Lifting as We Climb:
Womanist Pedagogy and Anti-Racist Teaching as Discussed by Black Women Science Teachers

Alexis D. Riley

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy under the Executive Committee of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2022
Abstract

Lifting As We Climb:
Womanist Pedagogy and Anti-Racist Teaching as Discussed by Black Woman Science Teachers

Alexis D. Riley

The purpose of this narrative study is to share a comprehensive and holistic understanding of the teaching philosophies of Black women science teachers. The theoretical lenses of Critical Race Theory and Black Feminist Thought are used to explore historical and contemporary experiences of Black teachers over time, to explain how and why there are so few women in science classrooms today. The pedagogical practices of Black women of the past are explored to reveal what is possible and needed in today’s science classrooms. The qualitative study used open-ended questionnaires, semi-structured interviews, and Sista Circles to center the narratives and experiences of the 32 participants, honoring their counter-stories and valuing their experiences. The findings of the dissertation are shared as two manuscripts: the first focuses on how Womanist Pedagogy is exemplified in Black women science classrooms. The second findings chapter focuses on how the participants discuss anti-racist teaching in their science classrooms as described in three frameworks: liberatory pedagogy (hooks, 1994); Culturally Relevant Pedagogy (Ladson-Billings, 1994); and Historically Responsive Literacy (Muhammad, 2000). Historically relevant science pedagogy is a theoretical contribution offered by the author to the science education community to enact anti-racist practices. By highlighting the pedagogical practices of Black women science teachers, this study aims to transform the practices within science teacher education and professional development fields.
# Table of Contents

List of Tables ........................................................................................................................................ iii
List of Figures ........................................................................................................................................ iv
Acknowledgments .................................................................................................................................... v
Dedication ............................................................................................................................................... vi

Chapter I: Introduction ......................................................................................................................... 1
  1.1 My Narrative ..................................................................................................................................... 3
  1.2 Significance of the Study .................................................................................................................. 10
  1.3 Purpose and Research Questions ..................................................................................................... 13
  1.4 Definitions of Terms ....................................................................................................................... 16

Chapter II: Review of the Literature ..................................................................................................... 16
  2.1 Exodus of Black Teachers .................................................................................................................. 16
  2.2 State of Education for Black and Brown Students Today ............................................................. 25
  2.3 Black Teachers Today ...................................................................................................................... 29
  2.4 Theoretical Framework ................................................................................................................... 39
  2.5 Critical Race Theory in Education .................................................................................................. 39
  2.6 CRT in Science Teaching and Learning ............................................................................................ 41

Chapter III: Methodology ....................................................................................................................... 50
  3.1 Narrative Research .......................................................................................................................... 50
  3.2 Intersectional Feminist Methodology ............................................................................................... 51
List of Tables

Table 1. Pre-Interview Survey and One-on-One Interview Participants…………………………….73
Table 2. Summary of Black Women Science Teachers’ Responses to Likert Items …………84
Table 3. Sista Circle Participants………………………………………………………………………127
List of Figures

Figure 1. Historically relevant science pedagogy graphic........................................147
Acknowledgments

“To be truly visionary we have to root our imagination in our concrete reality while simultaneously imagining possibilities beyond that reality.” – bell hooks

My visions have been ordained and ordered by God and I am eternally grateful to my ancestors who have served as guides during this journey. My guides on Earth are foremost my parents, Stephanie and Devin, who have imagined my possibilities far beyond our reality. Thank you to my father for sparking the flame that inspired this study and all my prior and future work. Thank you to my mother for reminding me constantly to relax so that I can enjoy the work, to remain grateful and gracious along the way. Using love, protection, and wisdom as a driving force to encourage me to move beyond and forward. To my sister, Briana, my main goal is to make you proud. Thank you for sharing your light through love with me and always sharing your joy.

To my chosen family, my friends, I have endless thanks. Ariel, Angelina, Milan, and Yvorn, thank you for holding my story and reminding me how far I’ve come to get to this moment. Simone, your emotional expressions and joy for my progress remind me to celebrate and try to be as proud of myself as you are proud of me. Brittany and Jennifer, thank you for making sure I had a place to write, and encouraging me by simply listening, and feeding me! Fred and Bearden, daily joy was a major requirement to complete this labor of love, thank you for being my rock. To all other chosen family, thank you for the smiles, gifts, hugs, and all the other small (yet impactful) ways you helped me feel loved during the last 5 years!

To my scholarly family, my mentors, and dissertation committee members, I am eternally grateful for you all helping me find light where there was uncertainty. As a first-generation college student embarking on a Ph.D., I routinely sought out examples to help me build a vision for my future possibilities and I was able to see you as a glimpse of hope. Thank you for pouring into me. Specifically, Dr. Althea Hoard who set the stage for first hearing that a doctorate in Science Education even existed, and who gave me tips and tricks to navigate this world. Dr. Lisa McDonald who opened her home to me week after week and fed me just to ensure I had the mental space to complete qualifying exams! I would like to thank my dissertation committee of Dr. Felicia Moore Mensah, Dr. Christopher Emdin, Dr. Michelle Knight-Manuel, Dr. Denise Mahfood, and Dr. Maria Rivera. Thank you for the thorough reading, thoughtful questioning, and caring comments. To my forever advisor, Dr. Felicia Moore Mensah, my first year at TC after a presentation you came up to me looked me in the eyes, and told me you wanted to work with me, this was the moment when I knew becoming Dr. Riley was actually possible. You’ve embodied love, grace, and wisdom for me, and I am grateful to know you and be a part of your legacy.

Lastly, to the Black women science teachers who shared their stories for this dissertation, your willingness to share your joys and struggles with me made me a better researcher and a better educator. Thank you for reminding me of what’s possible in education. bell hooks taught us that “true resistance begins with people confronting pain…and wanting to do something to change it.” Your participation in this project was a beautiful step in making real and systemic changes in our classrooms.
Dedication

For Nana and Auntie Joyce, my light beyond the heavens.

For my students, the world is YOURS! Take it, change it, build it.
Chapter I: Introduction

The demands of society’s call for diversity in the science field require systemic change in the urban science classroom. Today’s science students in high-need, racialized schools need more access to rigorous science content and a teaching staff that supports the whole child. Historically, Black women teachers’ pedagogical practices inspire their students to excel beyond the oppressed constraints put on them by society (Beauboeuf-Lafontant, 2002). Tragically, today Black women make up only 5% of the teaching force (Hill-Jackson, 2017). There is limited research that details if the historical traditions of Black women’s pedagogical practices have been sustained in the few science classrooms that are led by them (McMath, 2015). The goal of this study is to examine how socio-political factors, such as race, gender, class, and power, influence the pedagogical practices of Black women science teachers and how their critical consciousness is embodied in their science teaching.

Although the nation-wide percentage of high school students taking Science, Technology, Engineering and Mathematics (STEM) courses has increased in the last 20 years, between 1990 and 2009, the number of white graduates that took calculus increased by 18 percent, in comparison to the increase for Latinx and Black students were 9% and 6% respectively; the race divide in access to STEM courses is prominent (National Center Education Statistics, 2012, p. 78). Specifically in the science classroom, among the 2009 graduates who have taken biology, chemistry, and physics, those in “low-poverty schools” were granted more access to these courses than students in “high-poverty schools” (National Center Education Statistics, 2012, p. 78). Not only are Black and Brown students given less access to science education, and if given the chance to walk into a science classroom, they typically will not see a teacher that shares their intersectional views or who is trained or equipped to meet their needs. Based on this data and the
fact that “high-poverty schools” are historically attended by Black and Brown students, it can be deduced that Black and Brown students are given an unfair chance at having a science career. Those Black students who do persist in the science field have a solid science identity (Carlone & Johnson, 2007), receive powerful and meaningful support from family and past educators to cope with the chilly climate of the science field (Bush, 2013; Rosa & Mensah, 2016).

Madkins and Royston (2019) call for research that furthers “our understanding of how science teachers’ pedagogies can respond to students’ cultural background, their racial and local communities’ histories with science” and positively position the realities of marginalized and racialized students “relative to science and to scientific pursuits” (p. 1321). According to the literature, Black teachers historically choose to work in high-need schools, stay in the classroom longer than their white peers, and have pedagogical practices that result in academic achievement (Farinde et al., 2016; Hill-Jackson, 2017; Mosely, 2018). The pedagogical practices of Black women teachers have historically liberated the mind and encouraged the self-determination of its students (James-Gallaway & Harris, 2021). This pedagogical practice is desperately needed to diversify the STEM field, specifically diversifying who is represented in STEM fields and increasing diversity of thought in STEM fields. Currently, there is extremely limited literature that focuses specifically on the pedagogical practices of today’s Black women science teachers, and little literature detailing if teacher education programs or schools are striving to meet the needs of this much-needed population. The focus of this research meets an urgent need to diversify who gets to become a scientist.

There are two potential contrary perspectives to think about in science education. First, science and science education have historically been considered as an apolitical, neutral field that is taught objectively (Gilbert & Calvert, 2003). Second, the historical pedagogical practices of
Black women have been political and informed by their racialized, classed, and gendered experiences (Beauboeuf-Lafontant, 2002). Therefore, my work situates how these two contrary views—science education and the historical pedagogical practices of Black women—are embodied in the work of Black women science teachers.

1.1 My Narrative

We, Black women of today, must accept the full weight of a legacy wrought in blood by our mothers in chains. Our fight, while identical in spirit, reflects different conditions and thus implies different paths of struggle. But as heirs to a tradition of supreme perseverance and heroic resistance, we must hasten to take our place wherever our people are gorging on towards freedom. (Angela Davis, 1981, p. 15)

My personal teaching narrative is a continuation of a very long history of Black female teachers, doing more with far less. First teaching 7th-grade history, I spent 8 years teaching in the classroom, both in 99% Black and Brown public and charter schools in Harlem and Brooklyn. I also spent 4 years teaching 1st-year science teachers who teach in diverse classrooms across New York City (NYC) in a science methods course. Contrary to my value within the classroom, I was repeatedly treated as someone who should fill the gaps of her white peers (e.g., covering classes, conferencing with students that others were scared of, and writing curriculum with no additional compensation). Although I did not have the words at the time, my pedagogical practices and strategies for survival in a corrosive teaching environment were a part of a Black feminist/womanist tradition of deep caring, political clarity, and an ethic of risk (Beauboeuf-Lafontant, 2002). My deep caring for my students made this reality bearable; servicing the students was the only goal. Being alone in the fight had its wearing on my spirit. I inevitably left the K-12 classroom because I no longer felt psychological safety (Woodson, 2020), nor was I fulfilling the needs of my science students. I explore this personal narrative filled with overlapping and sometimes contradictory feelings with my role as a science teacher to both
situate why I am the person to conduct this study, but also to reveal that I am not alone. Systemic issues in education may not change quickly, but we need more voices in the room. The voices of other Black women science teachers must also be elevated to one day end the cycle of doing more when provided with less, and to embrace the power, content-expertise, and pedagogical practices of these women.

