underrepresentation of African American females in STEM.

Conclusion

In conclusion, examining African American girls' science identities through a Black feminist theoretical lens serves to build on the theoretical development of Black feminist thought (Collins, 2000/2009) through the concrete experiences of African American girls in a culturally relevant, science counterspace grounded in Black feminist science pedagogy. This is especially important within a space that incorporates pedagogical practices that encourage African American girls to challenge controlling images of themselves within the educational system in general, science classrooms in particular, and ultimately the larger STEM career circuit.

Keeping this in mind, it is imperative that Black feminist scholars continue to examine the experiences of African American girls in learning environments within future analyses to better articulate a holistic African American women's standpoint across generations. Doing so acknowledges that Black girls participate in every day practices of resistance and activism throughout their very existence and will to survive, especially in schools.

Finally, I believe that frameworks centered on the interesting role of race, gender, and class on African American girls' experiences that also have a strong focus on challenging the dominant discourse through resistance and activism are quite useful for the purposes of this study. Considering this, critical race theory and Black feminist epistemology serve as a fundamental theoretical frame to analyze the girls' identity development as participants in the STEMpowerment program.

Positionality

As the principal investigator in this study, I believe this is an opportune place to describe my positionality, as it has strongly influenced my interest in this topic and my reasoning for selecting critical race theory and Black feminist thought as guiding theories for this project. I am entering this study with both insider and outsider positions, as I share the same race and gender as the young women in the study. Beyond this, similar to the girls in the study, I grew up in Southeast Texas and have resided in the same locale as the girls for nearly my entire time as a student and educator in Houston, TX. Further, I have not only taught in the same locale where the girls are growing up, but I was a former teacher at their school prior to their attendance. I recognize the significant differences between our experiences growing up at different times and my experiences as a college student and professional within their neighborhoods; however, we also have shared experiences as young African American girls navigating the school system within a high-stakes testing environment in the state of Texas.

Although we will have shared experiences as African American females who have resided in Houston, there are still power dynamics in place given our age difference and my position as an adult and the science educator facilitating their learning within the counterspace. It is my hope that our commonalities and differences will contribute to the learning and development that will take place during the course of the study.

Beyond my position as an African American, female science educator influencing the actual learning environment through my pedagogical practices, I believe that my position will also influence my interpretation of the data collected. As a partial insider, there are contributing factors that I may be able to see and understand that an outsider cannot. Although

this may appear to be of assistance as a researcher, it is also important that I understand that

my position as a partial-insider may also inhibit my ability to see what a complete "outsider

looking in" may identify. Keeping this in mind, I must be diligent in my implementation and

analysis to ensure that I do not misrepresent the experiences and perspectives of the young

women whose science identity development I will examine. This diligence extends to

determining the usefulness of the science developmental model used to examine their identity

development within the culturally relevant, STEM counterspace.

CHAPTER FOUR
Methodology

The purpose of this study is to understand and examine the identity development of African American girls who are participating in a culturally relevant, STEM counterspace through a critical race theory and Black feminist theoretical frame. Given the push to increase the number of STEM graduates in the United States and the need to increase student performance and interest in science to reach this goal, this study seeks to reveal ways in which African American girls author themselves as science students (Calabrese Barton et al. 2012) within a counterspace that positions them as capable science learners. Such a space does not question their interest or ability in science, but serves to acknowledge the knowledge and skills they bring with them and provides opportunities to apply these within a non-constraining space. To focus my examination, I selected the Carlone and Johnson (2007) science identity development model to examine the identities that emerge and to seek understanding of their perceptions of how race and gender impact African American women's representation in STEM in addition to perceived challenges that may arise due to their race and gender. The goal of the study is to not only to determine the usefulness of the science identity model within the culturally relevant space, but to understand the identities that will emerge through a critical race, Black feminist theoretical frame. Doing so adds to the body of knowledge centered on Black women's and girls' experiences in the sciences using a framework centered on the intersectional effects of living in a society where racism and sexism abound.

The research questions that guided this study include:

1. What is the utility of using a science identity development model to examine the science identity development of African American girls in a culturally relevant STEM after school counterspace?

2. Given the three explicit dimensions in the model, what science identities emerge among the African American girls participating in the culturally relevant STEM after school counterspace?

3. How do African American girls perceive the role of race and gender on the participation and success of women of color in STEM?

Critical Race Methodology

I believe it is imperative to design a study that complements the theories that guide this work, as scholars have pointed out that many traditional methodological designs have a history of, however well-meaning, further marginalizing students of color (Evans-Winters, 2005; Solorzano & Yosso, 2002). Evans-Winters (2005) points out that previous educational research focused on students of color often begins with deficit minded questions that are then answered using traditional methods. Ultimately, this combination of deficit questioning and mainstream methodology served to marginalize the students' voices and experiences. As for African American women, these methods positioned the researcher as the informant of knowledge concerning student experiences through an outsider perspective. This is in conflict with the premise of Black feminist epistemology that argues for African American women's self-definition and valuation (Collins, 2000/2009). Evans-Winters (2005) asserts that too often research focused on African American girls mismanages their experiences by either silencing them or overwhelmingly concentrating on damaging aspects of their lives instead of positively framed explanations of their resiliency.

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She explains,

> In social science and educational research, African American female adolescents['] experience[s], in particular, have been left out, whited out (subsumed under White girls' experiences), blacked out (generalized within the Black male experience), or simply pathologized. The history of the study of Black girls has a cyclical pattern of excluding her experiences or simply suppressing her story within (White) feminist or Afrocentric led studies (Evans-Winters, 2005, p.9).

As a result, the previous educational scholarship on African American girls that was seemingly conducted to inform policy and practice has ultimately, "worked to serve and protect the needs of the dominant elite" (Evans-Winters, 2005, p.10). There is a growing body of research that employs more critical methodological designs that have redirected future research by highlighting the resiliency of Black female learners (Evans-Winters, 2005; Evans-Winters & Esposito, 2010; Henry, 1998; O'Conner, 1997). As a result, these studies disrupt the dominant narrative of African American girls' school experiences that has saturated the educational research conducted thus far. As for African American girls' experiences and identity development in science, science education scholars have acknowledged and addressed the role race, class, and gender have on African American girls' experiences in science and identity development through various theoretical frameworks such as employing critical feminist theory within their work and by directly addressing the differential treatment and understanding of African American girls in science classrooms (Brickhouse & Potter, 2001; Calabrese Barton et al. 2012; Hanson, 2009).

In Chapter Three, I presented the Carlone and Johnson (2007) conceptual framework used in this study to examine the African American girls' identity development within the culturally relevant STEM counterspace. Utilizing critical race theory and Black feminist epistemology as my theoretical frame calls for a methodological design that honors the purpose

of the theories in place. Keeping this in mind, I draw from scholars expanding critical race methodological practices in educational research (Cook, 2013; Cook & Dixson, 2013; Decuir-Gunby & Walker-Debose, 2013; Solórzano & Yosso, 2001, 2002) and research focused on African American girls (Evans-Winters, 2005; Henry, 1998).

Moving beyond the development of critical race theory of education, Solórzano and Yosso (2002) advanced the scholarship by conceptualizing critical race methodology in education. The authors posit that critical race methodology, "contextualizes student-of-color experiences in the past, present, and future" (p.37). They go on to explain, "[critical race methodology] strategically uses multiple methods, often unconventional and creative, to draw on the knowledge of people of color who are traditionally excluded as an official part of the academy" (p.37). These methods are primarily presented through the counterstories shared through composite narratives, oral histories, poetry, theatre, testimonials, and numerous other methodological approaches (Cook, 2013; Covarrubias & Velez, 2013; Decuir-Gunby, & Walker-Debose, 2013; Delgado, 1989; Solórzano & Yosso, 2002). In the previous chapter, I concluded that this project serves as a counternarrative of African American girls' experiences as science learners, especially considering they are operating within a science counterspace. In the following sections, I describe in more detail the setting of the study, the science learning space, and the modes of data collection and analysis employed within the study.

Setting

Founded in 1836, the city of Houston is the fourth most populous city in the United States and the most populous city in the state of Texas with over two million residents (U.S. Census Bureau, 2016). Of these two million residents, African Americans account for

approximately 23 percent of the population. The city's educational attainment is somewhat

parallel to the state and national averages with 28 percent of the adult population completing

a bachelor's degree or higher and another 23% with some college/associates degree; however,

Houston graduated fewer students from high school in 2014 with 76% earning at least a high

school diploma or its equivalent (US Census Bureau, 2016).

Houston is also home to NASA's Johnson Space Center, several energy/oil and gas

corporation campuses and refineries, and the world's largest medical complex, the Texas

Medical Center. Considering the substantial increase in STEM careers predicted over the next

decade, it is safe to postulate that a significant number of these anticipated positions will be

located in the city of Houston. With concentrated career opportunities in STEM, especially

within the energy/oil and gas sectors, there are significant efforts to train the next generation

of scientists, technologists, and engineers at multiple points of the education pipeline. For

example, there are high schools designed specifically to train students in energy fields such as

Houston Independent School District's Energy Institute High School in addition to incorporating

STEM magnet programs and initiatives at several elementary, middle, and high school

campuses (HISD, 2016). Considering this, I found it important to describe the direction of STEM

careers and education within the study's locale.

This study is situated in [1]Lakeside Academy, a public charter school located in Houston's

[2]Griffing Park neighborhood. Griffing Park is a predominately African American neighborhood

with a celebrated history, as it is one of the oldest African American residential areas in the city

and was founded by formerly enslaved African Americans. Griffing Park has a history and future

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[1] pseudonym
[2] pseudonym

much like many African American neighborhoods nationwide due to constituents leaving the surrounding area, which has imposed economic challenges on the remaining community; however, unlike neighborhoods that experienced "white flight," Griffing Park lost many African American families to suburban neighborhoods in the Houston area. Although Lakeside Academy is located in Griffing Park, students reside in various neighborhoods throughout the area, as there are less strict attendance zones for charter schools. Keeping this in mind, there are students who reside in the school's neighborhood, adjacent neighborhoods with similar racial and socio-economic demographics, as well as neighborhoods in suburban communities in Harris, Brazoria, and Ft. Bend counties.

[3]Lakeside Academy's school demographic and performance data for the 2014-2015 year is provided below and was retrieved from the Texas Education Agency (TEA), which compiles an Academic Performance Report for every public school in the state. Publicly funded charter schools such as Lakeside Academy are subject to the same academic accountability standards as traditional public schools, thus their performance data is provided by TEA to the general public and is quite often found on each public school's website for transparency. Lakeside has a student population that consists of approximately three fourths African American students and is nearly 23 percent Latino (TEA, 2015). Among the student body, 90 percent of students are "economically disadvantaged" and a little over half of the students are considered "at-risk" which is determined based on multiple indicators (TEA, 2010). In terms of student academic performance, Lakeside Academy's accountability rating from the Texas Education Agency was "Met Standard" and the school received distinctions in all core subjects. Despite these

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[3] The direct link to the TEA webpage including this information is not provided in the reference list to protect the identity of the school and the participants.

distinctions, the science performance for 5th and 8th graders did not meet the state or district average for students scoring at a satisfactory level. The mathematics performance for the 2014-2015 academic year only represents the Algebra I students, which accounts for a small percentage of the student population given the school serves 5th-8th graders and only a select number of 8th graders are generally enrolled in Algebra I. The standardized test scores for middle school math were not included in performance ratings for the 2014-2015 academic year, thus math performance was not included for 5th, 6th, 7th and 8th grades on Lakeside Academy's report.

Access and Outreach to Study Participants

I previously served as a science teacher at Lakeside Academy and continued to have a relationship with both the staff and the leadership team after I entered my doctoral program. This sustained relationship helped me gain access to the school for my study upon my return to the Houston area. In fall 2014, I met with the principal to present the program and study and was allowed to conduct the study at Lakeside Academy. Upon receiving permission from the University of California, Los Angeles Institutional Review Board and permission from the principal, I began outreach efforts to reach enrolled girls to join the program and participate in the study. I was allowed to post posters throughout the facility about the program as well as meet with groups of girls during lunch to describe the program and study.

While my role as a former science instructor at Lakeside Academy granted me an acceptable level of access to potential study participants; it proved more difficult than I initially anticipated due to my limited presence on campus. I soon learned which employees at the

school had the level of investment in the program that I needed to help me secure participants, and through their assistance, I was able to attract more girls to the program.

STEMpowerment After School Program

The [4]STEMpowerment Program was offered at Lakeside Academy during the 2014-2015 and 2015-2016 school years. During the first year of the study, I initially set my focus on recruiting 8th grade students; however, those in lower grades demonstrated interest in the program and I decided to open it to girls in 6th through 8th grades. For the majority of the program, we met bi-weekly for 60-90 minutes; however, we started meeting weekly during the 2015-2016 school year.

As stated in the introduction, the STEMpowerment Program was culturally relevant counterspace grounded in what I refer to as Black feminist science pedagogy. Culturally relevant pedagogy in science serves to position students as capable science learners and challenge deficit positions about their communities' contributions to science. Gay, (2002) identified creating a culturally relevant curriculum as an essential element of culturally responsive pedagogy, thus selecting a theme for the program that included topics closely related to the girls' lived experiences as African American girls was important. Developing a science curriculum that included the girls' community funds of knowledge and connecting that curriculum to their everyday lived experiences stood to increase their engagement and interest in science activities within the program (Boutte et al., 2010; Goldston & Nichols, 2009; Johnson, 2011; Laughter & Adams, 2012; Seiler, 2001).

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[4] pseudonym

STEMpowerment's culturally relevant curriculum was centered on the hair and cosmetic industry with a specific focus on Black hair. Selecting this theme not only appealed to a group of girls with a wide range of knowledge and interest in science, but also girls who brought with them their own knowledge and experiences related to Black hair and beauty. Through this theme, I was not only able to incorporate hair and cosmetics into the science and mathematics activities we conducted, but we also engaged in dialogue directly related to being woman of color as it related to the European standards of beauty projected on women worldwide. Example lessons included throughout the program are listed in Table 1 with brief descriptions of each activity. I also present in-depth descriptions of select activities to provide better insight on the culturally relevant lessons implemented in the program. Each meeting began with a group discussion that was either related to the activity we would engage in that day, topics concerning women of color in STEM, the girls' experiences in science classes, or simply a check-in to give them an opportunity to share with the group how their week was going. These discussions were not solely intended for data collection purposes, but were also implemented to build community within the program through dialogue. It was through these discussions that the group was able to bond, share their experiences, and build a culture within the counterspace that they took ownership of.

Table 1

Example STEM Activities within STEMpowerment Program

Activity	Description
Classifying Hair Type	Categorize different types of hair textures according to the classification tool used in the natural hair community.
Hair Dye Inquiry Experiment	Adjust variables to increase hair color changes based on concentration of product, temperature applied, time elapsed, and pH.
Is No Lye a Lye?: Chemical Compositions of Pure Substances	Differentiate between elements and compounds by identifying the elements and number of atoms found in the chemical composition of the main ingredients found in lye and no-lye relaxers (i.e. sodium hydroxide, lithium hydroxide, and potassium hydroxide).
Magazine Math	Analyze representations of Black women's hair in magazine photos by categorizing photos based on hair on length, color or texture, display data in tables and graphs & calculate ratio and/or percentage of each category.
Minerals and Bead-Making	Identify minerals used in bead-making based on their streak, luster, color, and hardness using the Moh's scale of mineral hardness.
Nail Polish Experimental Design Activity	Design and implement an experiment testing selected items among multiple substances such as nail polish, top/base coat, remover, water, etc.
Product pH: Acid or Base?	Determine whether a substance is an acid or base by testing hair products such as shampoo, conditioner, and lye relaxer using litmus strips and the pH scale.
Pure Substances: Nail Polish Inquiry Activity	Compare the strength of nail polish removers based on the amount of pure acetone used in the solution.
Team Natural: Social Media Math	Categorize representations of hair length on popular Instagram pages focused on Natural Black Hair. Present data in tables, graphs and calculate ration and/or percentage of each category.
The Essentials of Bath Bombs & Sugar Scrubs	Understand the use of Latin names for the Plant Kingdom taxonomy through use of essential oils, learn chemical composition of substances such as sugar and baking soda, and practice measurement through creating bath bombs and sugar scrubs.
What's the Difference?: Testing Hair Dyes	Differentiate between physical and chemical changes based on the chemical composition of hair dyes and their ability to change the appearance of a hair sample.