My personal journey into becoming a Black female science teacher is not typical. I started as a history teacher but was eventually pushed out and to take over some middle school science classes. My first year of teaching was challenging yet invigorating. I was able to foster a classroom community that was rooted in academic excellence, activism for the community, and a love of learning in my Social Studies class. During that year I taught my students a curriculum that included the mandated standards, while also centering the often-marginalized voices that mirrored the populace of my classroom. That year included a field trip to NYC’s African burial grounds, a comparative study of their textbook’s version of Columbus’ history versus Howard Zinn’s telling of that story from the perspective of the Taino and Native Americans, daily writing prompts that asked students to consider their racial identity and racism in Harlem and critical analysis of hip-hop lyrics and their call to action in oppressed areas.

When first tasked to be a science teacher in Harlem, my first reaction was disappointment. The school was considered a “failing” school. The students sitting in their seats and engaging in content was unfortunately considered an amazing accomplishment when I arrived. I was disappointed that I would no longer be teaching history to 7th graders after a year of many successes. Inevitably my social studies position was given to a white-presenting teacher, with the same amount of teaching experience but far less success with engaging students. My intersectional identities (Black, female, working-class) and the interlocking nature of the
oppression I experienced and witnessed informed how I developed my socio-political views about teaching science.

Leaving college with a degree in Sociology and earning a Master’s in teaching history, I was not well prepared to teach science, but was expected and pressured by my bosses anyway. All other faculty (white teachers) kept their positions despite creating dangerous conditions in the classroom, and no positive track record with the students. I chose to turn my anger and disappointment into action. As a young Black woman from South Central, Los Angeles from a family with racial pride and fervent belief in the power of access to education, I was excited to teach in “the Black mecca”, Harlem — literally teaching the next Black generation on the same streets that Malcolm X shared his messages and blocks away from where Langston Hughes lived. Teaching here was no small task for me, so when taken out of the history classroom to fill a gap in the science department, I had to quickly move past my disappointment and go into planning. Just like my history students, my science students deserved more than just your typical classroom. They deserved a classroom that embraced their interests, was rooted in social action and activism, and challenged them beyond the low expectations they grew accustomed to from previous teachers.

The summer before teaching my first science class I looked to my own experiences. I thought back to my aunt talking to me about the over-presence of electrical plants and smog in our poor area of Los Angeles and its connections to asthma in the Black and Brown community. I thought about my love of science in high school, working as an intern at hospitals, and how proud my family was of the idea of my being the first to attend college, and doubly proud that I would pursue a science major. I reflected on the fact that although admitted as a Chemistry major, I dropped my freshmen chemistry course after being forced to sit on the floor the first day
because the 400-capacity room was already full 10 minutes before class began. In a completely different space of attending a Predominantly White Institution (PWI) and being far from home, I graduated from college and decided that getting a college degree would be enough, and thought I left the science field for good.

Two years after graduating from college, I found myself back in the science seat and needed to consider how I could incorporate aspects of my previous history class that felt academically challenging and culturally affirming into my science teaching. Because I was attending graduate school at night to learn to teach secondary history, while also re-teaching myself science content, I found a way to make things work. I thought critically about my new Harlem neighborhood and considered the role science played in my students’ lives. Over the next 3 years, my pedagogy as a science teacher started to bloom. I chose to tailor my science teaching mostly around research projects and performance tasks that dealt with issues of systemic racism as it pertains to health equity, such as redlining and food deserts; the US’s handling of climate change and fracking and its effect on other countries; and critical issues in the science community such as stem cell research, cortisol, and racial health disparities in the Black and Brown community. My science classroom could not just be about the differences between ecosystems or how the cardiovascular and digestive systems work together, science in my classroom needed to discuss human impact on bee pollination and how the lack of access to healthy foods in poorer neighborhoods leads to high cardiovascular issues and death, for example. My science classroom would need to provide a space for students to think critically about their world and communities like theirs, create a place where students took risks and saw themselves as capable of fighting for themselves by first getting equipped with the tools of
knowledge. Even if they chose not to pursue a science major in college, they would make that decision for themselves.

In many ways, the success of my science classroom was in large part because I did not teach Mathematics or English-Language Arts (ELA) formally. During the two years I taught the course, my students scored better than any other cohort of students on the 8th grade NYC exam in the school's 15-year history, but this triumph was easily overlooked by the school’s administration. All other teachers in the middle school team, white teachers, were assigned a coach and had content-specific professional development to support them. Despite my proven track record in standardized tests and with student satisfaction, I was repeatedly denied leadership opportunities. As far as the school was concerned, my students sat in their seats, and they never heard about major behavior issues in my room so whatever was happening in there was fine. Being the only Black teacher on the middle school staff, my school leadership team treated me as if professional development opportunities were not for me. My students sat down and did work, and it did not matter what the work was as long as it did not interfere with Math or ELA.

This personal reflection on the first four years of my K-12 teaching career informs my curiosity into how professional development could have played a positive role in my development as a teacher and leader. When speaking to friends and colleagues about how I used my socio-political views to inform my science teaching, they shared that my teaching was not normal and should be celebrated. Outside of my circle, I wondered if anyone had been paying attention, would my teaching career had been different? Would THEY object and WHY were they so disinvested in the role I was given in the classroom? It makes me wonder how my teacher development would have thrived and been challenged in a science education opportunity
that may have embraced my interlocking identity markers (race, class, and gender) and socio-political beliefs about schooling and science education. I am more than sure that if my school had tried to force me to follow a racially-neutral or apolitical science curriculum (similar to the next 4 years of my teaching career), they would have pressured me to focus my class on more math or reading tests prep strategies. I may have been encouraged to control how students expressed themselves or pressured to decrease the scientific inquiry in my teaching, which would have diminished my confidence to display my autonomy in the classroom.

I did not realize how personal teaching was for me until my pedagogical practices and teaching philosophy was in direct opposition to practices in my next school. For instance, during the first four years of my teaching career, my decisions were rooted in my integrity and philosophy of teaching. I felt positive about my students’ experiences in the classroom because they were focusing on their education as an avenue to follow their dreams while also viewing themselves as change agents in the world around them. During the last four years of my teaching career, I did not feel positive about my class while succumbing to the pressures of following a racially neutral/apolitical high-school Physics curriculum. My integrity was in question not only because of the curriculum but also because I engaged in professional development that urged me to prioritize testing prep and exert my power by enforcing student compliance and rigid academic structures that left little for student or teacher agency.

During my 6th year of teaching, I had been an adjunct professor in science education for 2 years. I was led to apply for a Ph.D. program because there was a problem I wanted to solve. I knew something was wrong as I was feeling psychologically unsafe at my school and even within my classroom and methods course. The cause was more than a rigid Physics or science methods curriculum. My students deserved more from me, and I had run out of the fumes of
inspiration that had inspired me to teach in my truth and integrity years prior. I needed communal healing with others who shared in my experience. I needed professional development that embraced and pushed my pedagogical beliefs from people I trusted. I needed to know if I was alone on this journey.

Getting into the doctoral program and having the opportunity to have an advisor that is a Black woman science teacher educator was an exciting and daunting opportunity. Exciting because I knew this is what I needed and asked for, daunting because growth is difficult. Exciting because she also raised questions about socio-cultural and socio-political issues within the scientific context, daunting because I had much to learn. Outside of the kitchen table conversations where I heard about education in the context of race, class, and gender from my family members as a child, I didn’t know theories and praxis such as Critical Race Theory, Black Feminism or Intersectionality even existed. The opportunity to explore these concepts within the context of science education is rare, and that must change.

With this doctoral study in my heart, I am urged to dream. In her editorial *Teaching Black Women*, Russell (1982) urges her readers to “balance any discussion of the material circumstances of Black women’s lives with some attention to the realm of their dreams” because the “balance of power is not on our side, while the burden of justice is” (p. 120). While dreaming, the following questions came to mind: During this 8-year career, how could professional development and science teacher education have empowered me to continue the practice of reflecting on my past experiences to inform my teaching practice, to embrace my students’ realities to make critical connections to science and the world around them, and to provide healing for when I witnessed or participated in practices outside of my integrity? Would this type of professional development lead me to stay in the classroom longer? Would my
teaching experiences and ultimately the experiences of my students fare differently if I had been in a community with other Black women science teachers? What could we learn from our differences and similarities? How could having access to a Black, female teacher educator help me grow? How could a community of Black women science teachers provide healing and retention in a field where Black women rarely find themselves?

1.2 Significance of the Study

History of Black Women in Education

This dissertation is named honoring the work of the National Association of Colored Women (NASW), the first national Black organization founded in 1896, whose motto was defined in its mission—Lifting as We Climb. By 1900, there were about 400 Black women’s clubs with between 150,000-200,000 members nationwide with a large membership of educators (Knisley, 2020). Black women quickly realized that their greatest strength was in their identity. Their greatest weapon against racism was their, deep understanding of the plight of being Black, female, and oppressed in post-abolition America. In this time of radically heightened hostility, it was clear that Black women themselves would have to begin the work toward racial equity—and they would have to do so by elevating themselves first (Johnson-Roullier, 2007).

I believe that the American school system is greatly indebted to Black women. Since the Reconstruction era, Black women have pioneered in the education system by fighting for justice in a racialized society despite sometimes violent opposition. Without the pedagogical philosophies and political organization of Black women in education, some of our important social movements may not have been a reality. For example, in Baltimore, Lillie May Carroll Jackson (former teacher turned president of NAACP) led the way for civil rights in the 1930s and 1940s using non-violent tactics and voter registrations to steer a movement. Dr. Jackson laid
the groundwork for Black male leaders, such as Reverend Dr. Martin Luther King, who would follow her civil rights activism decades more recently (Cumberbatch, 2009). In its larger context, Black women have always played an integral part in using education to erase the stain of racism from America’s fabric.

With such a rich history in the background, the presence of Black women in education today is simply a tragedy. In her article, ...And Then There Were None: Reversing the Exodus of Black Women from the Teaching Profession, Valeria Hill-Jackson recounts the history and presence of Black women in education since the Reconstruction era. But of the nearly three and a half million teachers today Black women only comprise 5% of the field (Hill-Jackson, 2017). For context, between 1890 to 1910, Black teachers represented approximately 45% of the teaching force. In 1910, 76% of Black teachers were women (Foster, 1997).

During enslavement, the arrogance, self-interests, and disbelief in African humanity by white enslavers (Butchart, 1988) sometimes led to loopholes in the system of total domination. Gundaker (2007) explores the hidden, sometimes invisible aspects of schooling that Black people championed while enslaved. They (2007) share that the contradictory beliefs of enslavers left room for the whit and critical thinking of those enslaved (i.e., although it was illegal for Black people to read and write, enslavers also thought it was important for them to know selected passages of the Bible that supposedly encouraged involuntary servitude and capture, thus accidentally providing access to text). Led by their desire to obtain literacy and education, when white enslavers required them to watch over their children, entertain them with storytelling or sing and dance, Black people would “carefully gather snippets of schooled knowledge” (p. 1594) from their enslavers. Aware of the promise of amputation, beatings, or death, Black people
educated themselves. This legacy of using education as a tool to liberate Black people from racial subjugation would continue after legalized enslavement.