While the girls engaged in several culturally relevant lessons throughout the duration of the program, I would like to call greater attention to a select group of lessons for explanatory purposes. Doing so offers concrete examples of culturally relevant science lessons that can be modified in multiple ways. Below I describe three sets of lessons that built on one another and served as exemplar lessons that provided me with opportunities to observe students' performance and competence in mathematics and science as well as engage in meaningful dialogue depending on whether we included discussions that session. Following these descriptions, I also present ways the lessons can be modified to be less arguably "girl friendly" and appeal to audiences that may not be as interested in the hair and cosmetic industry notwithstanding which gender they identify with.

The first set of lessons includes the *Magazine Math and Team Natural: Social Media Math* activities. The Magazine Math lesson began with a discussion about the European standards of beauty as it relates to hair color, length, and texture and their representations in general and more specifically, in the media. Following the discussion, the focus of the activity was introduced to the girls, which was to analyze the various representations of hair length, color, or texture within the first 20 pages of a particular magazine. The girls were then prompted to select which category they would like analyze and begin collecting data from their magazines by characterizing the pictures on the magazine pages. Once they collected their data, the girls created data tables and bar graphs to display their data in addition to providing ratios for each category. Afterwards, the girls shared their data and drew connections to what we previously discussed about European standards of beauty and their findings. As it relates to science and mathematical competence, I was allowed to assess their ability to collect,

categorize, display, and interpret their data. This activity was followed by collecting and

analyzing data from popular Instagram pages focused specifically on natural Black hair. Here,

the girls elected to categorize the women's hair based on length and determine their own

categories. Like the Magazine Math activity, they were prompted to construct data tables,

create bar graphs, and provide ratios, but were also asked to calculate percentages for each

category.

The next set of lessons include the *Pure Substances: Nail Polish Inquiry Activity* and the

Nail Polish Experimental Design Activity. In the first activity, students were introduced to the

pure substance acetone and its use in nail polish remover. Participants were prompted to

analyze the ingredient list for three types of polish remover and make predictions about the

strength of each type based on their respective ingredients. Following this, the group was split

into pairs, made predictions about which remover would work best, and tested the products to

determine whether their hypotheses were correct. This activity provided an opportunity to

guide students through the process of developing and conducting an experiment as well as

reinforce learning about variables and controls. For example, it was essential that the students

used the same polish to test their removers and applied the name number of coats to each

artificial nail to ensure that their findings were valid. Following this activity, I allowed the

participants to design and conduct their own experiments using a range of nail products such as

different color polishes, different brands of top/base coat, removers, and other items in the lab

such as water. This activity provided an opportunity for participants to demonstrate their

competence with experimental design and application of science process skills.

Lastly, I will describe the *What's the Difference?: Testing Hair Dyes* and *Hair Dye Inquiry Experiment*. The first activity included an experiment to test which type of hair dye would change the color of a jet-black sample of hair to the color displayed on the packaging. Prior to the experiment, participants learned about the two types of hair dye and discussed how the results are related to physical and chemical changes they learned about in science class. Following this discussion, the students conducted the experiment by comparing the color change, if any, for each of the hair samples after 30 minutes. The follow-up activity involved the participants adjusting variables to increase the rate in which a hair sample would change color. During this activity, the participants watched a segment of Chris Rock's *Good Hair* (Hunter & O'Donnell, 2009) documentary that introduced four variables that affect the chemical change to human hair as a result to applying a chemical relaxer which included: pH, concentration, temperature, and time. While the experiment was not focused on chemical relaxers, the same concepts were used for the hair dye experiment. Salon-grade concentrated peroxide was used with salon-grade powdered bleach to create the dye and the students observed the color changes of the hair every 5 minutes. After ten minutes, the students were prompted to determine which variables served as controls (i.e. pH and concentration of peroxide), and which variables could be changed (i.e. temperature and time). This discussion provided opportunities for participants to connect their knowledge about thermal conductivity and draw connections to real-life observations of women using heat and foil when getting hair highlights. Adjustments were made to the sample following the discussion and students recorded their findings.

While the participants engaged in many activities through the duration of the study, the activities described above are representative of the type of culturally relevant science activities

that integrated the girls' science and mathematics competence with the knowledge and skills they brought with them from their everyday lived experiences.

Although these examples appear "girl friendly" I argue that they can be conducted with a group of male and female students as they are presented or modified to be more gender-inclusive or gender-neutral. For example, the nail polish remover activity can be compared to removing paint from wood furniture using paint thinner, which may be considered a non-gender specific activity. The nail polish inquiry experiment can also be paralleled to designing experiments testing different brands of protective paint, paint with primer included, or different types of primer. Lastly, the Magazine Math and Social Media Math activities can be implemented with multiple types of magazines and social media accounts based on the discussion topic such as categorizing the make, model, and year of cars found in specific car magazines or perhaps analyzing representations of hyper-masculinity found in male-centered magazines. The opportunities to integrate STEM and students' every day lived experiences are nearly limitless. Furthermore, incorporating meaningful discussions related to these activities that lead to identifying and analyzing social issues and problems facing their communities are certainly possible.

Sample

As described above, Lakeside Academy has a large population of African American students, with Latinos representing the next largest racial/ethnic group represented at the school. Although the study itself focused on the science identities of African American girls, participants who did not identify as Black/African American were not excluded from

participating in the afterschool program; however, only African American girls' whose guardians signed consent forms were included in the actual study. I initially sought to include only upper level students and was encouraged by the school leader to serve 8th graders to enrich their science learning in preparation for their exam. Once I started to outreach, I attracted younger students primarily due to scheduling conflicts with older students who participated in team sports. As I stated above, I reached out to students during their lunch period and posted signs around the school, which attracted a younger group of students. Those students then reached out to their friends about the program in addition to the technology instructor who encouraged students to participate. As a result, the final sample best represents a network sample that consisted of 11 African American girls who were in 6th, 7th and 8th grades when they joined the study. As shown in the table, there are four graduating classes represented, as Nichelle joined her 8th grade year during the first year of the study and Quincy joined her 6th grade year during the second year. Table 4.2 lists the study participants by their pseudonyms and graduating class. Of the 11 participants in the study, there was one each from the Class of 2019 and 2022, three participants from the Class of 2020, and six representing the Class of 2021.

Table 2

List of Study Participants by Pseudonym and Graduating Class

Pseudonym	Graduating Class
Nichelle	Class of 2019
Patrice	Class of 2020
Tyson	Class of 2020
Victoria	Class of 2020
Ashleigh	Class of 2021
Daphne	Class of 2021
Olivia	Class of 2021
Portia	Class of 2021
Princess	Class of 2021
Zoe	Class of 2021
Quincy	Class of 2022

Data Collection

After careful consideration, I determined that multiple qualitative methods would best deliver the data necessary to examine the identity development of the girls as participants in the counterspace using the Carlone and Johnson (2007) science identity model in addition to understanding their perceptions of race and gender on the representation and experiences of African American women in STEM. Each primary source of data was obtained through participant observation within the counterspace, individual interviews, and group discussions. In addition, no single method would have sufficiently revealed the data needed to employ the model as an analytic tool. Furthermore, the use of multiple methods and sources of data served to strengthen the internal validity of the study (Merriam, 2000).

Group Discussions

I started data collection with the dialogue sessions conducted at the beginning of and sometimes at the end of the program sessions. Each session did not include a formal discussion that was recorded for data collection purposes, as there were discussions and sessions that focused attention on becoming acclimated to the program as well as sessions that were entirely devoted to engaging in the STEM-related activities to sustain the girls' interest in the program. While the girls enjoyed our discussions, when they ran longer than expected, time was taken away from engaging in the STEM activity planned for the day. Recognizing this, I was careful about how often I held semi-formal discussions prior to the activities. Through the duration of the program, there were nine recorded dialogue sessions ranging in length from approximately three minutes to as long as 38 minutes for lengthier discussions.

Participant Observation

Participant observation data were collected during the STEM activities throughout the program with the purpose of capturing the girls' social performance within the science counterspace as well as demonstrations of their science and math competence. Observation field notes were recorded for 11 of the sessions using an adapted observation protocol (Appendix A) to organize my notes (Creswell, 2007), which differentiated between my descriptive and reflective notes.

Since I was the sole facilitator of learning in the counterspace, my role as the participant observer was second to my role as the instructor (Merriam, 2009), as I had to both monitor the student progress during the activities and observe their interactions within the space. To reduce distractions, I would often type descriptive notes on my cellular phone and, following the session, transfer my notes to the protocol. Students are more accustomed to seeing people on their phones during activities of all sorts, therefore typing into my device proved to be less of a distraction and a more effective means of recording notes.

As suggested by Merriam (2009), my role as a participant observer was influenced by my position as both the researcher and instructor for the program. While I often stepped into my observer role and allowed the girls to engage in activities in ways they are not generally allowed to do so in traditional settings (i.e. discussing current events in pop culture, singing popular songs, discussing school-related events), I also had to maintain an appropriate level of safety and order within the space. On certain days, I found it advantageous to concentrate on specific girls or groups of girls at a time during specific activities so that I could better recall concrete details of the observation (Merriam, 2009). Doing so allowed me to collect individual

observational data that informed questions I would ask in the group dialogue that, at times, followed the particular activity.

Individual Interviews

To gain more individual-level data, I conducted semi-structured individual interviews with each of the girls in the program, which were recorded with their permission. I also took interview notes directly on the protocol sheet used for each girl so that I could later refer to any interpretive notes I may have taken during the interview. This was especially helpful when a girl used "air quotes" to describe something, as I would not have understood the meaning based on the recording alone. The interviews ranged from nine minutes long to 30 minutes in length, and averaged 19 minutes. A set of protocols was developed for the interviews and is found in Appendix B. While there were specific questions asked, the interviews were semi-structured due to the flexibility of the wording I used to ask the questions and the order in which I asked them for each participant (Merriam, 2009). Furthermore, semi-structured interviews allowed me to incorporate follow-up questions within the interview to gain better clarity.

Closing Interviews/Member Checks

At the close of the study, I was able to follow up with five participants regarding their position on the role of race and gender on the representation of Black women in STEM as well as questions I had about my interpretation of how each student's interest in a science career impacted their participation in STEM-related activities. These short closing interviews were semi-structured and included fewer protocol questions (Appendix C) in comparison to the primary individual interview protocol. Like the individual interviews, I recorded these sessions

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with the girls' permission and transcribed sections of the recordings focused on the primary

questions of interest. The interviews ranged from approximately five to 14 minutes and

averaged nearly eight minutes. In addition to responding to the specific follow-up questions,

the girls also provided me with feedback for the future of the program, which was for

informative purposes only.

ANALYSIS

As stated above, I started the data collection with unstructured dialogue sessions that

were conducted at the beginning of the program. The initial recorded discussions were used to

inform the protocols I developed for the individual interviews. Data analysis was informed by

Glaser and Strauss's (1967) constant comparative analysis method for qualitative data analysis

and later ideas for qualitative data analysis presented by Corbin & Strauss (2015) in an effort to

engage in inductive and comparative analyses of the data (Merriam, 2009).

As suggested by Merriam (2009), analysis began early on in the study starting with the

unstructured dialogue sessions and the data from the individual interviews. As I explained,

individual interviews were recorded and transcribed using a denaturalize transcription method

which focuses more attention on the meaning and substance of the interview (Oliver, Serovich

& Mason, 2005). Although responses were transcribed verbatim, detailed codes representing

short versus long pauses, interruptions, and more specific transcription codes one would find in

a naturalized transcript were not used, as I was less concerned with, "depicting accents or

involuntary vocalization" than a naturalized transcription process would provide (Oliver et al.,

2005).

I also made sure to maintain slang or colloquialisms expressed by participants and remained cognizant of my propensity to inadvertently filter such language. Keeping this in mind, I must also call attention to Geo-ethnic accents in my transcription process and my decision-making regarding the spelling of words based on the girls' vernacular, accent, and my understanding of their use. Given we are from the same locale, I am, admittedly, not as hyper-sensitive to differentiating between our shared accent and the pronunciation of particular words in "standard" English. Thus, instances where the participants potentially said "ax" instead of "ask," when transcribing I type "ask" because I cannot differentiate between the two when I process what I have heard. This is the same for words such as "cuz" instead of "'cause," which are both short for "because" or stating "bof" instead of "both." The combination of using a denaturalized approach and having a shared Geo-ethnic accent that is influenced by our African American, Southeast Texas upbringing, led me to transcribe the words as I heard and understood them. Oliver et al., (2005) brings up important concerns regarding accents, especially as it relates to African Americans in their text and suggest that denaturalization with the intent to avoid invoking negative suppositions about study participants' education level may result in a biased analysis. In their text, they also considered how the participants responded to how they were represented when using a naturalized approach, which was also a cause for concern. When considering "whose perspective [is] being honored" (p. 10), I retained the use of a denaturalized approach primarily due to my role as an insider on our shared language and accent.

I printed each transcript from the individual interviews and started the initial open-coding process by reading through every transcript and coding words and phrases by question,

as each protocol was linked to a particular dimension of the Carlone and Johnson (2007) model or a research question for the study. I also employed this method because determining meaningful segments and units of data relative to one's research questions is a recommended start to data analysis (Merriam, 2009). For this process, I found it beneficial to number each transcript and use a different colored marker for every transcript. After open-coding the individual transcripts, I transferred all of the initial codes to another document separated by the particular topics related to each dimension or research question such as, "What is a scientist?," which was linked to the recognition dimension. Once I transferred the initial codes to the separate document, I used the same number and color to differentiate my codes between transcripts to more easily determine common codes across transcripts. This step in the process produced many codes, some of which were overlapping, and led to category construction by comparing the codes that emerged across the different transcripts and determining categories for these codes through analytical or *axial coding* (Corbin & Strauss, 2007).

Once I determined the categories based on the individual interview data, I uploaded the transcripts to the online qualitative data analysis program *dedoose* and inputted the categories and reduced codes I would use for the second round of coding. Dedoose is a password protected software primarily used for multiple methods and mixed methods data analysis. Using the new categories and accompanying codes, I coded each transcript again using the program and utilized the software's resources, such as the word cloud, to recognize trends across the data. The word cloud is a visual representation of data that sizes codes based on the frequency they are used within the dataset. This allowed me to visually see how many times I used a particular code within a category in comparison to other codes. I found the software

particularly helpful for this component of the data analysis process, as it helped me better organize the individual interview data; however, the onus of responsibility for analyzing the data remained on me as the researcher as the human interpretive element remains necessary within qualitative data analysis (Corbin & Strauss, 2015). From there, I analyzed the participant observation data in the same manner by coding each set of field notes and determining codes and categories that emerged from the data relative to the Carlone and Johnson (2007) model and the research questions. Unlike the individual interview data, I did not use the qualitative coding software for this step of the process.

After determining common themes for each dimension within the model and relative to the research question concerning the girls' perception of the roles of race and gender, I continued with a constant comparative analysis of the individual interview transcripts, observation field notes, and group discussions to determine specific categories within these larger themes that represented the identities that emerged and the ideas shared by the girls in the study.

Validity

As I described in the beginning of this chapter, I selected my methods to adhere to propositions of relying on multiple methods of data collection within critical race methodology to adequately support the counterstory to be shared. In addition, triangulating the data through multiple methods and using multiple data sources strengthened the internal validity of this qualitative study (Denzin, 1978). Relying on one method would not have revealed the data necessary for this project, especially as it relates to comparing what students did in the space

with what they verbally expressed within that space and in interviews. For example, without participant observation during the activities, I may not have been led to ask the girls specific questions that provided me with greater clarity about what I observed (Merriam, 2009). In addition, using multiple sources of data that included varied observations at different times of the program and follow up interviews strengthened the internal validity of the study by allowing me to compare and cross-check the data (Merriam, 2009). Lastly, using the constant comparative method of data analysis within qualitative data analysis also served as a strategy to increase validity (Corbin & Strauss, 2015; Silverman, 2005).

Next I call attention to my decision to transcribe my own individual interviews as an influence on the validity of the project. While the transcription process is a rather long and often demanding one, I believe that it is indeed a component of the analysis as opposed to solely a process to extract data from the recordings for later use. I do not suggest that outsourcing this step in the process is a threat to internal validity; however, I believe that the process of listening to the recordings with greater focus allowed me to "know" my data in a more in-depth manner once I started my analysis. Furthermore, although transcription services are helpful, I found that trusting an outsider with this task was not worth the trade-off of ensuring that the transcripts would meet my expectations as a researcher in terms of the accuracy and style (i.e. naturalized or denaturalized) that would have sufficiently led to an effective data analysis process.

Finally, throughout the data analysis and writing process, I received peer feedback from colleagues who also use qualitative methods, have experience using qualitative analysis software and whose work has focused on students of color within school settings. In contrast to

these more informal feedback conversations, I also met with my advisor throughout the process regarding my data collection, analysis, and the writing process. I met more frequently for detailed feedback once data collection closed and I entered a more intense period of data analysis and writing.