During the era of slavery, Angela Davis (1981) positions Black women “as the custodian of a house of resistance” not because they were there to clean but to illustrate that if “Black women failed to rise to the occasion, the community of slaves could not have fully developed” in their quest to physical and intellectual freedom. Eager to exercise their stolen human right to literacy, “female slaves took great personal risks to educate themselves and others in the dark cloak of night” (Hill-Jackson, 2017).

After emancipation, schools established by the Black community began to spring up in many areas of the rural South. Becoming one of the few occupations where Black women had access to a job (Fairclough, 2009), these teachers were commended for their commitment to the community as they used their classroom position to leverage social change and advocacy for their students and their families. During the Reconstruction Era and beyond, the Black community began to rally behind supporting and developing institutions that would train Black teachers for their children. As a result, by 1933, in comparison to their white peers, there were more Black teachers than them and they trained for more years before and during their career. (Fultz, 1995).

1.3 Purpose and Research Questions

The purpose of this study is twofold. First, to explore in what ways Black women science teachers fit within the long-storied legacy of Black women teachers while using their content expertise in the classroom. Second, investigating how Black women science teachers exemplify anti-racist teaching in their curriculum and classroom practices. This study uses a qualitative
research framework to understand how Black women science teachers discuss their pedagogical practices. The study answers the following research questions:

1. How do Black women science teachers at various levels of experience discuss and practice Womanist Pedagogy?

2. How or in what ways do Black women teachers talk about their implementation of anti-racist practices through their science teaching?

1.4 Definitions of Terms

1. *Black vs. African American*: For this study, the author uses Black and African American interchangeably, although she prefers the term “Black” as a racial identity marker.

2. *Critical Race Theory (CRT)*: Theoretical framework in education that exposes racism and proposes radical solutions for equity in education (Ladson-Billings & Tate, 1995).

3. *Race*: Race is a sociopolitical construction created by racism to categorize people by phenotypic markers, such as skin color, eye shape, and hair texture, and to attribute social meanings to these physical characteristics (Sheth, 2019).

4. *Racism*:

Racism = race prejudice + social and institutional power

Racism = a system of advantage based on race

Racism = a system of oppression based on race

Racism = a white supremacy system

Racism is different from racial prejudice, hatred, or discrimination. Racism involves one group having the power to carry out systematic discrimination through the institutional policies and practices of the society and by shaping the cultural beliefs and values that support those racist policies and practices (Racial Equity Tools, 2020).
5. Science is a process and activity as much as it is an organized body of knowledge; science cannot, therefore, be learned in any deep and meaningful way by reading and discussion alone. Science education should “promote learning activity, creativity, and involvement in acquiring data systematically, i.e., laboratory work” (Showalter, 1984, p. 3).

6. Sista: In group-term used mainly among Black women to refer to the solidarity and the connection we feel toward each other. “It can sometimes be used interchangeably with the term “sister”, but often does not refer to a biological relationship” (Dorsey, 2001, p. 71).

7. Socio-political factors: Combining social (such race, gender, class, age) and political factors.

8. White Supremacy: White supremacy is the systematic superordination of white people, culture, and institutions over, and the subordination of, people of color through the organization of the ideological, political, and material features of society (Bonilla-Silva, 2001, 2005; Brayboy, 2005; Fanon, 1967; Harris, 1993; hooks, 1989; Vaught, 2011; Vaught, 2013).

9. Why capitalize ‘B’ in Black people: In 1929, when the editor for the Encyclopedia Britannica informed Du Bois that Negro would be lowercased in the article he had submitted for publication, Du Bois quickly wrote a heated retort that called “the use of a small letter for the name of twelve million Americans and two hundred million human beings a personal insult.”

10. I use uppercase letters for “Black” and lowercase letters for “white” in this manuscript.
The term “white” has historically been used as a signifier of social domination and before privilege. In response, scholars (e.g., Toure (2011) are changing the capitalization scheme in their work as a political move to draw attention to the destructive nature of racism and white privilege in the United States and beyond.

In this study, when writing my thoughts, I use the principles described above but still stay true to the language used when citing other authors.
Chapter II: Literature Review

This literature explores how educational policy has caused the exodus of Black teachers generally. It also discusses the current state of education for Black and Brown students and concludes by detailing the literature that focuses on Black women teachers, Black science teachers, and lastly Black women science teachers. Although this study is not about educational policy, it is imperative to understand and recognize how the power of words in the legal system has provided only false promises in the guise of “equality” with the passing of Brown vs. Board of Education of Topeka in 1954. It is also important to provide the historical context and background of informal and formal schools for Black people during and since enslavement in America to demonstrate how imperative the presence of Black women science teachers is today. Their narratives also serve as examples of how oppressed communities over centuries can also shed light on a community of strength, action, and perseverance.

2.1 Exodus of Black Teachers

Education during Reconstruction and Segregation

“If the Supreme Court should rule that segregation in the elementary grades is unconstitutional our Board will proceed on the assumption that the majority of people in Topeka will not want to employ Negro teachers next year for white children. It is necessary for me to notify you now that your services will not be needed next year.” (Letter sent to a Black female teacher that was a plaintiff in the Brown case of 1954; Tillman, 2004, p. 281)

It is important to document the past to contextualize where we are today in American history, and without the full understanding of Black teachers’ educational scholarship, critical pieces of history are lost. At least since the 16th century, perceptions of Black people as “physically gifted, lazy, happy-go-lucky, and mentally incapable sexual predators” have been used to support systems of colonization, slavery, and segregation (Mutegi, 2013, p. 88). In 1877, an author, under the pen name Civis, describes public education as an “absurdity” that might
confuse Black people because it “prompts him to despise menial pursuits to which his race has been doomed” (Civis, 1993, p. 17 as cited by Mutegi, 2013). Showcasing the circular nature of institutionalized racism’s role in education, Vaught (2013) explains:

White society and the white state have sought to leverage education to destroy or diminish Black culture(s) through segregation as a larger mechanism of hoarding and denying material and other resources. This has taken on various forms over time, from the denial of literacy or formal schooling to the formation of segregated, under-resourced schooling, to assimilative curricular programs, to tracked special and behavioral education, to busing, to disciplinary policy, to disparate funding. (p. 115)

In America, it was illegal for enslaved Black people to learn how to read and write. Slave-owners and policymakers in the United States believed that literacy, the ability to read and write, should not have been wasted on a population that was sub-human and whose sole purpose in life was to be in service of white people. Many enslaved and free Black people fought and died for access to a book and the ability to read. Literacy was a way for both mental and physical liberation from the inhumane conditions of slavery. After the enslavement of Black people was abolished in 1865, Black teachers and formal schooling were a vital aspect of the Reconstruction era (1865 to 1877) and the Jim Crow era (1877 to 1965). For example, According to Foster (1997), Black teachers founded Sunday schools in the North in the late eighteenth century and native schools in the South before the end of the Civil War. They established several private schools in the South during the late nineteenth and early twentieth centuries. They taught in schools established by Black churches and organizations.

Fairclough (2000) explains that the organization of schools helped Black people define themselves as a community with values during the Reconstruction era. Due to the mass illiteracy
of Black people who were formerly enslaved, Black teachers became a natural source of racial leadership. Black teachers were positioned to lead “a benighted people”, who believed that “education brought the added duty of dispelling the ignorance, immortality, and superstition that, many believed slavery” has bestowed upon the race (p. 65). Those teachers who were taught with racial pride during the Reconstruction era would continue the tradition for generations (Foster, 1997).

By 1862, Virginia set up its first school for the training of Black teachers. Very soon after the Civil War in 1865, Black teachers outnumbered white teachers in rural areas because of political leadership by Black men who had recently gained the right to vote. Acting independently of northern white people, Black people in rural areas started to organize “freedmen’s schools” and “Sunday schools” (Fairclough, 2000). Although the systemic nature of racism caused many roadblocks for Black people in the quest for equality (i.e., Black men losing the right to vote, 70% gap in Black teacher salaries in comparison to white teachers), the establishment of schools and colleges in segregated Black schools were seen as imperative bridges to uplifting the race between the struggles for freedom going into the twentieth century.

Hill-Jackson (2017) posits that “Negro slave women suffered triple victimization: she toiled in domestic servitude and comprised nearly 60% of the agricultural field hands (Jacobs, 1861); her body endured brutal rape by her owners (Davis, 1981); and she braved the horror of having her children sold into bondage (White, 1999)” (p. 12). With some of these Black women coming out of enslavement after the ending of the Civil War in 1865, 90% of newly “freed” men and women were released into an unstable America with an illiteracy rate of “90%” (Albritton, 2012, p. 313). Five years after the Civil war ended, Black teachers were needed to answer the call of the Negro education movement and teach in separate schools, or to teach Black children.
After the failure of the federal government to provide proper funding of Black teachers as sanctioned by the Lincoln’s Freedmen’s Bureau (Manfield, 1980), “philanthropic and religious agencies were the second support mechanism for Negro education in the South” (Hill-Jackson, 2017, p. 14). With the belief that education was of equal importance to land ownership, the Black community during the third stage of building the foundation for Black education, at the turn of the century after traditional enslavement ended, saw change in education. There was a “dramatic surge in the number of Negro teachers at the beginning of the 20th century” (p. 14). Foster (1997) computes that

…between 1890 and 1910 the number of Blacks who were employed as teachers rose from 15,100 to 66,236. In the census years of 1890, 1900, and 1910, Black teachers represented about 44, 45, and 45 percent, respectively, of professional Blacks. In 1910, 76 percent of Black teachers employed were women. (p. xvii)

By 1917 in Vosston, South Carolina, some Black communities insisted on developing private home schools, providing a classical education, unlike the vocational education offered to Black students in most public schools. Unlike the sometimes well-intentioned white missionary schoolteachers who taught domestic skills, Black teachers believed Black children and communities deserved much more. Public schools focused on “domestic sciences” such as “washing, ironing, farming, and cooking” to keep Black people in their domestic place (Foster, 1997, p. 27). With the leadership of Septima Clark and her peers, Black teachers were positioned as a necessary component of schooling in public and private home Black schools.

In some cases, separation from white schools’ officials allowed Black teachers to teach in liberating ways, away from the prying eyes of the local and state school boards (Boykin, 1986). In the 1940s, one of ‘the elders’, Ora Benson, of Michele Foster’s Black Teachers on Teaching
(1997) details how she embedded racial pride in her classrooms in Flint, Michigan after realizing her students did not think an image of a Black woman was beautiful because of her African features and dark skin. She wondered, “if they couldn’t see the beauty in the woman, what did they think about themselves?”. In response, Benson decided to develop an entire pan-African curriculum in all the subjects she taught in her elementary class. By teaching about the common ancestry of Black people around the world, she was able to build relationships with the students through the curriculum.

As an example of building community and solidarity behind education, Tillman (2004) highlights the role of Black principals in the pre-Brown/Jim Crow South. Serving as a connection between schools and the community, Black principals served as professional role models for teachers and other staff members by encouraging “parents to donate resources to the schools and helped to raise funds for schools” (p. 283). Leaders in the struggle for Black education, Black principals also encouraged teachers to develop relevant curriculum while they directed the vision for the school.