Summary of Methodology

Drawing from critical race methodology, I used multiple methods to capture more holistic data from the participants throughout the duration of the program. Using my research questions and the Carlone and Johnson (2007) model as a guide, I selected methods that would permit relevant data to emerge for the purposes of the program. Allowing the research questions to guide how I selected my research methods streamlined the process and prevented having an abundance of data that was less useful for the study. Through the constant comparative method of analysis (Glaser & Strauss, 1967), I mined multiple sources of data using both conventional means of data analysis through open-coding hard copies of transcripts as well as using qualitative data analysis software to better organize my codes. The following chapter shares the findings that generated from data that emerged through this methodology, which are presented relative to the study's research questions.

CHAPTER FIVE
Findings

Within this chapter, I present the findings that emerged from the examination of the participants' identity development using the Carlone and Johnson (2007) science identity development model. I will begin this chapter by revisiting the structure of the model and the research questions that guided the project.

In Chapter Three I described the science identity model under examination, which consisted of three intersecting dimensions (i.e. performance, recognition, and competence) used to examine the participants' science identity identity development within the science counterspace (Carlone & Johnson, 2007). The *performance* domain is described as, "*social performances of relevant scientific practices*," *recognition* is explained as, "recognizing oneself and getting recognized by others as a 'science person', " and *competence* represents the participants', "knowledge and understanding of science content" (p. 1191). These three dimensions were considered interrelated with potential for overlap between them. As explained in the text, the authors proposed that one's race, gender, and ethnicity influence identity and, as such, are displayed in the model.

Carlone and Johnson (2007) used a grounded approach to examine the "recognition" dimension within their conceptual model, which is the approach I have taken to explore the identity development of the participants across the three dimensions of the model. This examination serves to understand the identities that emerge among a group of young African American female adolescents within a specific learning space, namely the culturally relevant science counter space STEMpowerment. Considered a "snapshot" of their science identity

development, the examination is not presented as a collective or individual fixed

representation of where they are in their identity development as science learners. These

findings are not provided to place students into a developmental "box," but to illuminate their

identity development within this cultural context using the Carlone and Johnson (2007) model

as an analytic tool. Keeping this in mind, this science identity development is fluid, as opposed

to static, especially within the non-traditional space in which they engaged in science learning.

Furthermore, the utility of this conceptual model as an analytic tool to understand science

identity development is under examination as a part of this study. Equally important to this

investigation is the utility of the conceptual model as an analytic tool to understand the science

identity development of African American adolescent girls.

Using the grounded methodological approach explained in the previous chapter, the

following research questions guided this investigation:

1. What is the utility of using a science identity development model to examine the science identity development of African American girls in a culturally relevant STEM after school counterspace?

2. Given the three explicit dimensions in the model, what science identities emerge among the African American girls participating in the culturally relevant STEM after school counterspace?

3. How do African American girls perceive the role of race and gender on the participation and success of women of color in STEM?

This findings chapter is organized into six major sections. The first section briefly

reintroduces the STEMpowerment program and its participants to better set the context for

readers. The second section introduces the major findings of the study followed by a summary

of the findings that address each of the research questions presented above. Next, I present

illustrations of the identities represented among the African American girls participating in

STEMpowerment Program, which are separated by the three dimensions. These findings are

supported by participant accounts and observations from group discussions, interviews, and

observations throughout the duration of the program. The subsequent section addresses the

second research question, which examined the girls' perception of the role of race and gender

on the STEM participation among African American women and girls. The final section

addresses the first research question regarding the utility of the science identity development

model for successful women of color in the sciences (Carlone & Johnson, 2007) to examine the

identity development of the African American girls participating in the culturally relevant

science counter space. The findings for research questions two and three are presented first, as

they establish the groundwork essential to support the findings addressing the utility of the

model.

STEMpowerment Program Revisited

As described in the previous chapter, STEMpowerment was a STEM focused, culturally

relevant after school program for girls grades 6-8, which served as the site for the study.

Throughout the duration of the program, the participants worked together on science and

math-related activities and experiments. In addition to these activities, they engaged in

dialogue about race and gender as both related to their experiences in school, science, and

their daily lives. Table 3 is a list of the activities the girls participated in during the program (See

Table 2 in Chapter Four for description of activities) as several of the activities are referenced

throughout the findings.

Table 3

List of STEM Activities within STEMpowerment Program without Descriptions

Activity
Classifying Hair Type
Hair Dye Inquiry Experiment
Is No Lye a Lye?: Chemical Compositions of Pure Substances
Magazine Math
Minerals and Bead-making
Nail Polish Experimental Design Activity
Product pH: Acid or Base?
Pure Substances: Nail Polish Inquiry Activity
Team Natural: Social Media Math
The Essentials of Bath Bombs & Sugar Scrubs
What's the Difference?: Testing Hair Dyes

Major Findings

Before I present the summary of the study's findings, I call attention to the major

findings of the study, which are listed below. These major findings are the primary focus of the

discussion chapter; however, I find it helpful to present them here to help readers apply more

focused attention on these findings as they read this chapter.

1. The model under examination served as a viable starting point to examine the science identity development of African American girls due to its capacity to reveal a holistic representation of identity development through the three dimensions; however, its usefulness within a culturally relevant counterspace requires an additional dimension to capture identities related to building critical consciousness.

2. The African American family, especially the role of female family members, continues to remain an integral source of support for girls throughout their schooling and, more specifically, within the STEM circuit. The role of African American fathers on their daughter's STEM experiences is also revealed in the findings.

3. The girls in the study have different perceptions of the influence of race and gender, which include a colorblind approach concerning race, a binary interpretation based on either race or gender, and an emerging intersectional understanding of the influence of race and gender.

Summary of Findings

The summary of findings begins with research Question Two, which focuses on the examples of identities that emerged within the three identified dimensions of the science identity development model used to examine the girls participating in the culturally relevant science after school program. The three dimensions of the model included competence, performance, and recognition (Carlone & Johnson, 2007). Within the competence dimension, two themes emerged: *Interest and Content Knowledge* and *Career Development.* Here, I learned that the girls exhibited knowledge and competence within their subject of interest. In addition, when considering competence in science processes and skills, two identities emerged with one representing students with self-directed/advanced competence and teacher-directed/general competence. The second theme, *career development*, revealed examples of identity construction based on the girls' engagement in developing and demonstrating their science competence in alignment with their career goals. The two science identities are identified within this theme are *stem for enjoyment* and *career focused.*

Following the competence dimension, the findings for their identity development within the recognition dimension are revealed. Within this dimension, two areas are addressed, which include the girls' constructed science identities in comparison to how they defined a scientist as a collective and the support they received from others. I found that their demonstrated identities were either congruent or divergent based on their authoring of a scientist. In reference to support, I learned that the majority of the girls received significant support from

female family members; however, there were also those who received support from their fathers. Finally, the performance dimension illuminated that the girls socially operated within the science space in two approaches, as leaders and contributors. Further investigation unearthed that the girls are often placed in or place themselves in these roles based on their previous performance and perceived competence in comparison to who they are grouped with.

Research Question Three focused attention on how the girls perceived the roles of race, gender, and ethnicity on their current and future experiences in science and the underrepresentation of African American women in STEM. Among the group, three forms of critique were represented: *colorblind, binary (race or gender),* and *emerging intersectional* critiques.

The final set of findings examine the utility of the science identity development model selected to examine the girls' identity development as science learners participating in the culturally relevant STEM after school program. The data revealed that the Carlone and Johnson (2007) model served as a viable starting point to examine the experiences of African American girls as science learners as it allowed for a more holistic examination of their identity development. In addition to providing a holistic representation of their identity development, the model also illuminated fluidity among identities within a single dimension, the interrelatedness of the separate dimensions, and potential relationships between identities between dimensions.

Competence Dimension

Within the Carlone and Johnson (2007) model, this dimension focuses primarily on the students' science content knowledge or representations of their content knowledge through various means. The authors suggest that representation of this dimension is not as "publically visible" (p. 1191) to researchers. This is especially true when competence is not determined in a standardized form. For the purpose of this study, students' competence and usage among the four STEM subjects (i.e. technology, engineering, and mathematics) were used as opposed to focusing solely on science content. From there, two themes emerged: (1) subject matter interest and competence with science process and skills and content knowledge and (2) STEM career development. The former focuses attention on which areas of STEM the participants both shared an interest in and how they engage in building their competence in these areas. I focused on their interests because these were the areas where the students recognized their own competence in, and subsequently built, greater competence in these areas through their actions. Further, their competence was also demonstrated through the knowledge they shared regarding their subject(s) of interest.

The second theme, career development, illuminates how the girls engaged in STEM-related activities that served to build their competence in STEM subjects. While this may be peripheral when considering the content knowledge students have, it takes into account the means by which students access STEM competence and the purposes for which they do so. Figure 1 below displays the themes and identities that were revealed within the competence dimension.
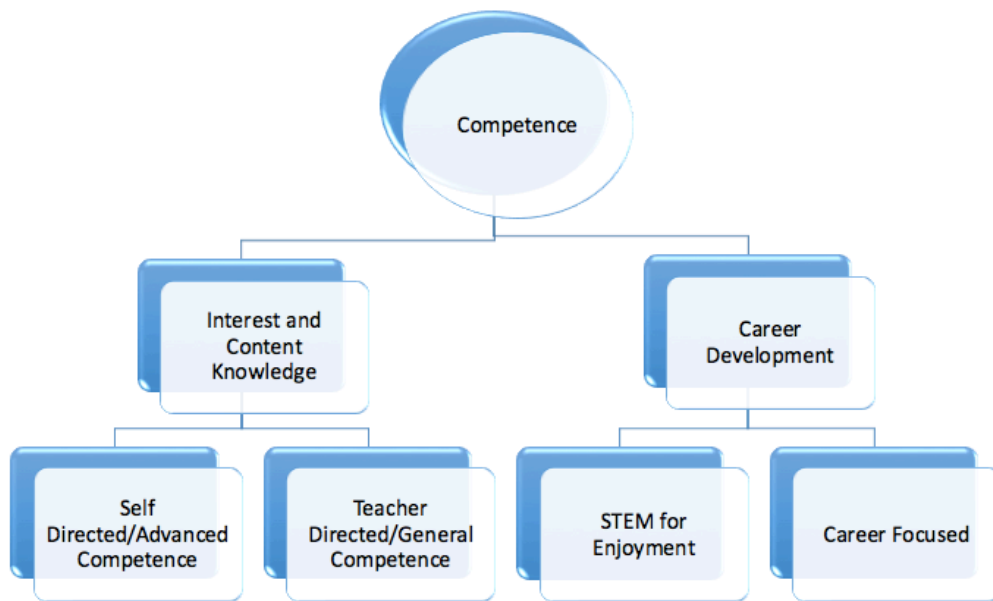
Figure 1. Competence Dimension Identities

Interest and Content Knowledge Identities

Although the STEMpowerment program focused primarily on science learning

objectives, an overwhelming number of participants also shared interest in and knowledge

about technology, engineering, and math or a combination of more than one area of STEM. It

was sometimes challenging to determine the extent to which each participant had advanced

content knowledge in one or more particular subject; however, through various activities they

were able to apply their content knowledge with their competence in science process skills and

experimental design. In addition, participants' competence in certain STEM subjects were also

revealed through the discussions by means of activating prior knowledge and using the

language of the discipline as it relates to individual subjects. For example, Eden shared that she

was interested in each area and provided specific reasons for her interests (personal

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communication, June 9, 2015). The following is an excerpt from Eden's interview when she

describes her multiple interests in detail.

Smith: Of the four primary areas of STEM, which fields interest you the most?

Eden: Uh, that's a tough question.

Smith: It can be more than one.

Eden: More than one? All of them.

Smith: All of them? So tell me something appealing about each one of them then.

Eden: Well math has a big impact on my life because it is in everything that we do. Whether it's going to the grocery store and figuring out probability, and seeing if you get something organic or regular price and seeing which one is which. My grandfather, he likes playing lotto, that's also something with probability with numbers and different things like that.

And then another one would be science. I like science because there's no really exact number. There's nothing that's exact. You can always find something that's greater, but even when you think that the greatest things have been invented like the light bulb, there's still more things that can be invented.

Smith: Okay, anything with tech and engineering?

Eden: Yes. Engineering, as I said, I love making things. I like to start from ingredients and make anything.

Technology is one of my favorites even though I'm not really into technology with all of the latest stuff. I like making, or putting back together phones and making microchips and megabytes to go into computers.

Smith: So not necessarily the use of technology, but the creation of it.

Eden: Yes.

During this exchange, Eden demonstrates her knowledge about each subject by drawing

connections between each area and ways they are applicable to real-life situations such as the

use of probability in mathematics for the lottery and the inventive nature of science. Beyond

this, her use of content-specific vocabulary and correct usage of these words give insight into her advanced knowledge about the subjects and how they are applied in particular situations and lead to the development of products. This is primarily demonstrated through her reference to microchips and megabytes within the technology domain and experience manipulating technology devices.

In contrast, another student with an interest in technology made connections with the use of technology in terms of output as opposed to the science and technology involved in making electronic devices work. Ashleigh connected her interest in technology with getting information from computers (personal communication, June 9, 2015). When explaining why she likes technology Ashleigh shared, "Well, the reason why I said technology is because I love working with computers and stuff. And you get more information off of the Internet" (personal communication, 2015). Unlike what Eden expressed above, Ashleigh enjoys technology because she likes *using* technology and the access to information technology provides. Each of the girls' use of and proficiency in their desired area of technology could possibly lead to different careers that are each STEM-related.

These contrasting accounts reveal how students can demonstrate varied competencies in a particular area that cannot necessarily be quantified or compared in a way that fairly differentiates between who has more or less knowledge about the subject through traditional assessments used to determine proficiency that are most often used in schools. Eden may have an understanding of how computers are built or the technology involved in making them work; however, Ashleigh's competence in technology can be demonstrated by her use of technology through social media apps like Snapchat, Instagram, etc.

Other demonstrations of the girls' their STEM competence were reflected in how they engaged in the science and math activities throughout the program based on the learning standards within "scientific investigation and reasoning" described within the Texas Essential Knowledge and Skills for Science (TEA, 2010b). Overall, students are expected to follow lab safety rules, use inquiry-based methods during lab investigations, use critical thinking and make inferences to solve problems, and correctly use a variety of science equipment (TEA, 2010b).

Based on the observations during our activities, I have identified two identities that represented how the girls demonstrated their competence in scientific investigation and reasoning: 1) Self-Directed/Advanced Competence and 2) Teacher Directed/General Competence. Self-directed/advanced competence reflects when students applied their science knowledge and skills within activities with very little to no direction from the me. On the other hand, the teacher directed/general competence was represented by those who needed more guidance from me during investigations and activities, as applying their science knowledge and skills appeared more difficult for them. While the girls had competence in varied areas, there remained observed areas of growth. Instances of ways the identities described above emerged among the participants are provided below.

Self-Directed/Advanced Competence

Among the participants, Zoe and Patrice were exemplars of students who demonstrated self-directed/advance level thinking by applying their scientific investigation and reasoning knowledge to the learning of the academic material of the program. In addition, they demonstrated self-assurance in their ability to lead and complete activities. For example, Zoe

exhibited this identity when she expanded on the *Pure Substances: Nail Polish Remover Inquiry* activity. After conducting the experiment, Zoe decided to retest it on her own for her science fair project (observation, April 7, 2016). This is an example of how Zoe expanded on what she was exposed to without further assistance. On another occasion, Zoe created a scientific study comparing the base/top coats of nail polish. With very little assistance, Zoe fully developed the project by identifying the variables for the experiment, identifying and addressing limitations, and determining adequate procedures (observation, May 5, 2016). She then went on to conduct her study and presented her findings in a poster session format to the group (observation, May 12, 2016).

An example of Patrice representing this identity was during *The Essentials of Bath Bombs & Sugar Scrubs activity* when she chose to use a different measuring tool to create her product (observation, November 19, 2016). When given the number of ounces in a cup, Patrice mentally calculated how many times she would need to fill the smaller measuring tool to get the necessary amount of that particular ingredient for her product. Patrice was able to move from station to station and successfully produce multiple products with very little direction in comparison to students in other groups. Another example of Patrice demonstrating this identity was evident during the *Team Natural: Social Media Math* activity. She aided the group in offering a more accurate way to determine the length of the women's natural hair during the classification part of the activity, which demonstrated that she thinks more deeply about how we should classify the data in comparison to the other participants present (observation, January 14, 2016). She then went on to update the categories she used to organize her data in an effort to have categories that best represented her entire dataset. After sharing her data,

Patrice drew connections between how we displayed data using a bar graph with the Hertzsprung-Russell diagram used to categorize stars. In reference to why graphs are used to present data, she explained, "It's easier to see the numbers. I like bar graphs, kinda like the HR diagram, but it's kinda not like a graph where we compare the luminosity with the temperature" (personal communication, January 28, 2016). Patrice's ability to activate and apply her prior knowledge to the program's activity demonstrated that she has internalized the content and is strengthening her competence in these areas. In addition to Zoe and Patrice, Portia also demonstrated self-directed competence such as when she developed a bar graph during the *Magazine Math* activity with a precise x and y axis that allowed her to display her data more correctly without teacher assistance (observation, October 15, 2016). During this activity, Portia successfully collected and categorized the appropriate data, developed a data table, and provided the correct ratios that represented her data.

Princess also demonstrated this of identity when she too drew on her prior knowledge and made connections to the current learning during the *Product pH: Acid or Base?* activity (January 21, 2017). She recognized the direct connection between the colors used to determine alkalinity or acidity on the litmus strip key with the colors in the color wheel, which are organized by their electromagnetic wavelengths (observation, January 21, 2016). Recognizing the color wheel is part of the foundational learning taught in elementary-level science learning about visible light waves and the electromagnetic spectrum.

In contrast to the examples of the self-directed and advanced-level competence identity explained above, the teacher guided/general knowledge identity represents when the girls needed more direct guidance to complete activities or relied heavily on others for direction. For example, during the first *Magazine Math* activity, Princess was inconsistent with how she presented her ratios by reducing one set of data without attempting to reduce another (observation, October 15, 2016). In addition, Princess made at least two mistakes while representing her data and only partially corrected her mathematical errors. I also attributed this to not paying close attention to detail with representing data. In addition to the varied representations of her ratios, Princess's bar graph was not well-constructed. Another instance when Princess displayed this identity was during the *Team Natural: Social Media Math* activity (observation, January 14, 2016). Throughout the activity, Princess worked on a math assignment from school, which resulted in her giving minimal attention to the bar graphs she constructed for the activity. After collecting her data, she constructed a bar graph that did not include the appropriate numbers on the y axis and relied completely on her counting tallies to share her data. When I asked her about her graph, she replied, "Oh, just like a teacher" and then appeared to correct her graph before returning to her math homework (observation, January 14, 2016). When I viewed her graph once more, very little was added. Although Princess was very distracted during the activity, she made the same mistakes on her bar graph as she did during the *Magazine Math* activity (October 15, 2016). This demonstrated to me that she had proficiency with tallying for data collection, but needed more guidance with focusing on constructing graphs to display her data. Constructing data tables and interpreting the data

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within those tables are required for multiple subjects, thus having competence in this area is beneficial.

Similar to Princess, Ashleigh struggled with paying attention during some activities and often required more direct-instruction to complete tasks. During the second trial of the *Magazine Math* activity, Ashleigh experienced difficulty calculating the percentages. She had difficulty remembering which formula to use and the division involved for her calculations (observation, October 29, 2016). I had to stop multiple times during this part of the activity to help Ashleigh with her division, which revealed that she did not have a firm grasp on that mathematical process. It is also important that I point out that this identity was primarily revealed when Princess and Ashleigh were engaging in math-related activities, which may be related to their competence specifically in math.

Although I have identified two identities that emerged through the data for science competence above, I found that there are cases where students will exemplify either example based on the situation. For example, Portia was not generally self-directed or very focused while conducting experiments or during mini-lessons when there was a large group; however, there were instances that she was more self-directed and produced quality work when she worked directly with Princess or Zoe, (observation, October 15, 2016; December 17, 2015). As it relates to science competence, Portia may actually have extensive competence in the subject area, but may choose not to demonstrate it to the extent that others do or in ways that I was unable to capture in this research.

These examples suggest that when this identity is represented, areas of growth are more pronounced for certain students and are manifested differently if students are not paying

attention to the work they produce. In addition, students may miss opportunities to strengthen their competence to produce products that best represent what they are capable of.

Career Development Identities

I posit that it is important to consider the career development practices students engage in as science students, as their engagement represented how they engage in activities that serve to deepen their current knowledge base. Although each of the girls voluntarily participated in the STEMpowerment program, several of the girls did not have an interest in pursuing a career in STEM. The identities identified within this theme of the dimension are related to the participants' interests in pursuing a career in STEM and the type of STEM-related activities they engaged in. A Career-Focused identity is represented when a student shares an interest in pursuing a STEM-related career and engages in science activities and programs that are designed to prepare them for careers in STEM. A STEM-for Enjoyment identity is represented when students do not currently express an explicit interest in a STEM-career; however, they still participate in STEM-related activities to appease their interests.

STEM for Enjoyment

Among the group, four girls represented the STEM-for Enjoyment identity, as they primarily participated in the program and other STEM-related activities simply because they enjoyed it. Each girl did not express an explicit desire to work in a STEM field; however, each of them still consider themselves a "science person" and have specific areas within STEM that they enjoy most. For example, Ashleigh shared that technology is most appealing to her because she enjoys working with "computers and stuff" (personal communication, June 9, 2015). In her

interview she expressed an interest in becoming a fashion designer, thus it is not surprising that

Ashleigh did not share any engagement in other STEM-related programs in addition to

STEMpowerment that would deepen her knowledge within STEM subjects. With Ashleigh's

interest in using technology and observations of her often engaging with technology on her

iPhone, she has the potential to develop the technological skills to further her interest in

fashion design should she combine her love for the two. Despite her interest in a career

outside of STEM, Ashleigh "really like[s] science" and sometimes replicates experiments she

sees on YouTube (personal communication, June 9, 2015).

Portia is another participant who exhibited a STEM-for Enjoyment identity, as her

participation in the program does not appear to be based on an explicit interest in science, but

rather for an opportunity to have fun. Portia shared that she is interested in becoming an

actress when she grows up and currently takes acting classes (personal communication, March

3, 2016). Interest in other careers were certainly not discouraged for participants in the

program and Portia appears to be exploring her interests while finding a space to potentially

develop a greater interest in a STEM. Princess is another student who expressed career

interests in areas other than STEM. Her interests varied greatly from becoming a fashion

designer to a chef (personal communication, January 28, 2016). I believe that her general

interest in STEM and the program's focus on the hair the cosmetic industry impacted her

interest in participating. With her broad career interests, Princess is also primed to consider a

STEM career, especially since she has not yet become deterred from engaging in STEM

activities. As was described earlier, Eden, who would like be an entrepreneur, shared an

interest in all of the STEM subjects because she enjoys particular aspects of each area. Eden

was already involved in starting her own businesses as well as hosting radio shows (personal communication, June 9, 2015) , which impacted her interest in becoming an entrepreneur; however, she does not discount potentially pursuing a STEM-career. During her interview she shared,

> Well um, I want to own and operate my own company. I already have one, but I wanted to expand and work with kids, but I also love STEM and my family is built with engineers and people who have surrounded their mind with STEM so I can go one way or the other. Or just have one as a Plan A or a Plan B. (Eden, personal communication, June 9, 2015).

Zoe exhibits this identity much like Eden since she has a strong interest in becoming a theatre director. Like Eden, Zoe considers a STEM-career as a viable option among the careers she will consider in the future. Zoe has a love for and has demonstrated talent in STEM and the visual arts, and her representation of career development identities is a hybrid of the two, as she works towards building her knowledge and skills in each of her career interests.

Career-Focused

One student who demonstrated a Career-Focused identity is Tyson, who expressed interest in possibly becoming a bio-medical engineer (personal communication, June 9, 2015). In our interview, Tyson shared that she joined a robotics team when she was in fourth grade after her teacher asked her to participate. Although she initially joined because it, "looked fun at the time," she eventually won a competition against other students in the program. Tyson shared that winning made her, "glad for the first time" (personal communication, June 9, 2015). Tyson's early involvement with STEM subjects contributed to her eventually considering a

STEM-related career. Olivia also shared an interest in becoming either an engineer or working in technology after attending an elementary school with a STEM focus in her home state (personal communication, June 9, 2016). She shared that "it felt good" to know that the school's robotics team competed and won competitions. Olivia also engages in STEM-related activities outside of the program such as watching science-related television shows and documentaries.

Other students constructed a Career-Focused identity through exploring specific scientific concepts through multimedia, conducting their own scientific experiments and engaging in scientific inquiry. For example, Nichelle, who wants to become a chemical engineer, shared that she likes to watch documentaries such as *Food Inc.*, visits STEM-related Tumblr pages, and has explored topics such as gravity and density in more depth on the internet (personal communication, June 9, 2015). Like Nichelle and Olivia, Zoe also watches science-related movies and television shows with her family in addition to exploring plants and animals with her older sister (personal communication, June 9, 2015).

Patrice is another participant who displayed a Career-Focused identity, as she is certain about her goal to become a biomedical scientist (personal communication, January 21, 2016). Although she participates in a wealth of activities outside of school such as chess, church, and dancing, STEMpowerment was the only formal STEM-related activity she participated in (observation, January 14,2016). Notwithstanding this, Patrice shared that her mother is accustomed to her "getting messy" when she tries things at home, which conveyed to me that she experiments on her own.

As I mentioned in the previous section, Zoe was interested in more than one career, which included becoming a theatre director as well as a physicist (personal communication, June 9, 2015). Given this, Zoe is constructing a blended STEM-for-Enjoyment and Career-Focused identity through her engagement with STEM both within and outside of the program. Zoe shared that her mother has encouraged her to consider a STEM career in addition to her other interests (personal communication, June 9, 2016). To build her knowledge and skills base, she applied to a science-intensive program at an east coast boarding school during summer 2016 (personal communication, 2016). Based on her actions, despite wanting to become a director, Zoe is taking systematic steps that may position her to successfully pursue a STEM career.

Although I have separated these two identities, Zoe represents someone who displays both examples. This is not entirely surprising, as the increase in career options for women of color may contribute to more women pursuing careers they actually enjoy. When asked about being a scientist, Tyson specifically expressed that scientists must have a, "passion with what you do and like actually enjoying it," before she went on to suggest that they can do more outside of work like develop STEM programs for aspiring scientists (personal communication June 9, 2015). In addition, when asked to draw their interpretation of a scientist, Quincy shared that she believed that scientists, "have fun and learn at the same time," which implies that she believes that they should enjoy their work as well (personal communication, December 3, 2015). When asked about these suggested identities in the post interviews/member checks conducted in June 2016, some participants agreed that a girl could participate in STEM-related activities notwithstanding her career interest.

Overall, while the girls participated in the same STEM-related program, STEMpowerment, some appeared to engage in the learning mostly from the standpoint of the Career-Focused identity in examples described above. Unsurprisingly then, I observed that some students who most represented the more than one identity in the previous sections also engaged in the STEM activities in dissimilar ways during the program. I explain this further when I describe the identities that emerged in the *performance dimension* section.

Recognition Dimension

As described in Chapter Three, the recognition dimension focuses on how students recognize themselves as scientists and how others recognize them as scientists (Carlone & Johnson, 2007). To better investigate this, I first explored the girls' definitions of or "authoring" of a scientist. I did this primarily because the students in this study are currently K-12 science students/learners, unlike those in the Carlone and Johnson (2007) study who were practicing scientists or pursuing undergraduate and/or graduate degrees in the sciences. The second section of the recognition dimension introduces the identities relative to how the girls define a scientist, which I refer to as *congruent* and *divergent* identities. I took this direction to gain better insight into how the recognition domain operates for emerging scientists within the STEM-circuit who have not made more finite career decisions and who have not been identified as "successful" scientists based on their place within the STEM circuit. Following the congruent/divergent identities section, I focus on how the girls are recognized as scientists by others and who serve as their primary sources of support. As described in the summary of findings, the girls' sources of outside support were divided into two groups: female family

supported and father supported. Figure 2 provides an illustration of the primary foci of the

recognition dimension, which includes the themes and identities that emerged.
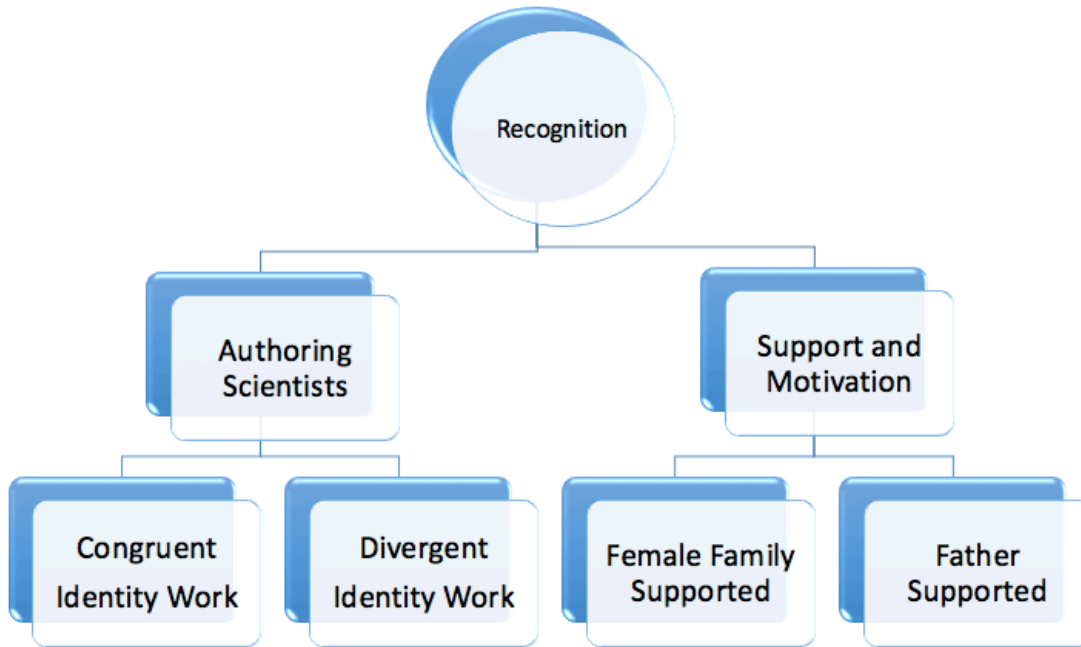
Figure 2. Recognition Dimension Identities

Definition of a Scientist: Authoring Science Identities

During our initial focus group sessions, the girls collectively described a scientist as

someone who goes "Beyond Z" and takes risks. "Beyond Z" is a phrase derived from the Dr.

Seuss Book (1955/1983) *On Beyond Zebra!,* which is used within the school to describe students

who go the extra mile. When I further probed into the words used to describe a scientist, two

major descriptors emerged from their explanations. They described a scientist as an *explorer*

and as an *inventive risk taker*. Being a scientist as an *explorer* was associated with having a

thirst for knowledge. Zoe stated that a scientist, "[has] to be able to want to learn more"

(personal communication, June 9, 2015). Nichelle shared a similar sentiment when she stated,

"A scientist should always be thirsty for learning…they should always want to learn something more because that's what pushes the scientist to explore new things like space and the ocean" (personal communication, June 9, 2015). The second descriptor, *inventive risk taker,* was initially split into two descriptors: *inventors* and *risk takers*. Upon further analysis, I realized that the participants' descriptions appeared interrelated. For example, Ashleigh described a scientist as someone who, "take[s] their own actions and own risks," while Tyson expressed that scientists, "come up with what they want to do, like new plans" (personal communication, June 9, 2015). Others described scientists as people who are, "not afraid to get dirty" (Olivia, personal communication, June 9, 2015) or simply "takes risks" according to Zoe (personal communication, June 9, 2015). Collectively, their descriptions were related to exploring new ways to practice science, take action, and demonstrate the willingness to "go outside the box" (Tyson, personal communication, June 9, 2015) in order to do so. Here, there is a risk involved with trying new things and creating new methods of thinking as in relation to STEM engagement.

Recognition Dimension Identities

When asked to compare their explanations of a scientist and themselves as scientists, nearly all of the girls either described themselves or shared congruent experiences aligned with their definition of a scientist. From this, I identified two identities within this dimension: *congruent identity* and *divergent identity.* A student displaying a congruent identity closely aligns how she engages in science with the collective definition of a scientist. A congruent identity is also exemplified when a girl individually describes a scientist and then shares that she does or meets most of the description's factors. In addition, explicitly naming oneself a scientist

constituted as constructing a congruent identity. In contrast, a student showing divergent

identity construction identifies specific attributes of a scientist, but shares that she does not

exemplify these characteristics or does not provide evidence that she does. In addition, she

may not practice science in line with the *collective's* definition of a scientist.