Black superintendents of segregated schools detail the exemplary practices and philosophies of Black teachers in Sonya Horsford’s (2011), Learning in a Burning House. Black teachers were dedicated to the livelihood and education of their students beyond just the classroom. Black teachers “were visible and involved in the local Black church and community” (p. 44) and consistently provided additional support to their students outside of the regular school day. Behavior and discipline were emphasized by Black teachers simply because they expected the best from their students who understood how important it was for Black children to be the best in an oppressive, racialized society.

**The Empty Promises of Integration**
“When they desegregated secondary schools in this parish (New Iberia, Louisiana) they threw Blacks back a hundred years.” (Retired high school principal; Fairclough, 2004)

Tillman (2004) asks us to consider “was the loss of unemployment for Black educators one of the (un)intended and (un)anticipated consequences of desegregation after Brown?”. Some focus on the reality of Brown's failure by the present state of Black education versus those who recall it with great optimism. Despite the positive narrative that is typically associated with the Brown decision, the differences in perspectives are informed by the racial identity and standpoint of the viewer (Walters, 2008). Critical race theorists argue that the issue of the Brown decision is the problem of “interest-divergence” because the unification of liberal white northerners and conservative Southerners resulted in desegregation rather than integration. As Horsford (2011) explained:

Racial liberation’s focus on the ideals of colorblindness (color or race doesn’t matter), meritocracy (access and achievement are based on individual worthiness), and neutrality of the law (all persons are treated equally under the law) was based on a definition of equality as the “the absence of formal, legal barriers that separated the races” rather than “a fair and just distribution of resources” (Guiner, 2004, p. 95). These important distinctions between and among our definitions of equality, justice, desegregation, integration, and opportunity are where the debate that informs education policy lies. (p. 6)

With the lack of intentionality with the language of lawmakers in the Brown decision, clearly defining the differences between integration and desegregation, Tillman (2004) and Horsford (2011) have argued that Brown did what it set out to do; give empty promises about the future of schooling for Black communities. Horsford highlights the definitions of integration and desegregation to illustrate why the two terms should not be used interchangeably. Adair (1984) in his book Desegregation: The Illusion of Black Progress, defined desegregation as “the
“physical reassignment of children and staff to change the existing racial composition in schools,” as compared to integration, defined by the U.S. Commission on Civil Rights as “a quality of education and interpersonal interaction based on the positive acceptance of individual and group differences as well as similarities” (p. 168).

**Exodus of Black Teachers since Brown**

After emancipation from slavery, few professions were acceptable to Black women outside of teaching. Black men and women teachers “taught freed slaves how to navigate into a new world with Jim Crow” and were admired leaders in their communities because they used their classrooms to influence advocacy and social justice for learners and their families (Hill-Jackson, 2017, p. 15). Official language concerning Black-teacher retention was included in neither the Civil Rights Act of 1964 nor the subsequent federal desegregation guidelines of 1966 (Orfield, 1969). After Brown, in between the years of 1954-1965, more than 38,000 Black teachers in 17 southern and border states were fired. As a long-lasting consequence, from 1975 to 1985, the number of Black students who chose teacher education as a major declined by 66% (Horsford, 2011). In one example, the effects of Brown on Black communities are illustrated in Virginia’s “freedom-of-choice” tuition vouchers ploy that allowed white families to choose where their children could attend schools. This resulted in Black teachers being bussed to school Black children in areas that had no school left. A Black retired superintendent in Horsford’s study remembered how the school districts she worked for mobilized Black teachers to travel to educate Black students in those communities that no longer had schools.

There are three phases of Black teachers in America according to Hill-Jackson (2017), *Reconstruction* (1865 to Brown v. Board of Education), *Integration* (Brown to 1970s), and *Exodus* (1970s to present). The current phase of Black teachers in education, *Exodus*, is defined
by the mass departure of Black teachers (both male and female) from the teaching force since the 1970s. In many ways, this was a legal exodus put in place by policies. Districts could also discourage Black teachers from the profession by transferring them to white schools, where they would face discrimination and hostility. For example, Hooker (1971) found widespread displacement; in Alabama, one-third of the estimated 10,500 black teachers were dismissed, demoted, or pressured to resign.

Another example of the legal exodus of Black teachers is detailed by the reclassification of the general teaching position that most Black teachers held, schools would begin to no longer accept applicants with this classification and would tell Black teachers that their jobs were eliminated by the federal government. Simply put, at the time Black teachers mostly held generalist teaching certificates, and school officials had the power to de-legitimize that credential, pushing Black teachers out. Continuing after the 1970s, other tactics included abolishing tenure laws where there were high percentages of Black teachers; “allowing the dismissal of teachers without cause; failing to replace retiring Black teachers with other Black teachers; assigning Black teachers to teach out of their content field, and evaluating them as incompetent” (Oakley et al., 2009, p. 1579).

These discouraging tactics and policies were not only limited to the teaching force, but also Black school leadership. Tillman (2004) details the experiences of the first Black woman to be appointed superintendent in a large urban city in 1973. Dr. Barbara Sizemore was fired within two years of her appointment after attempting to make the Washington, D.C., school system more culturally responsive to their mostly Black student population. Forced to be a sole representative of the Black race, Dr. Sizemore felt that her symbolic position was important for other Black teachers and Black students to see but was discouraged by the fact that there was no
true power in her position because of racist, white opposition. Dismantling oppressive structures from within is an important fight, but extremely difficult to accomplish alone.

2.2 State of Education for Black and Brown Students Today

“When the children were integrated into white schools, they lost something. Integration has helped in some ways, but it has hurt our Black children in some ways. Now, instead of seeing Black children winning prizes for their achievements, you see them all in special education classes. This has caused them to lose their pride, their self-esteem. They have been pushed back, as far as leadership is concerned. Instead of being taught to lead, they are taught to follow.”

(Ruby Forsythe, an eighty-year-old teacher, as cited by Michele Foster, 1997, p. xxxiv)

With the election of Richard Nixon, there came the end of the forced desegregation of all states in America. The Brown decision of 1954 not only brought along the mass exodus of the Black teaching force higher-order to but also white families and communities were enraged by the busing of Black students into their white schools (Metcalf, 1983). In her groundbreaking book, Can We Talk About Race? And Other Conversations in an Era of Resegregation, Beverly Tatum (2007) chronicles the federal government's role in ending the progress of desegregating schools in the United States. Beginning with the 1974 Supreme Court case, Milliken v. Bradley, this case moved efforts to desegregate schools by instructing states to only bus Black students within the same district. This resulted in “white flight”—the belief that court-ordered shifting of white students to desegregate schools would influence white parents to withdraw their children from the public schools or move away from the integrating district (Coleman et al., 1975). “In 1970 the Boston public schools enrolled 96,000 students; 59,000 of whom were white. By 2000, only 9,300 white students remained in the Boston public schools, just 15 percent of the current total” (Tatum, 2007, p. 10), which ultimately led to less public-school funding.

By 1990, the oversight of federally and state governed desegregation had completely halted with the Board of Education of Oklahoma City v. Dowell Supreme Court decision. Both the Milliken v. Bradley and Board of Education of Oklahoma City court decisions led to an era of
reversal and ‘resegregation’ of schools across the country. Tatum (2007) urges us to consider the effects of resegregation on the lives of students of color. Living in a racialized society, it is an unfortunate reality that in 2000 “76 percent of those living in neighborhoods of concentrated poverty were Black or Latino” (p. 13). Today the percentage of children under the age of 18 in families living in poverty is 18% nationwide, 32% of Black families and 26% of Latino families are living in poverty in comparison to 11% of white families (NCES, 2019).

For this study, “resegregation” characterizes the racialized disparities in achievement and outcome, due to the uneven distribution of resources, replicating the reality of schools before Brown (Orfield, 2009; Vaught, 2013). Resegregation efforts have left the poor to fend for themselves and have promoted ideals of intolerance because of a lack of exposure. White children post-Brown had less contact with people of color than their predecessors, or children pre-Brown, they still are encountering negative, false images of Black and Brown people and their intellect (Brown & Brown, 2014).

At the time of her book, Tatum (2007) asks her readers, “what is the significance of continuing residential segregation and increasing school resegregation?” (p. 13). Today we have some answers to her question; one, the school-to-prison pipeline. Although Black youth make up 15 percent of the overall U.S. juvenile (ages 10 - 18) population, they are 44 percent of all detained youth, and over one-third of all committed or incarcerated, youth (Slowikowski, 2011). In 2017, 38.3% of Black youth and 33% of Latino youth who had been placed in a correctional or health care facility dropped out of high school (NCES, 2019). The school-to-prison pipeline is “an immense system mechanized to under-educate and over-discipline youth of color, thereby inextricably linking education with incarceration for Black youth” (Vaught, 2013, p. 115). The school-to-prison pipeline also “refers to the link between citations or arrests in school, and
subsequent contact with the justice system; either as a function of exclusionary discipline and
dropping out and/or future participation in underground economies” (Morris, 2012, p. 10).

The resegregation of schools in poor communities of color has resurfaced the
discouraging and terrorizing conditions fought against before Brown. Segregated Black
classrooms were severely under-resourced, but, in many cases, they had the leadership of
exemplary Black teachers to encourage the students to look past their current situation and to use
their critical thinking skills and literacy skills to uplift themselves and their community. Now,
that source of pride, caring and encouragement has been replaced with a more competitive
educational climate led by a white teaching force (White, 2016), “childhood poverty, a lack of
early childhood education, and the denial of a college-preparatory K-12 education promoting
critical literacies” (Winn & Behizadeh, 2011, p. 148). Moving from one racialized system to
another (schools to juvenile detention centers to prisons), Black youth are struggling to persevere
let alone survive.

The education system has back-tracked so far, that recent scholarship is still dedicated to
arguing that literacy and critical literacy is a civil right (Greene, 2008) and that the current
conditions in schools fail students of color. Reading and writing critically, Meiners (2007)
argues, are essential tools for survival in a current education system in which students of color
are disproportionately suspended, expelled, and placed in special education, all of which
contribute to a higher likelihood of incarceration. Students of color routinely encounter
surveillance and policing more than a rigorous curriculum and safety net of caring adults (Winn
& Behinzadeh, 2011). In 2007, nationwide, 50 percent of Black male students enrolled in Grades
6 through 12 had been suspended at least once (NCES, 2007). Black girls suffered the second-
highest rate of school suspension at 35 percent. When students are suspended or placed in special
education self-contained classrooms, they are not able to exercise their right to literacy. Doubly troubling for students in urban classrooms are having a curriculum that prioritizes low-level skills and ignores the critical thinking and inquiry-based skills necessary to succeed in the 21st century.

Although touted as objective, high-stakes testing is based on a limited model of learning: the rote mastery of a series of skills that lead to good grades and high schools without enhancing critical and creative thinking capacities (Nieto, 1999). Lipman (2008) argues that “rather than enrich teaching and learning and promote the sorts of literacies and academic dispositions prized in the new economy, accountability policies promoted a narrow focus on skills to pass high-stakes tests” (p. 53). Gaps in standards test scores are not the real problem (Hunter & Bartee, 2003). The real problems are a focus on basic skills, remediation, and overzealous test preparation that occurs more often in classrooms serving students of color (Apple, 2001; Gillborn & Youdell, 1999). Students who are already behind because of the “education debt” owed to them (Ladson-Billings, 2006) are then presented with a watered-down, culturally and racially neutral curriculum that reinstalls the subordination of knowledge and identity historically experienced by marginalized groups (Lipman, 2008).