Nearly *all* of the girls associated with some characteristic of being a scientist, especially

the *explorer* descriptor. Olivia described herself as a student who likes to determine possible

solutions. She explained, "I like to figure things out because I know that I can find a solution, it

lifts a weight off my shoulders because I know that I did that." (personal communication, June

9, 2015). Daphne shared that a scientist, "has their own, might I say, issue, problem with things

and you just have to find the right thing that you want to explore" (personal communication,

June 9, 2015). Another example includes when Patrice specifically distinguished herself as a

scientist when she shared out her drawing of a scientist (observation, December 3, 2015).

During this activity, some of the girls drew specific people they identified as scientists or just a

person performing a scientific task. Patrice drew a women and shared, "I drew this picture

because when I think of a scientist, I think of a woman, and I am a growing young lady"

(personal communication, December 3, 2015). I understood this to mean that she drew her

image of a scientist in the image of current or future self.

While none of the participants strongly represented examples of a divergent identity,

there were instances when students shared illustrations that challenged the themes or added

to them in ways that were not shared by others. Tyson made a clear distinction between being

a student and scientist and her place in the middle. She explained,

> Well, we can't all be scientists because we are all students right now, but we have to do
> what our teacher shows us or she tells us to do, rather. But we just have to try to figure

stuff out on our own and if we can't, we can ask her for help because she's the more experienced person. (Tyson, personal communication, June 9, 2015).

Within her explanation, she placed the student in both congruent and divergent places a scientist. On the one hand, a student is not considered a true scientist because she is not in a position of authority and must listen to her teacher. Yet, the student has to figure things out on her own and uses the teacher as a resource when necessary. As for herself, Tyson shared, "I'm in the middle. Sometimes I just do what they say or I create my own way" (personal communication, June 9, 2016). Zoe also mentioned on more than one occasion the importance of scientists following directions, which challenges the idea that they are the risk takers she originally described them to be. She stated,

> Well, I think, if you know the right time and the right place to do a certain thing, I think you could be a scientist. But if you're a scientist and they say don't mix this with this and you do it anyways, then something bad can happen. (Zoe, personal communication, June 9, 2015).

Her contrasting descriptions led me to conclude that she believes that scientists can take risks as long as it does not result in harm being done to others or causes a catastrophe.

Nichelle shared that she believed that a scientist should also be kind and should be considerate of other people's ideas (personal communication, June 9, 2016). She goes on to explain, "They should be a nice person because when other people's ideas are, like, mixed with theirs…they shouldn't react in a way that's an attitude or anything. So they should be accepting to feedback also" (Nichelle, personal communication, June 9, 2015). Tyson also shared a more selfless description of a scientist when she suggested that as a scientist, "[you] could start your program, like, helping kids get into STEM or whatever field you're in" (personal communication,

June 9, 2015). Here, I understand that Tyson believes that scientists must give back to the STEM community through outreach.

The previous section examined the recognition dimension by centering the focus on the girls' recognition of themselves as scientists in relations to how they authored scientists. The following describes the role of those in their lives who recognize their potential and provide them with support.

Support from Others

This section considers the kind of support provided as the girls navigate the STEM circuit. I begin by briefly describing the importance of support from others, as this reinforcement to pursue or do well in STEM was deemed very important according to the girls. Over half of the participants referenced a lack of support as a contributing factor to African American women's underrepresentation in STEM. When expressing why there are few African American women in STEM, Eden explains, "I think it's so because nobody really pushed them to do that or maybe because, like, what we just talked about, people underestimated them. Or, maybe they had a problem with people saying no to them" (personal communication, June 9, 2015). Tyson shared a similar idea when she suggested, "they don't have anyone to motivate or encourage them" (personal communication, June 9, 2015).

The girls recognizably deem being determined and encouraged to pursue STEM as a deciding factor in African American women's representation in the field; however, it is important that we know who supported them along their journeys. Based on their responses, the girls shared two groups who primarily supported them to be successful in STEM and/or just successful overall. These groups include their female family members and their fathers, which I

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classify as *female family supported* and *father supported*. Between the two, female family members were overwhelmingly referenced when I asked the girls who believed in them the most. Of the group, three girls identified their fathers, as opposed to other male figures, as their sources of support to participate in STEM.

Female Family Supported

In concert with the literature focused on African American girls and science (Hanson, 2009), the vast majority of the girls shared that they were encouraged and/or influenced by their mothers and other female family members such as sisters, aunts and cousins. The kind of support the girls received varied and ranged from being reminded that doing well in school will lead to success to having the opportunity to shadow a family member at work. Most of the participants shared that their mothers believed in them the most and offer them encouragement to work hard, stay focused, and prepare for college. For example, Tyson explained how her mother provide her support and somewhat implies that she often reminds her of what she needs to do to be successful. She shared,

> She always says "make sure you keep your grades up," and blah, blah, blah, this and that. And um. 'remember you have to do your best every day because you want to have scholarships coming out and you want to have choices and stuff when you graduate. (Tyson, personal communication, June 9, 2015)

Her use of "blah, blah, blah, this and that" communicates to me that she has heard this from her mother many times. Olivia shared that her mother often encourages her to become an engineer, especially because she attended the STEM-focused school in her home state (personal communication, June 9, 2015).

Eden described her mother as her "cheerleader since [she] was born" and shared that her mother has always pushed her to participate in multiple activities so that she can have different career options to choose from when she grows up (personal communication, June 9, 2015). She also shared that her older cousin inspired her to pursue STEM in addition to her mother. Below is an excerpt from her interview describing their influence.

Smith: Okay, keep going. So how do you stay motivated to be successful in STEM?

Eden: Well my mom, she really pushes me in order to do this so that when I grow up I'm not just going to go upon what I want as a Plan A, but as a Plan B so that I can have beauty and brains.

Smith: Okay, so you'll have some options. So, you mentioned mom, can you describe specific people who've encouraged you to go into STEM?

Eden: Yes. My mom would be one. Another would be my cousin *Asia, she is the vice president of Amway and she works in Japan….and New Jersey.

Ashleigh also mentioned that her mother, "encourages [her] to work harder and focus and stuff" (personal communication, June 9, 2015). Nichelle, who aspires to work in STEM is primarily inspired by her aunt who works at Princeton and has three elementary-aged children who Nichelle believes will eventually look up to her as their older cousin (personal communication, June 9, 2016). Her aunt working at Princeton has inspired Nichelle to consider attending an Ivy League school in hopes of exceeding her aunt's accomplishments. She would also like do well to help take care of her mother. She stated, "And I just want to be successful for my mom too because I want to get her all this stuff. I'ma be like, I'ma get you that car" (personal communication, June 9, 2015). She also shared that she originally wanted to become a lawyer; however, her mother has pushed her to become a chemical engineer and she feels obliged to do so, but not in a negative way. She explained, "… I wanted to be a lawyer before,

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but then my mom, she kinda explained to me what chemical engineering [is]. She wanted me to pursue a different career so I, um, looked into it" (personal communication, June 9, 2015).

Zoe is the participant who spoke at length about the people who support and encourage her, which included her mother, older sister, and her mother's sisters. When speaking of her mother, she often quoted what her mother says to her as encouragement,

> …she's the one who tries to get me into all these programs. "If you can just stay focused, and you try. If you try and try you can go. "Like my sister, she traveled to like, five different states already. So you can do, you can do better than what she's done. You can go all these places. (Zoe, personal communication, June 9, 2016).

Although Zoe is significantly encouraged by her mother, she holds her high school aged sister in great esteem and considers her a role model. Zoe identified her sister as the person who believes in her the most. She stated, "I think my sister believes in me the most 'cause even when I'm not happy, she would say, 'you can do this.' She's the one who helps me. She thinks I have a lot of potential in me" (personal communication, June 9, 2016). When speaking about her sister, she explains how she has served as a role model to her. Zoe shared, "She's in a STEM program. She's in a lot of programs that have to do with, like, STEM and I always looked up to her like that so I always wanted to do STEM," (personal communication, June 9, 2016). Zoe describes her sister as "really smart" and shared that she has already accomplished many achievements. She also shared that her sister encourages her to be a better person and she strives to be like her or do better than her because they are competitive (Zoe, personal communication, June 9, 2015). Zoe's sister currently attends the local visual and performing arts school and focuses on visual arts. Like her sister, Zoe participates in STEM programs as well as the visual arts through drawing.

Although the following source of support is not nearly as represented in the data as the female family influence profile, I find it of great importance to describe the role fathers play in their daughters' success in life, school, and STEM. This not only gives voice to those girls whose fathers are influential figures in their lives, but also serves as a counternarrative as it relates to the role of African American fathers in their children's lives, especially their daughters' participation in male-dominated fields such as those within STEM.

Father Supported

Three girls shared that their fathers served as supporters and influential figures as it relates to their participation in STEM. Examples of how the girls are influenced by their fathers include: making him proud, following is his footsteps, or being inspired by their family history. Daphne shared that her dad would be disappointed if she ever decided to quit anything that she started (personal communication, June 9, 2016). In addition, she shared that he buys her science kits or supplies for experiments when she asks him to. Patrice declared being supported by her mother and gaining knowledge from her great aunt as sources of encouragement; however, she credited her father for providing a greater influence for her to pursue a STEM-related career along with her brother (personal communication, January 21, 2016). Below is an excerpt from her interview, which reveals the primary role of her father in her pursuit of a STEM career as well as her brother's influence.

> Smith: So you mentioned your great aunt and your mom. Would you say they encourage you to do science?
>
> Patrice: Yes. But my dad is probably the most.
>
> Smith: So can you talk about that?

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Patrice: Um, my dad is a director at a college. Um, he was actually going to go to medical school. He became a welder and he also, he stopped, pretty much, he stopped because he had my brother so…when he had my brother, he continued welding instead of continuing towards medical school. So, um, surprisingly, I don't know where it came from, but my brother and I want to go into the medical field. Um, he knows a lot about math and science, those are his top subjects too.

Smith: So, dad believes in you the most with this science thing?

Patrice: Yes, and his background. [His mom] made him work for everything. He had a job, paid half of the bills, so his drive to do all that and still go to high school and get great grades. [H]ow can I not do that when I have everything right at my feet? If I want something, I can get it, as long as my grades are straight. (Patrice, personal communication, January 21, 2016).

Patrice also shared that she and her brother plan to go into business together as medical professionals. He would work as an anesthesiologist and she as a biomedical scientist. The final student who shared that her father supported her engagement in STEM, specifically through the program, is Portia. Although Portia participated in STEMpowerment from the beginning, she shared in her interview that her mother does not fully support her participating in the program. This is primarily because her mother wants her to focus on her acting career and use more time after school to complete her homework (personal communication, March 3, 2016). In contrast, her dad encouraged her to continue with STEMpowerment because she was interested in the program and engaging in STEM, although she is not currently considering a career in STEM.

Though there were two clear themes within this segment of the dimension, one student referenced the school as a source of encouragement due to its specific focus on students going to and through college. Through their accounts, it was very apparent that their family members played a significant role in motivating them to not only participate in STEM activities and/or pursue STEM careers, but to also strive towards becoming successful

individuals. This finding corresponds to the literature regarding the role families play in girls and

women of color's success within the STEM circuit (Hanson, 2007, 2009; Carlone & Johnson,

2007). What follows is an examination of the third dimension of the model, *performance*, prior

to delving into the participants' perception of the role of race and gender on the STEM

participation of African American women.

Performance Dimension

The performance dimension within this model represents the social performance of

science learners as they participate within a learning space (Carlone & Johnson, 2007). It is in

this space that the girls may choose to live out the characteristics they believe a scientist

possesses among their peers, and where their capacity to take on the role of that kind of

scientist is reinforced or potentially fades.

During the program, I noticed that, at times, students served in two main roles as

participants. Much like the other identities that emerged I have described within the previous

dimensions, the findings suggest that the participants may exemplify these roles at different

times. The two roles that emerged from the data are identified as *lead actress* and *supporting*

cast identities (Figure 3). The instances when participants took on the lead actress role were

when they took on leadership roles within the science space, led by example when completing

activities, and actively engaged in the dialogue during our discussions. In contrast, supportive a

cast identity is displayed when a participant helped with an activity or engaged in the dialogue;

however, her role may be as an active or passive contributor, but not in a leadership role.
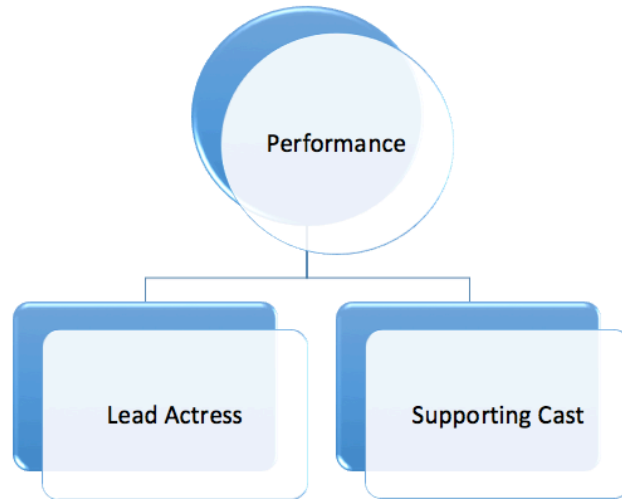
Figure 3. Performance Dimension Identities

Lead Actress Identity

Among the group, this identity was demonstrated when Zoe pushed the learning

forward while we were learning about the Moh's Hardness Scale during the *Minerals and*

Beading activity (observation, December 17, 2015). In the middle of the lesson, Zoe explained

to the group that what we were learning was similar to the scale used to mine on the game

Minecraft. She took her phone out to demonstrate her observation, which also helped me

make connections between the popular game and the content. As a lead actress, Zoe took

ownership of the learning and taught others ways to make connections as well.

During an engineering challenge used to start a session, it was quite apparent who took

on the lead actress roles and who served in supportive roles as the girls built free-standing

structures made of index cards and tape, which had to hold at least one book (observation,

February 11, 2015). Zoe paired up with her good friend, Portia, during this activity. Throughout

the activity, Zoe made nearly all of the decisions about the structure, while Portia only

contributed when Zoe asked her to. The primary responsibility was placed on Zoe for the

activity. During this same activity, Quincy took on the leadership role as she worked with

Kourtney who was a participant in the program, but not the study due to her grade level. Like

Zoe, Quincy appeared to make the decisions about how the structure would be built and

Kourtney assisted her. Portia also demonstrated the lead actress role when she worked

alongside Princess during the *Magazine Math* activity (observation, October 15, 2015). During

this activity, Portia was very focused on the content, created an accurate bar graph to

represent her data, and provided accurate ratios of her data. In this instance, Portia led by

example through her focused work and the product she produced. Next, I will provide examples

of supporting the cast identity before offering my interpretation of why the girls take on these

roles based on the information they shared with me.

Supporting Cast Identity

Examples of the supportive cast identity primarily revealed itself when students worked

opposite those who exhibited a lead actress identity. For example, during the engineering

challenge referenced in the previous section, Portia, who worked with Zoe, primarily operated

as a passive participant during the activity by talking to Zoe about unrelated topics and adding

on to the structure when Zoe asked her to. During discussions, Portia often sits back while

others speak unless it she has something she really wants to share (observation, February 11,

2016). Ashleigh and Princess also take on this role, as they rarely led during the activities and

discussions and did not lead by example due to sometimes being distracted (observation,

October 15, 2015; October 29, 2015). As a result, they sometimes made mistakes in their work

or did not pay close attention to the quality of their work. When we discussed the roles they play, they each shared that they prefer to help. More specifically, Ashleigh stated that she prefers to make sure that her team is on task; however, she does not take the lead to actually get the work done or make primary decisions (personal communication, February 11, 2016). Despite this, when Ashleigh and Princess teamed up for the engineering challenge, this supporting cast role worked in their favor as they worked as a cohesive unit. During the activity, it was difficult to determine who served as the clear leader. At certain times Ashleigh took the lead role in determining the next move, Princess would agree, then she and Princess would move forward. At other times, they appeared to work more collaboratively as they built their structure and decided on what to do together (observation, February 11, 2016). Below I present a rationale for how they are positioned within these roles.

Role Selection

In this final section of the examination of the performance dimension, I address how girls are selected, at times of their own volition, into each of the above roles. When a participant takes on the lead actress role either in school or within the program, she assumes the role as a leader within the group or is selected to do so based on previous performance by the group or a teacher. Zoe and Patrice spoke about how they assume leadership roles when they separate into groups during classes (personal communication, February 11, 2016). From their dialogue, I gathered that they often feel obligated to lead when they are in groups so that they can make sure they receive a good grade. They also shared that there are other students who take on these leadership roles and their teachers often make sure that they are not

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assigned to the same groups (personal communication, February 11, 2016). Patrice explained

that her current science teacher places two other girls in the same group with her because they

will each take the lead role. She also expressed that other students believe it is not fair when

they are in the same group together because they are all "smart" (personal communication,

February 11, 2016). The girls believe their teachers do this so that there is at least one "leader"

in each group, which is a practice I have done as a teacher when I attempt to create

heterogeneous groupings. Upon hearing this, Zoe agreed that similar things happen in her

classes as well and for the same reasons (personal communication, February 11, 2016). In the

case of Zoe and Patrice, ensuring that the work gets done and is done correctly appears to be

the primary determinant when they are in lead actress roles. In addition, their selection is

based on how well they do in science in comparison to the other students present.

I argue that constantly being positioned as the designated group leader increases the

pressure on these girls to be knowledgeable and lead the group in the right direction. Zoe

shared that having to lead *indeed* increases the pressure on her

> [be]cause nobody's perfect, nobody knows everything, so if they…keep holding me up
> to that standard and I don't know what I'm doing, I have to just try to, I have to try to
> know, *act* like I know what I'm doing and try to do the best I can do. (personal
> communication, February 11, 2016).

They take on what appears to be a heavier burden than others in the group because

their role as a leader is contingent on their previous performance and content knowledge, but

not necessarily having well-developed leadership skills. This is similar to how Olivia describes

the responsibility of scientists to figure things out and how it makes her feel when she does so.

She shared, "Well, like, I like to figure things out because I know that I can find a solution, it

kinda, like, lifts a weight off my shoulders because I know that I did that. And I came to the

conclusion" (personal communication, June 9, 2015). While her account was partially about

demonstrating her ability to take ownership of figuring things out, stating that it "lifts a weight

off" of her shoulders demonstrates that she internalizes the importance of getting to the end

goal and feels responsible for doing so. Quincy shared a similar sentiment when she stated that

she would rather work alone during an activity because she wanted to make sure that it was

done correctly. She then shared that if she made mistakes, then she would know they were

hers and would learn from them (personal communication, November 19, 2016).

In contrast, those who displayed a supporting cast identity shared that they serve in

these roles when they believe they are not the "smartest" person in the group (personal

communication, February 11, 2016). Swift judgment would lead one to conclude that those

who tend to take on supportive roles simply are not leaders or have little to contribute;

however, the girls expressed that they often defer to the person they believe is smarter if they

are in the same group, which could be influenced by who their teachers identify as "smart" or

leaders. On the other hand, the girls expressed that if they are in a group and believe *they* are

smarter than other members, then they will take on the leadership role. Portia explained that

she typically does not do any work unless her partner needs her to hold something or figure

something out; however, she went on to share that if she works with two specific classmates

that she takes the lead role to avoid getting a bad grade (personal communication, February 11,

2016). Ashleigh and Princess followed Portia and shared that it depended on the situation and

whether or not they are asked for help (personal communication, February 11, 2016). This

example demonstrates that the girls are indeed capable of taking on a leadership role in science

activities; however, their perceived competence in science in comparison to others plays an integral role in their decision to lead.

The final segment of this chapter focuses on the role of race and gender on the STEM experiences and underrepresentation of African American women. I primarily examine this based on how the girls perceive the roles of race and gender on their experiences and the experiences of African American women as a collective.

Race, Gender, and Ethnicity

The Carlone and Johnson (2007) study focused on women of color as a whole and included women from various racial and ethnic groups. Within this study, I examine Black girls. During the program, I conducted group discussions and interviews where we discussed the roles of race and gender on their experiences as science learners as well as their perceptions of the impact of race and gender on the participation of African American women in STEM careers. This section, "Race, Gender, and Intersectionality" discusses how the girls perceive the combined role of race and/or gender on the underrepresentation of African American women in STEM. Here, I identify three representations of the girls' thinking regarding race and gender, which are: (1) Colorblind/No Critique; (2) Binary Critique; and (3) Emerging Intersectional Critique (Figure 4).
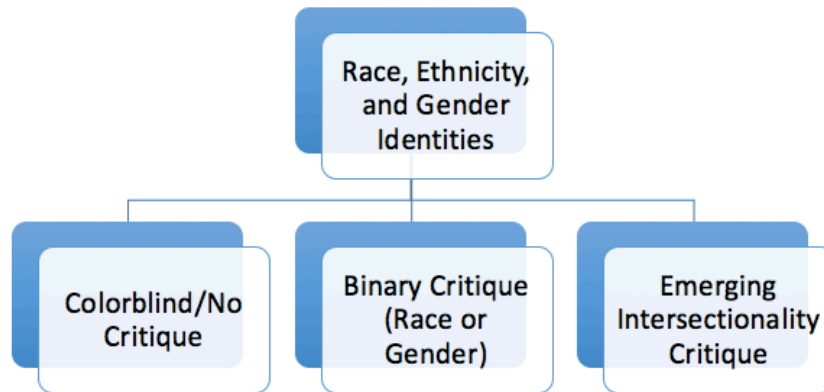
Figure 4. Perception of the Influence of Race, Ethnicity, and Gender

Colorblind/No Critique

I will begin by focusing on those who took a colorblind stance or no stance at all. Among the group, three girls took a colorblind approach or placed the responsibility entirely on themselves and African American women when they addressed the role of race and gender on STEM participation. When asked about the influence of race and gender, Eden combined her critique with what she believes *should* happen in the world. She stated, "I don't think that it influences me at all because I don't think that race or nationality should determine what your future should be" (personal communication, June 9, 2015). She shared that the primary reason that African American women are underrepresented in STEM derives from others not pushing them or people who "underestimated them" (personal communication, June 9, 2015). Being self-determined or having someone to support an individual to pursue a career in STEM was mentioned by several of the participants as an important factor; however, this was not considered the only influence.

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Although Daphne shared a gender-centered critique, she also made colorblind statements in reference to whether she believed African American women are stereotyped. She shared, "Let me think about this. I can't think of anything. I don't see color," (personal communication, June 9, 2015). She also conflated the role of race with any other personal characteristic that would set one apart from the "norm" such as style of dress or a hairstyle. She shared that if a White girl explicitly stated that she would not "hang out" with her because she was African American, then it would be the same as saying, "I don't want to hang out with her because she's weird" (personal communication, June 9, 2015).

During her first interview, Patrice shared that there will likely be challenges to pursue her career as a medical scientist, but stated that she did not believe being African American would be a challenge. She also explained that this was her first experience going to a predominately African American school and that she grew up with White students. Because of this she declared, "So, I don't see it that way, most people do, but I'm not all Black so…" (personal communication, January 21, 2016). Both Patrice and Eden somewhat disassociated themselves with being identified as a Black girl because they are multiracial based on their extended family history, which may be why they believe that race will not affect them. Daphne does not share a strong understanding of racism, as suggested by how she reasons through why someone would not want to befriend her for being African American. I will also explain more about Daphne's focus on gender within the next segment, which focuses on those with a binary approach.

Binary Critique: Race or Gender

The binary critique focuses on participants who believe that either race or gender can impact their future in STEM or influences the underrepresentation of African American women in STEM. Among the group, six girls initially selected one or the other as opposed to choosing the colorblind approach like the girls above or considering both race and gender. Among this group, three girls shared gender-centered critiques and three selected race as the primary influence.

Daphne was one of two participants whose primary critique focused on the role of gender and patriarchy. While she aspires to "rub [her] victory in a male's face" she also shared that being better than the boys "really doesn't affect me" (personal communication, June, 9, 2015). When speaking about the role of gender as it related to women in STEM, she shared, "Some people doubt females can do things that males can do, like engineering, building a car, they probably would select the man, instead of the female" (personal communication, June 9, 2015). Although she states that this does not affect her, I believe that she thinks this because she does not believe that it will stop her from pursuing STEM. Through her accounts, she believes that patriarchy exists and influences the underrepresentation of women in STEM; however, her optimism apparently does not allow her to accept that it could affect her future in STEM or in life.

Ashleigh initially shared that she thought it was "kinda" both during her interview in June 2015; however, she did not offer a rationale for this perspective (personal communication, June 9, 2015). When I revisited the topic, Ashleigh leaned toward selecting both, then changed her answer to gender as the primary influence. She shared, "Some people thank that all men

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can be scientists and women can only, like, discuss it" (personal communication, June 2, 2016). When asked about race, she stated that she did not think it has an influence (personal communication, June 2, 2016). Princess explained that she believed gender is the main influence primarily evidenced by wage differences between men and women in the workforce (personal communication, June 2, 2016).

Nichelle focused more of her attention on race when discussing African American women in STEM due to the stereotypes people have about African American women. When discussing underrepresentation, she shared that society thinks that, "we're loud and crazy," and, "that's probably why there's not a lot of African American women in engineering because people don't think that we can handle being ourselves and, uh, having a good career and stuff" (personal communication, June 9, 2015). Although the majority of those held a critique based on gender, race, or both, Nichelle is the only student who also shared that being an African American female may personally serve as a positive influence on pursuing a career in STEM through diversity initiatives (personal communication, June, 9, 2016). Olivia shared a similar critique as Nichelle by focusing on how African American women are stereotyped as "loud and ghetto" which, according to Nichelle, has an impact on how they see themselves as capable women in STEM (personal communication, June 9, 2015). She explains, "...they actually think that can't do it because of who they are. And people will, like, tell them they can't and so, they're like. They are stereotyped," (personal communication, June 9, 2016). When asked if you can be "loud and ghetto" and still work in STEM she replied, "You could, but you'd have to work extra hard to get that label off of you," (personal communication, June 9, 2016).

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Zoe had a race-centered focus during her first year in the program; however, her position was not very firm and was centered on the internal effects on one's self esteem due to racism and discrimination. She explained,

> I think…it's kinda, like, has to do with racism. Since…like, most African American women have low self-esteem because of everything, like, how there was segregation and discrimination and everything. They don't believe in themselves so they might think, "I *could* do this, but I'm kinda scared to try," and since there's like a lesser amount those people will have to face all the other people around them that aren't the same race. So that's, that's why I think they might be self-conscious. (personal communication, June 9, 2016).

In her response, Zoe made reference to racism as well as how it is socially and systematically exhibited through segregation and discrimination. She declared that these acts contribute to low self-esteem among African American women, which may lead some to self-select out of the STEM-circuit to avoid racism and discrimination in the workplace.

Among the group, Tyson shared the most direct race-centered critique when asked about potential challenges related to being an African American girl in STEM. She held a gender-focused critique regarding girls in general; however, when speaking directly about whether being an African American girl influences her future success in STEM she indicated that racism could be an influence. Below is an excerpt from her interview.

> Smith: Um, so you think that being a Black girl influences your opportunities to participate in STEM or to be successful?
>
> Tyson: It could.
>
> Smith: How so?
>
> Tyson: Some people are still racist.
>
> Smith: So could you explain why you think that is?

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Tyson: I believe that now, especially now, because it's coming out more. But I'm pretty sure someone would choose a White woman over a Black woman in STEM because of that.

Smith: Just because of that?

Tyson: Yes.

Although I mentioned being both African American *and* being a girl in the question, Tyson went directly to racism having an influence on her opportunities to participate in STEM and her success as opposed to gender or both race and gender. She then went on to reference that racism was "coming out more" which could possibly be due to increasing national attention on issues concerning race and racism, especially through social media.

The following section offers an explanation of the final observed evaluation of the combined role of race and gender, *Emerging Intersectional Critique,* which focuses attention on those who shared that both race and gender have an impact on African American women in STEM and/or could have an influence on their participation in STEM.

Emerging Intersectional Critique

The theory of intersectionality moves away from "treat[ing] race and gender as mutually exclusive categories of experience and analysis" (Crenshaw, 1989, p. 139) by focusing attention to how these, and other, social characteristics interact to shape our experiences (Crenshaw, 1989, 1991). Crenshaw goes on to propose that looking at these social characteristics in isolation does not adequately allow for a comprehensive analysis of the experiences of African American women operating within a racist and sexist society (Crenshaw, 1991).

I chose to identify the girls' evaluation of race and gender combined as an *emerging*

intersectional critique primarily because it appears that the girls are still developing their

understanding of how multiple social identities, in this case race and gender, influence one's

experiences in STEM. I concluded this based on the language they used and their description of

how these identities work together in comparison to one with a more developed understanding

of the theory. In addition, two girls' critiques evolved over time, which is evident during our

conversations about race and gender. This evolution of thought relayed to me that they have

more recently started to think this way and are still developing an understanding of how their

combined social identities interact.

Four girls shared that they believed both race and gender had an influence on the

underrepresentation of African American women in STEM and posed a potential challenge

within the field. As I shared above, Zoe initially shared that she believed that racism was the

influential factor (personal communication, June 9, 2015); however, a year later, she moved

towards an intersectional analysis (June 2, 2016). Unlike her somewhat uncertain analysis of

race in 2015, she was firmer in her conviction about the influence of race *and* gender during a

group discussion and her follow up interview (personal communication, June 2, 2016).   She

shared,

> I think that's why it's both because if it's like first, if you're a woman, you're already
> below because of that and then if you're Black, also, you're more below. That's the main
> reason why I think that's one of the reasons why.

Her analysis is considered "emerging" due to her description of race and gender working as a

"double" form of oppression. Her current perception of how oppression operates for those

with multiple social characteristics considered in the "minority" are intensified instead of intersecting.

Although Patrice initially held more of a colorblind attitude, after a lively debate with Zoe about race and gender's impact, she started to think differently (observation, February 11, 2016). I believe that Patrice is still problematizing the impact of race and gender as she continues to think about it more. She explained that she believes both have an impact on African American women; however, still offered a two-sided interpretation to explain the impact of race. Specifically, she recognizes that race has an impact on hiring practices of African Americans due to perceptions about our intellectual abilities, but also proposed that it could also be due to African Americans not working as hard or not pushing themselves (personal communication, June 6, 2016). When discussing the role of gender, Patrice shared that she believes that people still consider men more dominant and that women still have to push towards making their voices heard.

Portia and Quincy also shared that they believe both race and gender are influences. Portia believes there is "still a lot of racism going on today" and then provided an example of how gender may have an impact (personal communication, June 6, 2016). Portia also recognized sexism in a *The Simpsons* episode that showed a woman scientist's ideas being taken and introduced to others as a male's ideas. Although she did not believe her example was a "good one," it was directly related to historic unfair practices towards women in the sciences. As for Quincy, although she specifically stated that she believed it was both, her explanation focused more on the roles of racism and White privilege. She shared, "Lots of people, they are

coming from a heritage that is very racist and think that Black people still can't do things that White people have privileges to [do]" (personal communication, June 2, 2016).

Although Patrice, Portia, and Quincy provided reasons why race and gender may have an impact, they do not explain them in an intersectional manner. Despite this, I consider their responses as emerging intersectional critiques because they, at least, are beginning to recognize the influence of each social characteristic without denying or ignoring the impact of the other.

Utility of the Science Identity Development Model

As I previously indicated, research Question One inspects the utility of using a science identity development model to examine the identity development of the girls within the STEMpowerment program. More specifically, the Carlone and Johnson (2007) model was selected as the analytic tool to examine the identities that emerged, which was originally introduced as a model to examine the experiences of successful women of color in the sciences. In brief, the model indeed served as a viable one to initiate an examination of the girls' identity development due its usefulness to explore a holistic understanding of their identity development within the space. The model also exhibits the interrelatedness of the three dimensions, which illuminated potential relationships between identities demonstrated between and across dimensions. I placed emphasis on its use as an *initial* model as I propose adaptations to both the structure of the model and its use when employed within a culturally relevant learning space, which are explained further in the discussion chapter.

Similar to Carlone and Johnson's (2007) findings, the identities within the recognition dimension were significantly discernable, especially through interviews and group discussions for this examination. It was the intent of the study to examine all three dimensions of the science model and I found that by incorporating multiple qualitative methods, I was able to observe evidence of identity construction within the remaining dimensions. Doing so revealed a more holistic representation and understanding of the identities that emerged and how they were represented by each participant. Through this, I also learned the complexity of using such a model in terms of data collection, as a single method did not sufficiently capture the identities demonstrated across dimensions. Thus, while the model served as a useful tool to examine the identities across dimensions, special attention to how one captures the identity development within each dimension must be taken into account to achieve the holistic examination.

Keeping this in mind, studying each dimension in provided valuable evidence of the girls' identity construction, such as observing the girls' demonstrating different identities at different times. A primary example of this was described when Portia performed two identities within the performance dimension. As described in the performance dimension section earlier in the chapter, Portia showed both a leadership identity as well as a supportive role identity, which was relative to the context in which we operated. This revealed the fluidity of identity, which challenges notions of students developing fixed science identities, especially this early in one's trajectory in the STEM circuit. In sum, while examining each of the dimensions in depth offers important insight into their identity development, employing the entire model allowed for a more all-inclusive understanding. Furthermore, doing so made visible the interrelatedness of

the three dimensions, as suggested by Carlone and Johnson (2007) and the potential

relationships between the identity construction represented between dimensions.