2.3 Black Teachers Today

Black Women Teachers

Retaining Black female teachers in classrooms with Black students is a critical issue (Hill-Jackson, 2017). Black teachers’ proven ability to use their pedagogical training and shared cultural identity with their students to bridge culture and curriculum (Villegas et al., 2012). In comparison to their white counterparts, Black women teachers also demonstrate a greater commitment to teaching Black students (Dixson & Dingus, 2008). In high-needs, culturally
diverse urban schools, Black teachers’ retention rates are higher (Scafidi et al., 2007). Farinde et al. (2016) posit that to retain Black women teachers the “administrative support, salary increases over time, and professional development advancements must become a priority among school leaders and policymakers” (p. 115). In their study, their participants knowingly chose to teach in Title I, high needs schools despite the additional work required to meet the needs of the students. They contemplated leaving because of oppressive tactics by their administration such as demanding high student test scores, micromanagement, and resistance to upward mobility.

In their quantitative analysis of survey results of Black women teachers, Campoli and Conrad-Popova (2017) reported that a sense of community from teaching staff and high engagement from students with a lower socioeconomic status were motivating factors for high academic achievement. While these motivators are not unique to this racial group or gender, they should inform the actions of school districts that are interested in diversifying their teaching staff. Black women teachers thrive when supported by their principals and have a strong sense of autonomy in the school experience collegiality with their colleagues. When schools can create work and school environments that “promote engagement of low-income students” Black women teachers are “seven times less likely” to leave the classroom (p. 132).

**Black Teachers in Teacher Education Today**

Traditional teacher education programs today have not met the needs to recruit, retain and train prospective Black teachers (Ladson-Billings, 2014; Young & Easton-Brooks, 2020). Teacher education programs are not attractive to Black scholars for various reasons; one reason is that most programs are implicitly designed to meet the needs of middle-class, white women who will teach in urban areas (Sleeter & Milner, 2011). Sleeter and Milner suggest that traditional teacher education programs seek external evaluation from school districts with
veteran teachers of color as they redesign their programs to include the needs of prospective teachers of color. There has been a special emphasis in the literature on the shortage of Black teachers entering the field. These reasons included pipeline issues (Lewis, 2013), inadequate educational opportunities (Pabon et al., 2011), standardized testing requirements for teacher licensure (Goldhaber & Hansen, 2010; Nettles et. Al., 2011; Rogers-Ard et. al., 2012), and lack of funding of HBCUs (Dilworth, 2012; Irvine & Fenwick, 2011). Furthermore, programs that maintain the status quo by ignoring the pedagogical practices of Black teachers from the past (Philip, 2011) and not preparing Black teachers for the reality of working with white staff in their future schools (Cook, 2015) are other reasons for Black teacher shortages or low retention.

In his study focusing specifically on the teacher shortage of Black males, Lewis (2013) reports a continued gap in education. The largest disparity by race and gender in the U.S. public student is held by Black males (Toldson & Lewis, 2012); Black male students represent 7.39% of the student population, in comparison to Black male teachers which comprise 1.81% of the teaching force. In the pipeline from high school graduate to teacher, Lewis (2013) shares that although 83% of Black males hold a high school degree or GED and that the top collegiate major choice of Black males is education (Toldson, 2011), Black male educator degree holders are largely choosing not to teach.

Lewis’ (2013) data reveals that “only 23% of Black males that completed educator preparation programs chose to select teaching as a career in comparison to 27% white males, 41% of Black females, and 42% of white females” (p. 8). Understanding why Black male educator degree holders are not choosing to teach is still a gap in the literature, but it does highlight that other career options are available, and schools of education and school districts must do a better job at recruiting and retaining this much-needed population.
The data also reveals that some Black teachers face further obstacles while earning a teacher education degree. Rogers-Ard et. al (2012) provide an example of the challenge of recruiting Black male teachers at a Teach Tomorrow in Oakland (TTO) informational session:

22 African American men interested in teaching attended an orientation session for TTO. Of the 22, 15 had demonstrated significant experience with urban children or schools and were granted interviews. Ten of the 15 were offered positions as teachers, pending passage of required state tests. Eight of the 10 failed these tests, despite test-preparation support and completion of required coursework. In the end, only one African American male was placed as a teacher. (p. 459)

Teacher assessment tests serve as a “racially biased filtering process” (Rogers-Ard et.al, 2012) for Black people in teacher education programs. Although no study explicitly analyzes the relationship between teacher licensure test performance for specific populations of teachers, it is known that Black teachers perform “substantially less well” than white teachers, causing a disparate effect on who gets to become a teacher (Goldhaber & Hansen, 2010; Nettles et al, 2011). Rogers-Ard et.al (2012) share that Black teachers cannot afford to repeatedly fail teacher licensure tests while pursuing a teaching career. Many teacher education programs require anywhere from several months to a year of unpaid student teaching. The median of the Black and Brown family is 10 times less than the median white family (Shapiro et al., 2010). Thus, in addition to teacher education fees and “difficulties balancing a full-time job while earning a credential, test fees, test study guide fees, tutoring fees, college application fees, fingerprinting fees, and other required fees become financial barriers” for Black students desiring to enter the teaching profession (Rogers-Ard et.al, 2012, p. 455). If Black teachers work for the racial uplift
of the community, then standardized teacher assessments seriously block their potential to achieve this goal.

Historically Black Colleges and Universities (HBCUs) have been able to meet the needs of Black pre-service and in-service teachers. HBCUs’ have historically and are currently graduating the highest percentages of the Black teaching force in comparison to Predominantly White Institutions (PWIs) (Dilworth, 2012). HBCUs graduate 50% of Black teachers with bachelor’s degrees (Irvine & Fenwick, 2011). HBCUs not only enroll significant numbers of students from the areas that have the greatest need of quality teachers, but they also offer “incentive programs that are directed to the needs of these students (e.g., loan forgiveness and remission of tuition)” (Dilworth, 2012, p. 124).

As a result of reforms in teaching in the 1980s and the No Child Left Behind (NCLB) Act, federal standardized testing of K-12 students has negatively affected the structure and funding of HBCUs. K-12 standardized testing reported that students’ academic achievement was low and that this was a direct failing of teacher education programs, including HBCUs (Dilworth, 2012). As a result, teacher education programs waived the undergraduate degree of education as a requirement for licensing, required post-baccalaureate degrees, and “diminished the value of pedagogical knowledge” (Dilworth, 2012, p. 127). Irvine and Fenwick (2011) recommend that funding from philanthropic, federal, and state sources should financially support HBCUs to meet the charge to recruit more Black teachers and that there should be a statewide strategy for eliminating racial disparities in the pass rates of teacher licensing exams.

For Black teachers that did not attend HBCUs, Phillip (2011) recommended that teacher education programs begin to step back from their “progressive lens” of teaching and provide space for their Black prospective teachers to learn from the pedagogical knowledge of Black
teachers who taught in segregated classrooms in the past. Teacher education programs that mainly serve the needs of white women typically focus on a ‘progressive lens’ of teaching which leads to low expectations of Black and Brown student achievement and little structure in the classroom (Philip, 2011). Still today, Black “teachers recognize their students’ intelligence and voice in profound ways” but they also understand that “the most important contribution they could make as teachers was to develop their students' proficiency with the culture of power” (p. 365). Culture of power as discussed by Delpit (1998) examines the silent dialogue that exists when those in power implicitly communicate the ‘acceptable’ rules of engagement or norms which exclude others and maintain the white status quo. To develop students’ proficiency in the culture of power, Black teachers take on a more authoritarian and demanding role in the classroom that makes their white colleagues uncomfortable.

The political and ideological clarity of Black teachers of the past and today should be offered to prospective Black teachers as they build their pedagogy in a teacher education program (Philip, 2011). Philip offers that teacher education programs must provide “scholarship that represents the pedagogy and purpose of teachers of color” (p. 365) from the segregated South and radicalized Black Panthers to help prospective Black teachers see their part in a larger history.

**Black Teachers in Professional Development Today**

Literature that explicitly focuses on the professional development of teachers of color (Pour-Khorshid, 2018) or more explicitly Black teachers (Mosely, 2018) is extremely limited. Both articles focus on sustaining, healing, and developing collective knowledge while engaging in racial affinity spaces for professional development. Specifically, Pour-Khorshid (2018) charges that racial affinity groups are needed for all educators who must “tend to unhealed
trauma caused by white supremacy, patriarchy, and other forms of oppression” to break the cycle of the “social toxicity” that occurs in schools (p. 326). Mosely (2018) also reports that “racial affinity-based professional development decreases isolation and increases retention for Black teachers” (p. 267).

Mosely (2018) shares that little is known about what supports are helpful to Black teachers as they navigate and respond to racialized experiences; instead, the literature mainly focuses on the racism Black teachers experience (Lynn, 2002; Kohli, 2018). In response, Mosely developed the Black Teacher Project (BTP) to support Black teachers in the San Francisco Bay Area and New York City. Through the racial affinity professional development in this program, teachers of various expertise reported that before the BTP professional development, they had not received the instructional support needed from their schools. Because they had strong relationships with students, they had felt silenced, and although they had leadership positions, they were showing signs of Racial Battle Fatigue (RBF). Racial Battle Fatigue involves psychophysiological symptoms, from high blood pressure to anxiety, frustration, shock, anger, and depression, that people of color may experience living in and navigating historically white spaces (Smith, 2004).

During and after the racial affinity spaces created in the BTP professional development, teachers shared that they were able to find support preparing for demanding teacher licensure exams, they learned techniques on how to respond to anti-Black behavior from white and non-Black parents (refusing to acknowledge them or questioning their intelligence when their child did not earn an A), and they learned how to teach their students better from participating in a book study (Mosely, 2018). To not lose Black teachers, professional development leaders must do more than teach a new instructional strategy. Professional development for Black teachers
means “allowing who they are, including their racial identity, to be brought into their professional learning environment in multiple ways” (p. 280).

**Black Teachers in Science Classrooms Today**

The literature that specifically focuses on the experiences, needs and, instructional practices has been blooming in the last decade. Some have zoomed in on the practices of “exemplary” or “successful” Black science teachers (Coats & Xu, 2013; Fraser-Abder, 2010; Xu et al, 2012a; Xu et al, 2012b), while others highlight the instructional practices (Madkins & McKinney de Royston, 2019; Mensah, 2009), motivations to teach (Morettini, 2017), challenges for accreditation (Davis, 2012), positional identities (Blackwell, 2012; Moore, 2008), and experiences and needs in professional development (Sherman-Morris et al., 2012). All these studies shared that Black science teachers demonstrate clarity about the impact their racial, cultural, and socioeconomic backgrounds have on their science identity and use that knowledge to make connections for their students.

Consciously or subconsciously, Black science teachers must consider their positional identity both in the science field and in the science classroom (Blackwell, 2012). Positional identity is one’s perception of themselves to others. Positional identity is influenced by race, gender, age, and socio-economic status (Blackwell, 2012; Moore, 2008). Black science teachers gain a sense of power by defying stereotypes that have no place in the science field. However, Black teachers do not thrive on holding power but instead, they view teaching to share power with their students (Blackwell, 2012). Due to their positionality, Black pre-service science teachers are “especially motivated to instill a sense of importance in the STEM discipline” and are readily able to name race as a motivating factor for teaching science, in comparison to white teachers (Morettini, 2017, p. 172).
Black science teachers view “teaching as a profession that was all-encompassing, where students and their lives are a top priority” (Fraser-Abder, 2010, p. 245). They have a wide range of strategies to meet the needs of all students which gives space for students to bring their full self to the classroom in a way they might not in another teachers’ classroom. Black science teachers demonstrate their political clarity or socio-political consciousness, a tenet typically ignored, while making their science instruction culturally relevant (Madkins & McKinney de Reston, 2019). Their findings show that Black science teachers “emphasize and utilize their students’ lived experiences in the science curriculum, they evidence their political clarity and more importantly, create spaces for powerful science teaching” (p. 1338). Moore (2008) argues that the strength and knowledge that Black teachers bring to the science classroom must be acknowledged. They need opportunities to “reflect on their personal experiences to critique both institutional and societal systems” (p. 701).

In schools, Black teachers must work harder to merge the goals of content-specific professional development and their pedagogy. Black science teachers can make analogies that connect their students’ realities to the science content. They use tools acquired in professional development to merge with their pedagogy, which is rooted in embracing the talents that their students bring to the classroom and beyond (Blackmon, 2005).

Xu et al. (2012a) provide an example of the magic that is possible when Black science teachers intentionally take the time to reflect on their personal experiences and transform their classrooms to critique structures that harm students. In their study, teachers exemplified Boykin’s afro-cultural ethos (Boykins, 1986) by providing their students space for “personal autonomy, uniqueness, and creativity by giving students the freedom” (p. 21) to choose topics they liked or wanted to know more about through homework. Black science teachers value
harmony by embracing the whole child. Their findings show that Black teachers emphasized
harmony by considering the unique position of science, merging writing and mathematical skills.
They viewed the science content to “develop the whole child and to integrate what they teach
with the other subjects as well as they can” (Xu et al, 2012, p. 21).

Science Education Today

In the context of science education, higher-order thinking is an imperative component of
the curriculum and practices in the classroom. In their argument for higher-order thinking,
practice-based assessments in science classrooms, Osborne (2014) summarizes that science
should be seen as:

...a set of practices whose goals are theory development, reasoning, and empirical inquiry
all of which are components of a larger ensemble of activities that include networks of
participants and institutions (Latour, 1999; Longino, 2002); specialized ways of talking
and writing (Bazerman, 1988); modeling, using either mechanical and mathematical
models or computer-based simulations (Nercessian, 2008); making predictive inferences;
constructing appropriate instrumentation; and developing representations of phenomena
(Latour, 1990; Lehrer & Schauble, 2006). (p. 271)

Across racial lines, it is common for science teachers to misalign the needs of procedural
and conceptual thinking in science classrooms (Engelbrecht et al., 2005). It is unfortunate but
true that students of color experience science teaching and learning that is different than their
white counterparts despite being interested in science (Atwater, 2000b; Brand et al., 2006;
Oakes, 1990; Tate, 2001). In science classrooms with Black students, science teaching is an
“endangered species” (Conderman, & Woods, 2008), where elementary science classrooms
rarely have science instruction (Berg & Mensah, 2016; Jeanpierre, 2004; Lee et al., 2007), and
secondary science classrooms have disparate access to learning technologies in the classroom (Atwater, 2000a; Lynch, 2000). As a result, Black and Brown students show lower interests in K-12 science classrooms (Brown, 2006; Hill, Pettus & Hedin, 1990), in STEM majors (Lent et al., 2011), and for the few who declare a STEM major, many students of color struggle to persist while in college (Green et al., 2019). In 2013, less than 2% of PhD-holding scientists were Black, reporting very little change since 1977 when this statistic was first introduced by the National Science Board (Mutegi, 2013). In 2017, the percentage of Black college graduates with STEM bachelor’s degrees was 12%, while 19% were white (NCES, 2019).

Recent critiques of science teaching of Black students show that science classrooms today use race neutrality to dismiss skepticism (Sheth, 2019), they ignore the distinct Black culture students bring into the classroom (Boutte et al., 2010), and in science classrooms, students are taught by teachers that view Black students as “inferior others” (Mutegi, 2013). In her study, Sheth (2019) finds that even when science teachers attempt to bring discussions of race into the classroom, they maintain colorblind science teaching because they are “not prepared to engage with students’ questions and ideas in race-conscious ways that validated the legitimate skepticism that students of color brought to science learning that examined the racialized dimensions of science and community relationships” (p. 51). Ignoring how racism plays a role in how Black science students engage with the content or ignoring the idea that doing science can be socially and politically situated displaces the reality of the students destroying a bridge between the student and the science field.

2.4 Theoretical Framework

Critical Race Theory
Disgruntled and unenthused by the all-white faculty and their irrelevant and watered-down classes, a few Black law students at Harvard Law in the late 1980s acted by first meeting with each other to identify what was missing from their experiences. They resoundingly found that the acknowledgment of race, racism, and power was missing in the cases their professors presented. Those cases routinely and drastically affected the lives of communities of color both in their day-to-day experiences and their mental welfare.

By 1989, that group of Black law students began to develop central themes to what was to be called Critical Race Theory. As they began to invite other law students to the table, the Critical Race Theorists started to understand that their origins were built “on the insights of two previous movements, critical legal studies and radical feminism” (Delgado & Stefancic, 2017, p. 5), and that despite celebrations of the Civil Rights movement before them, there was still plenty of work to be done. While the tenets of Critical Race Theory are not completely agreed upon by all CRT scholars, there are central tenets, such as interest convergence, colorblindness, the myth of meritocracy, and intersectionality that drive the thought process of all CRT scholars and their spin-off movements, such as LatCrit and critical white studies.

2.5 Critical Race Theory and Education

Critical Race Theory and its place in the system of schooling and education has been cemented by many scholars, led by the foundational work of Gloria Ladson-Billings and William F. Tate IV (1995) in their groundbreaking Toward a Critical Race Theory of Education article. They reported that an analysis of the effects gender and class has on poorly performing and marginalized groups paint an incomplete picture and is not enough to explain the state of education then and today. Education scholars must understand and root their work in the fact that racism is endemic and should be used as a tool in “the analysis of educational inequality” (p. 50).
Racism is endemic, meaning “deeply ingrained legally, culturally, and even psychologically” (p. 52), thus the cause of poverty experienced in the everyday lives of Black people and other marginalized groups work “in conjunction with the condition of their schools and schooling is institutional and structural racism” (p. 55).

In their analysis of the intersection between race and property, Ladson-Billings and Tate (1995) assert that the customs, norms, and practices of whiteness - that which white people alone possess - as a dominant ideology determine who has access to intellectual property through curriculum, public funding, and rights of disposition. Harris (1993) proposes that we might comprehend the paradox presented by public education—of inequality despite rights coupled with the continuation of racial exclusion despite juridical inclusion—through what she terms “whiteness as property”. Whiteness as property articulates the right to exclude others. The ways that American histories of colonial genocide and slavery are continually inscribed into “racially contingent forms of property and rights,” also are consistently supported by the right to exclude. Post-Brown the predicament of unequal resources for poor children of color has remained unchallenged and undisturbed, leaving disparate results in an already defeated battle against the high academic achievement levels of the White norm (Aggarwal, 2016).

The curriculum for children in affluent, white neighborhoods emphasizes critical thinking, reasoning, and logic (Kozol, 2012), giving space for the privilege of higher-order thinking and the ability to critique the world around them and to see themselves as intellectual beings. Unequal access to high-level courses and challenging curriculum, especially in fields like mathematics, science, and foreign language, explains another important component of the difference in achievement between students of color and white students (Pelavin & Kane, 1990). Darling-Hammond et al. (2007) argue that the No Child Left Behind (NCLB) federal mandate
created "drill and kill" classrooms, where students are “rarely allowed to talk about what they know, to read real books, conduct research, write extensively, or construct and solve novel problems,” leaving them ill-equipped with the skills workers need today, such as being “able to engage in independent analysis and problem solving, use new technologies, and access resources in new situations” (p. 291). Post-NCLB schools that mostly serve Black and Brown students continue to prioritize rote memorization and pressure to perform well on standardized assessments, inscribing lack of self-efficacy, test anxiety, and stereotype threat for Black and Brown students (Wasserberg & Rottman, 2016).

The property value of Black students and other marginalized groups in comparison to middle-class white students today shows a clear picture of the privileges of whiteness and its role in education. In her analysis of the role district, state, and federal funding places in the educational achievement of students of color, Ostrander (2015) reports: “We have seen that lower funded schools are often in low property tax areas with high minority [read Black and Brown] populations” which leads to “de facto segregation in schools through the finance structure” (p. 294). In addition, funding among school districts highlights the inequities of educational funding within individual states. Leonardo and Grubb (2014) explain that “local revenues for schooling depend heavily on the property tax, so that wealthy school districts” that are heavily populated by white residents “can afford to spend much more for schooling than property-poor districts can” (p. 106). Funding on the district, state, or federal level does not always tell the full picture. Looking at the resources provided to students also sheds light on the structural problem of education. Effective resources such as improving teacher salary to attract a larger pool of applicants, increasing teacher experience in secondary education, and having
access to counselors in Black and Brown high schools will improve the academic outcomes in marginalized areas (Leonardo & Grubb, 2014).

When students of color are critiqued for any form of expression outside of white norms, they are overly penalized for not conforming or assimilating. In schools when “students are rewarded for conformity to ‘white norms’” (Ladson-Billings, 1995, p. 59), they receive implicit and explicit messages about how their cultural practices are devalued and sometimes counter to the values needed to be successful academically. White property or whiteness alienates the everyday expressions of students of color when cultural practices such as “dress, speech patterns and unauthorized conceptions of knowledge” are sanctioned, increasing the policing of marginalized students (Ladson-Billings & Tate, 1995, p. 95). The disciplinary action not conforming to white norms in schools is dependent on the race of the student and the educator because “the disciplinary decision maker evaluates the behavior of the student within an existing framework of social meanings associated with the student’s racial category” (Simson, 2014, p. 533). Racial stigmas and certain performative racial assignments, such as accent, demeanor, dress, and phenotype, combined with a ‘zero tolerance’ school environment only harm marginalized students. In today’s classrooms, Black and Brown students are “left learning to merely survive, learning how schools mimic the world they live in thus making schools a training site for a life of exhaustion” (Love, 2019, p. 27).