Within their study, Carlone and Johnson (2007) suggest that the dimensions "overlap"

(p. 1190). They went on to describe how alignment can be observed between identities

represented in each dimension or potential mismatch between the dimensions. The current

study unearthed the interrelatedness between the dimensions. For example, the data revealed

overlap among dimensions as it related to the career development theme within the

competence dimension analysis. Using the entire model as an analytic tool revealed that many

girls who were constructing a Career-Focused identity also demonstrated a lead actress role

within the performance dimension, showed self-directed/advanced level competence, and

displayed an identity that was more congruent to their definitions of a scientist within the

recognition dimension. Key examples of such interrelatedness are represented through tracing

the identities represented by participants such as Zoe, Patrice, Tyson, and Olivia. In contrast,

many of the girls within the *STEM-for-Enjoyment* examples, also demonstrated a teacher-

guided/general competence identity and took on more supportive roles within the

performance dimension. However, as Carlone and Johnson (2007) imagined, there were

examples of how identities are represented in, "various degrees and different configurations"

(p. 1190). For example, the overlap described directly above included girls who demonstrated

an identity congruent to their definition of a scientist, but did not disassociate themselves with

being "science people" based on their career goals.

Another example of the interrelatedness of the model is illustrated through Zoe who

considers STEM as a viable career, but it is not her *first* career choice. Since she still sees herself

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possibly pursuing a STEM career, she exemplifies a student who demonstrates both a *Career-Focused* and *STEM-for-Enjoyment* identity. It is also quite possible that the girls who have thus far decided to work in STEM also do so because they enjoy the subject, as suggested through the girls' sharing their love for math and/or science in reference to pursuing careers in STEM. Further examination revealed that many of those who are pursuing a science career also shared that their mothers have pushed them to do so, which suggests a possible relationship between influential figures in their lives within the recognition dimension and their career development and performance. The current study did not examine the direction of this potential relationship; however, it uncovered overlap between the dimensions that can lead to further examinations of these potential relationships in the future.

Closing Remarks

Based on the evidence above and examination of the utility of the model, the Carlone and Johnson (2007) science identity model served as a viable starting point to examine the identity development of the African American girls participating in STEMpowerent. As I described in Chapter Four, STEMpowerment was a STEM program grounded in culturally relevant pedagogy as the foundation of its curriculum development and pedagogical practices in addition to Black feminist science pedagogy. Keeping this in mind, there are elements of the program that are incongruent to how science is taught in traditional science spaces, which rendered STEMpowerment a counterspace for science learning. I argue that there are potentially examples of identity construction that can go unnoticed within such counterspaces if we use science identity models that do not account for the additional knowledge and skills

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that are developed and exhibited within these spaces. In the next, and final, chapter I propose a

revised model to examine the identity development of students operating within a STEM

counterspace grounded in culturally relevant pedagogy.

CHAPTER SIX
Discussion

The previous chapter delivered, at length, the findings from the study based on the research questions under examination. What follows is a discussion of the major findings relative to the research questions and the theories that guided this study. Critical race theory (CRT) and Black feminist epistemology were the guiding theories for this project. In addition to these theories, I also aimed to build students' critical consciousness through a culturally relevant curriculum as it relates to determining the utility of the science identity development model use within a culturally relevant counterspace. While there are multiple central tenets for both CRT and Black feminist epistemology, there are select tenets that inform the discussion. I primarily focus my attention on the permanence of racism and challenging liberal colorblind ideologies within CRT along with Black women and motherhood and Black women's activism within Black feminist epistemology throughout the discussion.

I will begin by further discussing the utility of the science identity development model as an analytic tool with the culturally relevant STEM counterspace. More specifically, the discussion of the models' utility will be centered on its usefulness specifically within spaces that are grounded in culturally relevant pedagogy. From this, I present an amended conceptual model to examine students' identity development within culturally relevant counterspaces based on the findings. This is followed by examining the major findings using both critical race theory and Black feminist epistemology as an analytic lens. The final sections of the chapter discuss the study's limitations, significance, and implications for research and practice.

Utility of the Science Identity Development Model Revisited

When I initially envisioned this project, I sought to examine the impact of the culturally relevant, Black feminist science pedagogical practices that served as the foundation of the STEMpowerment program on the participants' identity development. The aspect of developing a culturally relevant science curriculum and its impact were also under consideration. As I started the work, I recognized that the viability of the identity development model I drew upon to examine their identity construction within the science learning counterspace required more focused attention. Before attempting to conclude the potential impact of the program, I determined that the model used to evaluate said impact should be investigated first. Furthermore, when I reflected more on the theories that guide both my pedagogy and theoretical analysis, I found it critical that I move away from attempting to examine supposed changes in development and focus greater attention on the utility of the model through capturing a portrait of their identities in this space while considering the current historical and social context.

The major finding related to the research question scrutinizing the utility of the science identity development model that guided my work (Carlone & Johnson, 2007) is as follows:

> **Major Finding One**: The model under examination served as a viable starting point to examine the science identity development among African American girls due to its capacity to reveal a holistic representation of identity development through the three dimensions; however, its usefulness within a culturally relevant counterspace requires an additional dimension to capture identities related to building critical consciousness.

In Chapter Two, I described the guiding theories for the pedagogical practices used within the STEMpowerment after school program: Black feminist science pedagogy which draws from culturally relevant pedagogy, Black feminist pedagogy and feminist science pedagogy. As the

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findings state, the Carlone and Johnson (2007) model served as a viable *starting point* to

examine identity development within this space. Examining identity construction through these

three dimensions not only provided a means to understand their development more

holistically, but the model also aided me in organizing how I would implement the model.

Notwithstanding its usefulness in this regard, there remained something missing in the model

based on the learning context in which the students operated. Although the model takes into

account the influence of race, ethnicity, and gender on the experiences of successful women of

color in science, that alone would not capture identities related to the building of critical

consciousness within such a counterspace. Figure 5 is the adapted model based on my

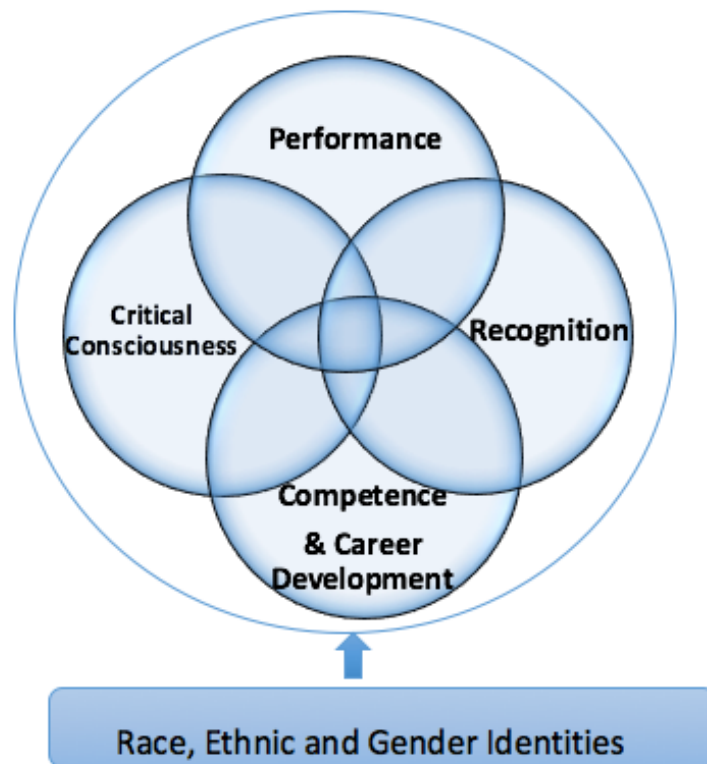argument that critical consciousness should be included in the model.

Figure 5. Culturally Relevant STEM Identity Development Model
Adapted from Carlone & Johnson (2007).

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Before delving into the inclusion of the *critical consciousness* dimension, I will briefly call attention to my renaming the *competence* dimension within the model to *competence and career development*. While not a major finding of the study, a theme that emerged within the competence dimension focused on career development identity construction as it related to the girls building their STEM competence. Given the original model was used to examine the development of women of color who were already designated as "successful" in science due to their positions within the STEM-circuit, I find that considering the methods girls use to build their competence within the pre-collegiate stages of their academic journeys is important and should be accounted for in the model.

Critical Consciousness Dimension

As I explained in Chapter Two, I drew upon Ladson-Billings's (1994, 1995a, 1995b) core themes of culturally relevant pedagogy and Gay's (2000) tenets for culturally responsive pedagogy. For the purposes of presenting the new model, I will specifically focus my attention on developing students' critical consciousness (Ladson-Billings, 1994, 1995a, 1995b) through a culturally relevant curriculum (Gay, 2000). While the other core themes described by both authors influenced my pedagogy; the aforementioned themes informed the adapted model presented in Figure 5.

In Chapter Four, I expounded on the culturally relevant curriculum developed for the STEMpowerment program. Throughout the program, I implemented a culturally relevant curriculum that integrated science and mathematics content with aspects of the hair and cosmetic science industries. More specifically, the Black hair industry because the girls could

directly relate to the activities and discussions. In addition to lessons that were grounded in the content, we also discussed issues concerning the influence of dominant European standards of beauty on the lives of African American women, the decisions we may make concerning our hair, and our representation in print and social media. Beyond this, we also engaged in dialogue about the role of race and gender on the experiences and representation of African American women in STEM.

Through drawing connections between the content and their lived experiences and how they interpret those experiences, the girls participated in problem-posing work (Freire, 1970/2002) that served to build their critical consciousness to, "understand and critique the existing social order" (Ladson-Billings, 1995b). Given this, I argue that including a dimension that allows researchers to capture identity construction related to critical consciousness is necessary when examining identity development within a culturally relevant space. This is especially so considering the interconnectedness of the model, which creates the opportunity for researchers to draw connections between critical consciousness and the identities observed within the other dimensions. Furthermore, including this dimension allows researchers to examine students' critical consciousness using various theoretical models. For this research project, recognizing racism and sexism as factors that influence the lives of African American women, especially within the STEM fields, would represent the theoretical focus (i.e. critical race theory and Black feminist epistemology) within the critical consciousness dimension.

According to Freire (1970/2002), as people reach *conscientização*, they must first come together to recognize the problem and "critically recognize its causes" (p.47), thus the identities among the girls represent their construction of becoming critically conscious through how they

each critique racism and sexism in our society. Other theoretical frames can also be used to examine students' *conscientização* within the critical consciousness dimension such as the cycle of critical praxis Duncan-Andrade and Morrell (2008) used to inform their curricula within their "critical counter-cultural communities of practice" (p.1). Using such a model allows researchers to examine students at each step of the critical praxis model as emerging critically conscious students. In addition, the model used to examine students' transformative resistance (Solórzano & Delgado Bernal, 2001) is another example of how researchers can examine students' conscientização in the critical consciousness dimension when students are learning within a culturally relevant counterspace. While these examples are certainly not exhaustive, they serve as representations of the abundant ways that theoretical models can inform how the critical consciousness dimension can be utilized as a contributing analytic component of this adapted model.

Role of the Family on STEM Experiences…Including Fathers

In accord with research affirming the positive role families can play in African American girls' experiences in science (Hanson, 2004, 2007), the girls from this study shared similar sentiments. The second major finding of this study claims:

> **Major Finding Two:** The African American family, especially the role of female family members, continues to remain an integral source of support for girls pursuing throughout their schooling and, more specifically, within the STEM-circuit.

Below, I discuss this finding through a Black feminist lens and literature focused on the role of the family in and on African American girls' academic engagement.

The majority of the girls expressing that their mothers supported and believed in them the most is representative of the role of female family networks and othermothers described by Patricia Hill Collins (2000/2009). This source of support and direction from mothers, aunts, sisters, and cousins expands the role of othermothers from those who take on caregiving responsibilities to include the responsibility to serve as role models and supporters of young women within the family network. This also suggests that while the configuration of othermother networks was and continues to be threatened within urban communities (Collins, 2000/2009), the reliance on othermothers for support among the girls in this study demonstrates that the othermother structure is intact for some African American families.

Keeping this in mind, whether it is the expressed intent to engage in Black women's activism or not, the support they lend to young women in their families to achieve academic excellence represents a form of Black women's activism (Collins, 2000/2009). This is especially so for those who have pushed their daughters to pursue male-dominated STEM careers. This act of resistance combats longstanding social expectations for girls to pursue work more "appropriate" for women, which can also be perpetuated within schools (Sadker & Sadker, 2001). Given African American women have a longstanding history of participating in the labor force to support their families (Collins, 2000/2009; hooks, 1981), it should come as no surprise that some African American mothers would usher their daughters into potentially lucrative STEM fields and support their participation in STEM-related programs such as STEMpowerment. Strongly encouraging their daughters to do well in school, especially within an area (STEM) that is often associated with scholarship opportunities and financial security after college, represents the philosophy of education as an intermediary for freedom within the African

American community (Perry, 2003). Beyond this, the girls recognized African American women, including themselves, as the primary group responsible for encouraging young African American women to pursue STEM careers. Distinguishing African American women as the principal bearers of instilling academic excellence and educational attainment for younger African American women indicates that the political activism through education, formal and informal, by African American women remains a necessity as well as an expectation within the community if we are to continue striving toward racial uplift and equality (Collins, 2000/2009; Perry, 2003).

The significant role female family members have in developing the confident and resilient young African American girls within the STEMpowerment program remains undeniable; however, the findings also reveal that fathers served as influential family members for a select number of participants. The majority of the girls indicated support from female family members, yet this does not negate the potential role fathers play in supporting their African American daughters within the STEM circuit or throughout their educational journeys. Collins (2000/2009) indicated that although there are families within the African American community that are led by women, their leadership role does not necessarily replace the positive impact fathers can make on their daughters lives, notwithstanding whether they physically live in the household. The girls who shared that their fathers play a significant role in their journeys and provide them with support are representative of such girls within the African American community. Their affirming relationships with their fathers can potentially serve to impact their success in school and the STEM-circuit (Cooper, 2009; Hanson,2007).

The Cooper (2009) study revealed that the quality of the bond between the African American girls and their fathers had a strong relationship with the daughters' academic engagement and self-esteem. Within science education research, Hanson (2007) shared similar findings regarding the importance of a close father-daughter relationship among African American girls within the STEM circuit. There is currently limited research examining the impact of father-daughter relationships on African American girls' academic attainment (Cooper 2009); however, the research focused on their relationships for girls interested in pursuing STEM careers is particularly scarce. Although the majority of the girls who shared that their mothers and other female family members offered them support, I do not take this to mean that their fathers or other male figures in their lives do not have an impact as well. Therefore, the findings within this study reveal the relevance of further exploring this topic not only to expand the body of knowledge concerning family influence, but to also challenge the dominant narrative and controlling images of the Black family concerning the role of the fathers on their daughters' personal lives, academic achievement, and success in STEM.

What's Really Keeping Us Out of STEM? Race, Gender…Both?

In James Baldwin's *A Talk to Teachers* (1963/1985) the philosopher expounded on the reality that children, namely Black children, begin to see and understand their "place" in society based on the conditions in which they operate. Although these conditions may appear more covert than seeing "Whites Only" signs in front of water fountains and restrooms or being forced to sit in the back of the bus, African American students nonetheless begin to recognize the influence of racism, sexism, economic inequality, homophobia, etc. as they grow older. He

states, "Children, not yet aware that it is dangerous to look too deeply at anything, look at everything, look at each other, and draw their own conclusions" (Baldwin, 1963/1985, p. 326-327). Despite popular sentiments that today's youth do not care about social issues, they are most certainly paying attention and drawing their own conclusions, as demonstrated by the recognition of the role of race and gender concerning African American women in STEM by the participants.

> **Major Finding Three:** The girls exhibited a range of explanations for the role of race and gender on African American women's experiences and representations in STEM as well as their perceived challenges based on race and gender. As I explained in the previous chapter, the girls' critiques were separated into three categories: (1) colorblind/no critique, (2) binary critique (race or gender), and (3) emerging intersectional critique.