2.6 Critical Race Theory in Science Teaching and Learning

Conversations and analysis of science and racism are ignored in the “pursuit of ‘value-neutral science’” (Harding, 1993, p. 11). In terms of science education, science teaching and learning has been historically accepted as an ahistorical, apolitical objective way of experiencing and knowing the natural world. The Next Generation Science Standards (NGSS) have
encouraged teachers to root scientific ideas and experiences of the students as a starting point to developing conceptual understanding of science (NGSS, 2013). There is currently a push for science education reform that incorporates new ways of teaching science that includes science and engineering practices and sense-making around scientific phenomena (Bybee, 2014). While rooting the ideas and experiences of students of color in science classrooms is a good idea, it is only a part of the solution. If the goal is to develop critical consciousness, critical science agency, and transformative learning in the classroom, more needs to be done for science teaching and learning.

Students of color are often discouraged from enjoying science (Bran et al., 2006), often because of the pedagogical practices that still maintain the white status quo and culture of power of Western Modern Science; thus, when science is taught in these ways, science maintains its culture of power as inclusive for some and exclusionary for most. In other words, “science as white property is a right for the possession, disposition, use and enjoyment for some and not for all” students (Mensah & Jackson, 2018, p. 9).

Critical race theory can be used as an analytic tool to reveal how science teachers choose how they apply science knowledge in their classrooms. A CRT analysis of science, science teaching, and science learning highlights that studies on race (Fish, 2001) and structural racism (Evans & Gusmano, 2021) have legitimized their superiority under the guise of science knowledge. Over 200 years ago, scientific research (also known as scientific racism) was used to prove that Black people were the inferior race, and today “depictions and characterizations of African Americans as intellectually inferior are ingrained in American society through the media and other social institutions” (Wallace & Brand, 2011, p. 343). Despite the ways science has been used to perpetuate racist ideologies, some teachers have found ways to use science
knowledge positively in their classrooms. According to Wallace and Brand (2011), critical race theorists themselves, ‘culturally responsive’ science teachers of Black students showed a critical awareness of the influence of societal construction of race. Their sociocultural awareness informed their perspectives of their students’ needs and behaviors, which yielded a positive learning environment for the Black students in the science classroom.

Many scholars have challenged the science for all rhetoric because it focuses only on inclusion and has little promise of change through action (Bang & Medin, 2010; Barton, 1998; Bryan & Atwater, 2002; Mutegi, 2011) while continuing to erase the realities of race, racism, and power (Sheth, 2019). Critical race theorists highlight the damage colorblind, universalistic, and individualistic ideologies have in the erasure of the experiences and knowledge of historically marginalized people. Sheth (2019) used CRT to critique colorblind practices in science classrooms. She found that her participants who attempted to make connections to relevant experiences of their students of color only flattened those experiences of racism. For instance, a participant in her study created a space for her Black female students to connect their experiences with hair as an entry point to a lecture about protein structure and function in their biology class. In her attempt, the white teacher asked her mostly Black and Asian science students, “Who has gotten a perm?”, when a Black female student asked, “Are you talking about you or Black people?”, and the teacher responded by saying, “Same end. I know when I get a perm my hair gets curly, when you go to get a perm, your hair gets straight. The result is the same. You are changing the shape of your hair.” In this instance the teacher was able to spark the interest of her students but was not willing or “ready to attend to and critically examine ideas of race and racism embedded in students’ experiences of hair variation, focused on the sameness of the phenomenon to push standard science teaching learning forward” (p. 45). Unfortunately, the
reluctance of the teachers in the study to “grapple with racism served to flatten the ideas and experiences of Students of Color, as members of communities of color with particularly historically contingent racialized experiences with science” (p. 53). Likewise, Milner (2017) discussed the erasure of race and racism from the widely used Culturally Relevant Pedagogy (Ladson-Billings, 1995) and the need to re-center and re-emphasize race to support students of color and provide them with “educational opportunities that address and build on their many strengths” which will ultimately “support students with tools to improve their communities for the benefit of mankind” (p. 24).

Critical race theorists acknowledge the need for and importance of counter-storytelling as a method to eradicate the damage of racism and the notion of ‘science as white property’ (Mensah & Jackson, 2018). Specifically, the curriculum, structure, pedagogy, and underlying philosophy of science education courses must challenge dominant perspectives that determine who science is for, who should teach science, and who gets to become a scientist (Gunning & Mensah, 2010). When science teacher education courses include curricula with multicultural approaches to teaching and learning, science teachers of color can view themselves as scientists with a place in science. This affirmation “highlights the importance of naming one’s reality, transforming one’s views, constructing knowledge for oneself, and moving toward more equitable learning experiences, which are key themes of CRT” (Mensah & Jackson, 2018, p. 28).

The mere presence of historically excluded groups in science education, such as Black women, is not enough if the complexity of their experiences and philosophies is not the center of their development. A Critical Race Theory approach to analyzing the professional development and teacher education of Black women science teachers can highlight how the past experiences
of the teacher inform their current practice and how to conceive of their personal and professional goals in the future (Moore, 2007). Black women science teachers need spaces to analyze how dominant ideologies influence and construct their educational experiences in science classrooms, how their voices and experiences are showcased in their K-12 and college experiences, and how dominant ideologies show up in their current classrooms. Allowing space for them to reflect on how their perceptions of science are constructed is also needed, and whether they agree with that philosophy and how they would like to shift their practices to better align with their pedagogy and the needs of their students and their community are also needed.

Critical race theorists disrupt liberal ideologies of individuals and the myth of meritocracy. In science teaching, CRT is needed to tackle low numbers of Black people in science college majors, science doctoral programs, and different science fields. A CRT approach to considering the racialized experiences of science persistence in K-12 and college classrooms helps us understand why Black and Brown students are failing in these spaces. Learning from the narratives of the few Black science professions that exist can support the fact that meritocracy and liberalism are a myth, and its continuation is detrimental to the progression of all marginalized groups.

2.7 Black Feminist Thought

Black Feminist Thought, which is a manifestation of the groundbreaking works of Toni Cade Bambara, Barbara Christian, Ntozake Shange, Angela Davis, Toni Morrison, June Jordan, Alice Walker, Audre Lorde, and other Black women scholars of the 1970s is the second theoretical framework for this doctoral study. Chapter 4 will discuss Womanist Pedagogy as a theoretical framework, so readers need to understand that all of these terms (Black feminism, womanism, and womanist pedagogy) fit under the Black Feminist Thought umbrella term. I pull
heavily from the work of Patricia Hill Collins as she has a robust record of literature that details the history of Black women scholars’ work and how we self-define. Her work has continuously been used to influence trailblazing research about Intersectionality, such as Vivian May (2015) and Kimberle Crenshaw (1989), which also fits within the work of Black women’s scholarship of today.

During the 1980s and 1990s Black women scholars found themselves needing to make an intellectual decision about which terms (Black feminism or womanism), if either, encompassed the diversity of thought and realities of Black women (Hill Collins, 1996), it seems as though there was no clear resolve for all Black women which demonstrates the complexity and nuances within the Black female experience. For this study, Black Feminism (used broadly in the 1970s to distinguish itself from white feminism) and Womanism (coined by Alice Walker in 1983) are terms that both fit under the Black Feminist Thought umbrella and are used interchangeably.

**Black Feminism or Womanism?**

In a long-standing history of Black women scholars in the quest to self-define, Alice Walker’s multiple definitions of *womanism* highlight “why many Black women prefer *womanism* to *Black feminism*” (Hill Collins, 1998, p. 62). The key difference for Black women scholars can be captured in the history of the terms although the overarching goals are the same. Womanism is rooted in Black national traditions, including but not limited to, the idea that Black and white people cannot function as equals while existing in the same territory or participating with the same institution (Van Deburg, 1992). Womanism simultaneously focuses on the needs of Black women to have a voice and power in the quest for Black liberation. For this reason, some Black women cling to the womanist term to ensure that roots in the liberation of Black men and Black women are clearly stated. Shirley Williams (1990) takes this view when she notes that
in contrast to feminism, “womanist inquiry … assumes that it can talk both effectively and productively about men” (p. 70). Womanism seemingly supplies a way for Black women to address gender oppression without attacking Black men. Large numbers of Black women reject the term "feminism" and consequently prefer womanism as opposed to Black feminism because of what they perceive as its association with whiteness (Hill Collins, 1996). More recently, Black feminism has shed its past ties to white feminism and fits in discussions about transnational feminism which opposes the colonial form of globalization, capitalism, and genocide on a global scale (Hong, 2008; Omi & Winant, 2014). In that vein, “global feminism is to reach out and join global struggles to end sexism, sexist exploitation, and oppression (hooks, 2000, p. 47). Below I share the tenets of Black Feminism and Womanism to add to the argument that the two ideas are similar enough to serve the same purposes in praxis and research for Black women researchers today.

In its introduction to the academic world, Black Feminism was used as a knowledge project that stemmed from the social, cultural, and political realities of Black women, thus informing the same for other groups of color within America and beyond (Hill Collins, 2015). There are three key themes in Black Feminism (Hill Collins, 2000). First, the framework is constructed and formed by the experiences Black women have encountered in their lives. Second, while the stories and experiences of each woman are unique, there are intersections of experiences between and among Black women. Third, although commonalities do exist among Black women, the diversity of sexual orientation, religion, age, and a class of Black women as a group are multiple, and conditions from which their experiences can be declared and known are still different and similar. These themes may not become apparent to Black women initially, so one role of “Black female intellectuals is to produce facts and theories about the Black female
experience that will clarify a Black woman’s standpoint for Black women” (Hill Collins, 2000, p. 469).

Similarly, three central points support womanism as standpoint epistemology. First, womanists understand that oppression operates as an interlocking system that affords all people different levels of privilege and punishment. Second, womanists believe social transformation is achieved when individual empowerment is combined with collective action. Lastly, they seek liberation of all, not simply themselves (Hill Collins, 2000). Womanist epistemology allows for a more nuanced and complicated understanding of how institutionalized racism, classism, and sexism contributed to the disenfranchisement and oppression of Black people in education during the Jim Crow era (Johnson, 2009). Womanism “also centers on how womanist African American women educators developed pedagogies that were aimed to subvert the educational policies and practices that negatively impacted the lives and academic experiences of their students” (Johnson, 2017, p. 51).

**Black Feminist Thought in Science Education**

One of the overarching purposes of Black feminist thought is to resist oppression by building a community with Black women to embrace differences and similarities (Parsons & Mensah, 2010; Hill Collins, 2002). In the science classroom, oppression has many faces. Voicing the creativity and thoughts of Black women science teachers is imperative to dismantle the oppressive nature of the field. Intersectionality, a concept tethered to Black Feminist Thought (Nash, 2019), is a defining component of Hill Collins’ (1999) “matrix of domination” which argues that people experience and resist the interconnected systems of oppression on a personal, community, and system level.
Black Feminist Thought as a theoretical framework stem from the notion that its focal point is the value of storytelling as a methodology. Privileging the voices of Black women helps to develop a self-defined and shared perspective from Black women in creating models of teacher education versus the values of the White, dominant culture. Black Feminist Thought positions Black women to share their counternarratives while also revealing that all Black women’s experiences are not the same. Parsons and Mensah (2010) testified to the reality that while they shared common experiences and challenges as Black women in science education, they were not the same in how they chose to tackle their challenges in similar situations. In this instance, they “exemplify the collectivity and homogeneity domains of the collectivity-individuality and homogeneity-heterogeneity dialectics of Black feminist thought” (p. 23). Yet and still, the notion that Black women can come together collectively with a shared expression of identity while having unique histories and conceptualizations of how they would like to tackle their challenges still makes this proposed study plausible.