This finding is significant primarily because it illuminates the girls' critique of social issues that can disrupt their opportunities within the STEM circuit. Furthermore, as I explained above, developing students' critical consciousness is a central tenet of culturally relevant pedagogy (Ladson-Billings, 1995a, 1995b), which served as the cornerstone for the STEMpowerment curriculum. Through the lens of the *critical consciousness dimension* introduced in the first section of this chapter, I was able to capture how the girls perceive the role of race and gender, which serves as a starting point in developing one's critical consciousness—identifying the problem (Duncan-Andrade & Morrell, 2008; Freire, 1970/2002).

I will begin with the girls who provided a colorblind assessment or relayed no assessment at all. While they are limited among the group, it is important to attend to this assessment considering the girls have lived most of their lives during the Obama Administration, which has propelled the fabricated notion of a "post-racial society" within the United States. Using Bonilla-Silva's (2006) four frames of colorblind racism, the *minimization of*

racism is characterized among the girls who shared a colorblind perspective. Eden stating that

she "doesn't see color" (personal communication, June 09, 2015) is among the general

statements represented in the minimization of racism frame, which implies that one does not

consider another person's race upon encountering them. While she, and others, may deliver

similar statements to suggest that they do not judge others based on their race or simply do not

consider race as an influence on people's experiences or opportunities, they fail to

acknowledge the privilege and oppression between those within the dominant group and

people of color (Bonilla-Silva, 2004). Furthermore, as a person of color, adopting a colorblind

ideology can inhibit the ability to recognize when one is subjected to racism. As with the case of

Eden, by "not seeing color," she denies that racism would be the source of someone not

wanting to "hang out" with her even if the person explicitly shared that it was due to her race

(personal communication, June 9, 2015).

For those who shared a binary critique (i.e. race or gender), their identification of race

or gender as the problem facing African American women within the STEM fields represents

their recognition of social inequality based on either social characteristic. Doing so

demonstrates that they are building their critical consciousness regarding the role of social

inequality as it relates to either race *or* gender, but not quite both. It is also possible that they

selected their position by ranking the impact and not necessarily denying that the other has an

influence on social inequities. While this realization is important, going in either direction is

representative of the history of the racial and feminist equality political movements that

decentered the concerns of African American women (Cho, Crenshaw, and McCall; Collins,

2000/2009; Collins & Bilge, 2016; hooks, 1991). Given race continues to remain a major

influence on inequities within U.S. society (Bell, 1992), education systems (Dixson & Rousseau, 2005; Ladson-Billings & Tate, 1995), and the STEM education circuit (Museus et al., 2011), it is important that students consider the intersection of race *and* gender as they develop their critical consciousness to combat these issues. This brings me to the girls with an emerging intersectional critique, as they are beginning to contemplate the impact of race and gender on the lives of African American women. Since their analysis is limited to asserting that African American women are more oppressed or experience "double oppression" due to their race and gender, continual engagement in critical dialogue about the how the *intersection* of race and gender in addition to other social classifications such as class, sexuality, and religion impacts one's lived experiences is essential. Doing so will aid the girls in understanding, analyzing, and sharing their experiences using an intersectional approach that embodies their experiences as African American girls.

I would be remiss if I did not call attention to the national climate concerning race and gender during the time of this study, as the girls are coming of age during the Black Lives Matter movement. I shared in the findings chapter that Tyson made reference to racism "coming out more" (personal communication, June 9 2015), which insinuates that she believes there is more racism now than in previous years. As an adult, I know this is not our reality because racism has always been prevalent within our society; however, the rapidity and means by which we currently learn of incidents has increased. With the advancements of social media, the wait time between an incident occurring and it being shared with millions of people is nearly non-existent. Now, adults and children alike become witnesses to their peers being excessively restrained and slain through video recordings posted then reposted thousands of

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times on social media.   Public opinion regarding these tragedies and their subsequent aftermath are then discussed on multiple social media platforms, which many students have access to.   On the one hand, we may wish to shield ourselves and our children from witnessing these tragedies through our computer, television, and phone screens; however, our access to these occurrences can serve to inform young people about social issues that are part of their reality.   Considering this, it is not surprising, then, that there are girls within the study who believe racism impacts their lives.

In addition to racism being a near all-consuming topic of discussion, we are also in a time where the possibility of having a female president is upon us. As I mentioned above, the girls have lived nearly half their lives with a Black, male president; however, the country is now setting its eyes on the next "first." Due to this, the discussion regarding gender politics is also at the forefront and may impact the girls' perception of the role of gender on obtaining positions of authority within powerful, male-dominated professions. With increased dialogue about the intersection of race and gender, imaginably some will begin to problematize whether a woman of color, especially an African American woman, can secure the nomination in their lifetime. This is especially so given our foremother, Shirley Chisholm, laid the very foundation for men of color and women to pursue such a position—yet we are still expected to patiently wait our turn.   Perhaps they will begin to challenge racism and sexism in such a way that will lead to the next generation of African American women finishing what was started years ago.

Significance

The previous discussion of the major findings of the study relative to the research questions and the theoretical framework serve as the basis for the study's significance. Within the science education research community, this study expands the research on science identity development focused specifically on African American girls within the STEM-circuit. As we continue to include more narratives of Black girls' experiences in education, it is critical that we capture their identity development in multiple learning spaces as they each play a role in potentially inspiring more young women of color, namely African American girls, to pursue STEM-focused careers.

More importantly, given the space was a grounded in Black feminist science pedagogy and implemented a culturally relevant curriculum, the study also expands the body of knowledge related to culturally relevant science counterspaces. While the research concerning culturally relevant pedagogy and critical pedagogy has greatly expanded over the last thirty years, there remain areas of growth for literature focused on this work within the sciences. As the call for disrupting traditional learning spaces for students of color continues to gain traction both within the research and practitioner communities, research of this nature remains necessary as critical scholars continue to press for curricula revolutions within science and mathematics. Furthermore, examining identity development within a science counter learning space allows researchers to examine identities that may not be illuminated within a traditional learning space due to the absence of implementing a culturally relevant curriculum that builds students' critical consciousness. This study delivers a conceptual model that can be used in multiple learning environments to holistically capture students' identity construction as it

relates to knowledge acquisition, positioning within a particular subject or career track, social performance within the learning space, and building critical consciousness.

Parallel to the significance regarding the pedagogical practices and culturally relevant curriculum developed for the study, this study provides concrete examples of culturally relevant lessons in science. Keeping this in mind, current and pre-service science educators who seek to implement such practices can refer to studies such as this that demonstrate that science classrooms and other learning spaces can be transformed into culturally relevant science counterspaces. Furthermore, as the literature focused on culturally relevant practices and curriculum development in science spaces continues to grow and evolve, teacher educator programs are poised to develop courses focused on developing culturally relevant curricula in science and mathematics grounded in the literature. Such a learning opportunity for pre-service educators will provide them with a firm foundation to challenge curricula and pedagogical norms in their schools as it relates to science and STEM education.

Finally, the study serves to disrupt the dominant narrative that girls, especially Black girls, simply are not interested in science. Here, I presented girls who are both currently interested in STEM-related careers and those who are not, yet *all* recognize scientist-like qualities in themselves. Furthermore, their commitment to spending additional time *after* school within a science counterspace represents their interest in science, especially the means by which they engaged in the learning and the dialogue that complemented the activities. Engaging in dialogue about the role of race and gender were not met with resistance and such discussions were encouraged to remain a part of the program. This demonstrates to me that there continues to be a need for counterspaces that not only provide an opportunity for girls of

color to engage in science in ways that are related to their lives, but also spaces where they can find their voice and discuss social issues in their own language. What follows are limitations of the study, which lead into the implications for future research and practice, followed by my concluding remarks.

Limitations

The limitations of the study are associated primarily with the generalizability of the stud and concerns regarding the depth of the identity development examined when using the full model,. These limitations situate the discussion for future research, which are explained in the implications section.

Due to the small sample size and controlled environment of the science counterspace, the study is not generalizable to the entire population of African American girls engaged in STEM or science spaces in terms of the representations of identity development that emerged from the study. Thus, the data that emerged may not adequately represent the identity development among African American girls across the spectrum and in various learning spaces. Threats to generalizability include the space itself, as the findings that would emerge within a traditional classroom, especially one absent of culturally relevant and/or critical pedagogy, may reveal different findings. For example, the girls self-selected into the program, which implies that there was at least a willingness to participate in science activities. This predisposition to *not* have an aversion towards science and STEM activities may impact the identities revealed, especially within the recognition dimension.

While generalizability is a limitation of the study and other qualitative studies, Merriam (2009) suggests that such studies provide researchers the opportunity to, "understand the particular in depth, not to find out what is generally true of many." Furthermore, given the first research question focused on the utility of the model as an analytic tool, employing it within a small setting to determine its usefulness proved to be quite beneficial. Keeping this in mind with the situation-specific nature of the study, this study provides a working hypothesis (Cronbach, 1975) for the science identity development of African American girls within a culturally relevant STEM counterspace that can inform future research and is also transferable to similar contexts (Erickson, 1986).

The second limitation relates to examining the utility of the full model within one study, as there is more breadth of the overall model at the expense of depth within a single dimension. Although the usefulness of the entire model as a means to understand the girls' identity development more holistically was a major finding, the drawback is not being able to focus intensely on any one particular dimension. A more in-depth focus on identity development within a particular dimension allows the researcher to apply current research related to specific aspects of the dimension. For example, focusing intently on discourse and identity development within science spaces among African American students (Brown, 2004) to inform identities within the competence dimension or conducting a video analysis of the girls' social interaction within performance dimension would reveal much more than what can be captured when employing the entire model at once in the time allowed. Despite this, through determining the usefulness of the model, future research focused on any one particular

dimension of the model will further uncover multiple means to apply the model to culturally relevant learning spaces.

Implications for Research and Practice

The implications for future research are primarily informed by the study's significance as well as the limitations explained above. First, there is a need to increase scholarship on the identity development of African American girls in culturally relevant science spaces, which would include both the "traditional" classroom grounded in culturally relevant pedagogy and counterspaces such as after school programs and summer programs. Such research stands to significantly expand our knowledge base about the similarities and differences between ways African American girls engage in these spaces—especially those rooted in culturally relevant pedagogy in comparison to those that are not. Longitudinal studies can also reveal change over time within and between science spaces. In addition, while I maintain that this model is essential to examining the experiences and science identity development of African American girls, I believe that the model can be used to examine the experiences of other sub-populations of students of color using relevant theoretical frameworks.

More in-depth examinations of identity development within each dimension are also needed, which will provide considerable understandings of identities relative to the theoretical underpinnings guiding the work. As I explained in the previous section, such research allows the investigator to apply a more sharpened examination of identity development situated within specific disciplines and research communities. Finally, as I mentioned in the beginning paragraphs of this chapter, I was initially interested in the role of the culturally relevant space

as the unit of analysis as it related to its impact on the girls' identity development. This study also calls for practical classroom implications such as encouraging more opportunities for students of color, especially girls of color learn within communities of practice grounded in culturally relevant pedagogy. Doing so will not only provide learning spaces that will go beyond teaching content for the sole of purpose of knowledge acquisition through the dominant lens (Freire, 1970/2002), but will cultivate critically conscious students within a STEM learning environment.

I argue that such learning should not be found solely in after school programs, summer programs or within English language arts and social studies classrooms. From a researcher's perspective, having more culturally relevant spaces within STEM provides an increased opportunity to engage in the suggested research described above. Furthermore, if school officials and legislators alike are charged with determining "best practices" within science and math education in an effort to increase future STEM graduates, successful implementation *must* include substantial representation among students of color (PCAST, 2010). Also, the pedagogical practices should be grounded in "good teaching" for African American students and students of color alike (Ladson-Billings, 1995a). To achieve this, teacher educator programs must revisit their missions and subsequent to this, their course requirements to require increased learning opportunities to engage in culturally relevant pedagogy and develop culturally relevant units and lesson plans in all subjects including science. Doing so allows new teachers to become familiar with the pedagogical practices and curriculum development that can create the science communities of practices that move away from traditional science learning that may not foster a greater interest in science and engage all students in science

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learning that leads to success. One such example is the move to implement project based learning with real-world application in STEM programs. Having prior knowledge of culturally relevant pedagogy, practice developing culturally relevant curricula, and building their own critical consciousness through their teacher-education program can ultimately prepare pre-service educators to transform project based learning into social justice oriented STEM projects.

Finally, although the proportion of students of color attending public schools is beginning to eclipse that of White students, the teacher educator force still does not reflect a critical mass of educators whose culture and lived experiences are parallel to the student body. Furthermore, there remain educators of color who can certainly benefit from such training as well, as being a person of color does not equate to having the critical consciousness and skills necessary to move science instruction into a direction where more students of color will thrive. Without requiring such opportunities for pre-service educators to develop their craft in ways that best serve the students they will serve, they stand to continue reinforcing the pedagogical practices that have historically marginalized students of color in the STEM subjects and ultimately limit their opportunities to pursue careers in STEM.

Closing Remarks

This project served to examine African American girls' identity development within a culturally relevant science space that positioned them as capable scientists within a learning community that they considered their own. It additionally provides a counterstory for African American science education. This counterstory challenges the notion that African American women educators sit by as African American girls are continuously marginalized within learning

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spaces, namely science learning spaces. Therefore, this project exhibited dual exemplars of

Black feminist thought through African American women's activism via the young women's

resistance as science learners via their participation in the space and the activism of African

American women educators through my initiation of the program and study.

Ultimately this study is one that attempts to venture beyond expanding the body of

knowledge concerning African American girls' science identity development and the factors

that influence these identities, but also serves as a political project that further expands Black

feminist thought by means of educational and intellectual activism. It was through this study

that I was able to examine their identity development as emerging critically conscious "STEM

Girls" who are beginning to recognize the potential challenges of being both African American

and female within the STEM-circuit. Doing so allowed for authentic dialogue about the role of

race and gender so that they may move forward in the STEM-circuit with the confidence to take

on any challenges that may lie ahead.

APPENDIX A

Black Pearls Observation Protocol	
Location: Date Time of Day: Observer:	
Participants Present:	
Observation Focus:	
Length of Activity:	
Descriptive Notes	**Reflective Notes**
Diagram of Setting	

Adapted from:

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions* (2nd ed.). Thousand Oaks, CA: Sage.

APPENDIX B

Individual Interview Protocol Questions

1. When we met as a group, you all described characteristics of a scientist such as being curious and willing to take risks. Can you explain in your own words your idea of who a scientist is?

2. Think about the characteristics of a scientist you just described. Compare and contrast those with the kind of science student you are?

   • What about in other settings?

3. Do you consider yourself a scientist or someone who can work in STEM? Why or why not?

4. In what ways do you choose to participate in STEM-related activities of *any* kind?

5. Of the four primary areas of STEM (science, technology, engineering, and math), which fields are most interesting to you?

   • What about this area is appealing to you?

6. What challenges, if any, do you think there could be to pursue a career in STEM?

7. How do you stay motivated to be successful in STEM?

8. Describe how specific people have encouraged or discouraged you from becoming successful in STEM?

 9. Who believes in you the most?
   • In STEM?

10. Who do you think does not think you can be successful in STEM?

11. Why do you believe there are so few Black women in STEM?

12. What do you think about those women who *are* in STEM fields? How do you think they got there?

13 How do you believe being a Black girl influences your opportunities to participate and be successful in STEM?

14. What are some barriers for girls in STEM and how we can address them as a collective?
   • What about women of color?

15. Who do you believe is responsible for encouraging young Black women to consider STEM careers?

16. The group discussed the competition between boys and girls in your classes, how do your teachers manage this?

17. How are Black girls stereotypically perceived in society? Your school?

18. How does this compare or contrast with the characteristics you described about scientists?

   Can you be both or do you have to act a certain way to be successful in   STEM?

19. What does it mean to be a STEM Girl? A Black STEM Girl?

STEMpowerment Program Questions

1. It was discussed that girls need programs like STEMpowement? How do you think this and similar programs would be helpful?
2. Describe your experience in the program.
3. How could the program be improved? What would you add?

APPENDIX C

Follow Up Protocol Questions

1. We have previously talked about whether race, gender, or both influence the number of Black women in STEM. I would like to follow up with you and get your thoughts on that since we last talked.

2. It has been some time since I have asked about your career goals. What are your career goals now that you've finished _____ grade?

3. I noticed that some of you appear to like participating in STEM for your enjoyment and others are more career focused. Why do you participate in STEM?

   • Do you think that some girls participate for both reasons?

4. Most of you were inspired by your mothers, aunts, and sisters. What do you think about the impact of female family members on all of you?

STEMpowement Questions

1. Some people believe that we should add an "A" to STEM for Arts and call it STEAM. What are your thoughts on the program becoming STEAMpowerment?
2. Would you be interested in volunteering next year or serving as an ambassador?
3. What are ways I should outreach using technology? Social Media? Websites?

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