In her dissertation, Dr. Olayinka Mohorn (2021) used Black Feminist Thought as a theoretical framework to “illuminate Black female science teachers’ experiences that promoted science teacher identity development, as well as highlight those serving as barriers to science identity development” (p. 39). She reported that Black women science teachers taught content but also shared experiential knowledge with their students which disrupted systems of oppression and exclusion from science which granted “students new opportunities to do science and see themselves as practitioners of science” (p. 116). Black Feminist Thought as a theoretical lens helps clarify how Black women science teachers use their praxis as a way to dismantle multiple systems of oppression for future generations.
Chapter III: Methodology

“Black women interested in the lives of Black women, have much, herstorical, theoretical, and practical knowledge to contribute to contemporary qualitative and discourse.” (Venus Evans-Winters, 2019, p. 14)

Intersectional feminist methodology (discussed in-depth below) was used to research with Black female secondary science teachers around their pedagogical practices and experiences in teacher education and at their schools. This methodology was included in my approach to data collection, data analysis and, presentation of the findings of the study. The narratives and experiences of the participants are at the center of this study to honor their counter-stories and value their experiences. This practice is following narrative research when the researcher has a critical lens that shows how women’s voices are muted, multiples, and contradictory (Chase, 2005). Drawing from a Black feminist tradition, storytelling about these experiences became the main mode of data collection, and data analysis actively involved the participants in the interpretation and meaning-making process (Hill Collins, 2000).

3.1 Research Design

Narrative Research

To understand the lived experiences of the Black women science teachers and hold to the goals of critical research methods, narrative research was chosen to represent a method of qualitative research that “begins with the experiences as expressed in lived and told stories of individuals” (Creswell & Poth, 2018, p. 67). Thus, a qualitative research method gives an account of teachers’ experiential knowledge. Connelly and Clandinin (1990) built on Dewey’s (1938) understanding of experiences and began to “use his ideas to think about teacher knowledge that was personal, practical, shaped by and expressed in, practice” (Clandinin, 2019, p. 212). Specifically, I chose narrative. Narrative “is the study of the ways humans experience
Empowering relationships are possible within the narrative research process when the researcher builds a research relationship that involves “feelings of connectedness that are developed in situations of equality, caring, and mutual purpose and intention” (Hogan, 1988, p. 12). With that said, when working with communities that have been historically silenced, such as participants in this study, it is recognized that “practitioners have experienced themselves as without voice in the research process” (Connelly & Clandinin, 1990, p. 4), and might be reluctant to share or feel empowered. The researcher and participant should engage in a process of collaboration, “including mutual storytelling” as the research proceeds (Connelly & Clandinin, 1990).

One aspect of narrative inquiry that separates it from other qualitative methods is the emphasis on sequencing a narrative into chronological events (Cortazzi, 1994). A process of ‘restorying’ is conducted after a narrative is shared, and restorying allows the researcher to organize a participant’s stories into a chronological sequence and to analyze the events for key elements of the story (Creswell, 2007). Beyond the chronology of the story, a narrative researcher should detail themes that emerge from the story to provide a more detailed discussion of the meaning of the story (Huber & Whelan, 1999) while also engaging again with the participant after the initial interview.

## 3.2 Intersectional Feminist Methodology

The theoretical contributions of Black feminist scholarship since the 19th century, particularly intersectionality (May, 2015), have transformed social research (Rice et al., 2019). Intersectionality, coined by Kimberle Crenshaw in 1989, is heuristic in nature, serving to point out the ‘matrix of domination (Hill Collins, 2000) experienced in the everyday lives of marginalized groups to foster social transformation through change. To honor the overlapping
and dynamic nature of intersectionality, intersectionality scholars such as Vivian May (2015) hesitate to provide a single definition to express the essence of intersectionality.

Intersectionality is also an analytic tool used to “amplify and highlight specific problems, particularly by drawing attention to dynamics that are constitutive but generally overlooked and silenced” (Crenshaw, 2011, p. 232). Intersectionality counters single-axis ways of knowing, the belief that race, class, gender, sexuality, and other social markers are experienced or oppressed by systemic oppression separately. Instead, a straight, Black woman experiences gendered racism daily; those identity markers are not separated. Intersectionality provides a “both/and” tool to build knowledge around and to fight against the multiple ways (within and outside of their group) marginalized groups are disenfranchised. Rice et al. (2019) argue that there are two ethical criteria to truly encompass intersectional research; the researcher must (1) respect and cite the radical roots of intersectionality, or Black feminist theorist to honor its genealogy, and (2) engage in research practices that disrupt the political status quo.

The theoretical contributions of Black feminist scholarship have led to the development of a methodological approach that begins with the experiences of groups that occupy multiple social locations and find approaches and ideas that focus on the complexity rather than the singularity of human experience” (Dill & Zambrana, 2009, p. 2). An intersectional feminist methodology pays attention to “the different and sometimes contradictory or unexpected ways in which race, gender, social class, national origin, marital status, employment, and other social categories manifest themselves in narratives of lived experience” (Hamilton, 2019, p. 3). An intersectional feminist methodology also requires reflexivity of the researcher and demands a “reconceptualization of power” that highlights its complex “constraining and productive function” (Rice et al., 2019, p. 414).
Overview of the Methods and Methodology

This chapter is organized to provide a general overview of the methods and methodology used in this doctoral study. The following sections are abbreviated and discussed in further detail in the two findings chapters (Chapter IV and Chapter V). In this chapter, I discuss how participants were recruited and categorized before providing a preview of the data collection and data analysis process. The reliability and validity of the dissertation are discussed and connected to intersectional feminist methodology.

3.3 Setting and Participants

All data for this dissertation was collected virtually. This study was conducted using the Zoom software in response to the COVID-19 global pandemic. Originally, I was planning to engage with participants for in-person one-on-one interviews and Sista Circles, but the realities of the pandemic encouraged me to open up the study to include any Black women science teachers within and outside of New York City who were willing to participate in Zoom data collection sessions. There were concerns in conducting the Sista Circles virtually. The Sista Circles for this study were conceptualized based on the “At the kitchen table: Black women English educators speaking our truth” study by Haddix et al. (2016) study which honored the distinct and unique linguistic practices of Black women. While the Haddix et al. study was also conducted virtually, the women were friends before the study, and displaying vulnerability may have been more easily accomplished.

Due to the muting function and culture norms (i.e., communicate only when ‘off mute’) in the Zoom platform, I was concerned that the ways that participants implicitly shared agreement or dissonance (shaking heads, eye contact, verbal interjections such as “mmhmm”) would be lost. The linguistic traditions of Black women transcended the virtual space where the
participants would use the chat feature of Zoom to respond while others were speaking and consistently added to each other’s comments both verbally and in writing. For this study, I video recorded the Zoom chat and transcribed the video (discussed later).

This study consisted of 32 Black women science teachers (See Table 1, pp. 65-66). Pseudonyms for all participants were developed for this study. This study organized participants based on years of K-12 secondary science teaching experience. There are four categories of participants: Novice (0-4 years), n=8; Veteran (5-14 years), n=10; Elders (15 or more years), n=7; and Post-Service (no longer teaching with at least 8 years of K-12 teaching), n=7. This dissertation includes 240 years of combined teaching experience among the participants. The most novice of the participants was Whitney Nash who just ended her first year of teaching at the time of her one-on-one interview, and the most senior in-service teacher was Dr. Zubaidat Evans who just ended 21 years of teaching. To support readability, participants’ pseudonyms match their categories. For example, Jahnay Noble has a last name that begins with ‘N’ to signify being a novice teacher and Ariel Valdez has a last name that begins with ‘V’ to signify being a veteran teacher. This nomenclature is used throughout the entire document.

**Data Sources and Data Analysis**

This study included three separate stages of data collection: the Pre-Interview Survey, which consisted of a Qualtrics Likert scale questionnaire with two open-ended questions (Appendix A), the One-on-One Interviews (Appendix B), and the Sista Circles (Appendix C). The Qualtrics Likert scale was sent out as a recruitment tool after Institutional Review Board (IRB) approval in July 2020. The time to return the survey ended in September 2020. The one-on-one interviews were conducted between September 2020 and October 2020, concluding with Sista Circles occurring in October 2020 and November 2020. The data collected for the pre-
interview surveys and the one-on-one interviews are reported in Chapter 4, and the data for the Sista Circles are reported in Chapter 5.

Thirty-two Black women science teachers across the United States, Canada, and Qatar responded to the pre-interview survey which included responses to a Likert scale questionnaire on Womanist Pedagogy (Beauchoeuf-Lafontant, 2002), and two open-ended questions. The pre-interview survey was created with the Qualtrics software, a service provided by the university to collect survey data. The survey was available at the URL https://tccolumbia.qualtrics.com/jfe/form/SV_cNCHFiTPJn8pHeZ. I sent out a flyer with the link to the survey, which was sent through direct email, social networks, and professional associations.

Although all 32 participants agreed to participate in the study, 21 one-on-one interviews were successfully scheduled and completed (See Table 1). All 21 of the one-on-one interviews were conducted using the Zoom software and lasted between 1-2 hours each. Womanist Pedagogy (Beauchoeuf-Lafontant, 2002) was used as the theoretical framework when coding the pre-interview survey and one-on-one interview survey data.

After all the one-on-one interviews were completed, three separate Sista Circles were conducted via Zoom. Of the 21 participants from the one-on-one interviews, 18 Black women science teachers (Table 3) participated in the Sista Circles (more details are found in Chapter 5). Dr. Felicia Moore Mensah attended each of the Sista Circles as a research participant. As a post-service Black women science teacher herself, she engaged a researcher-participant by both asking questions of the other participants and sharing her narrative in the Sista Circles. Three conceptual frameworks were used to code the Sista Circle data; liberatory pedagogy (hooks,
The Zoom recordings from the interviews and Sista Circles were recorded for data collection and the transcriptions were analyzed using the Google Docs and OneNote software. I stored all of the transcripts in Google Docs using the comment feature to make initial codes for all of the data. After all transcripts were read and coded, I moved responses to pre-selected interview questions to OneNote to continue the coding process to search for themes. In OneNote I organized responses based on interview questions and professional status.

3.4 Reliability and Validity

My role as the researcher was in a researcher-participant position, I facilitated the space by asking questions while also engaging when the participants in sharing my narrative (Guba & Lincoln, 1981). In Sista Circles and discussions, I must remain true to my personal history as it connects to the experiences and narratives of the participants while allowing the participants to share their stories first.

To speak to elements of rigor (Merriam, 2009), I followed qualitative researchers who routinely employ member checking, triangulation, thick description, peer reviews, and external audits. Researchers engage in one or more of these procedures and report results in their investigation (Creswell & Miller, 2000). It was imperative that the voices of the participants guided data collections and that the findings and implications of this study were grounded in the participants’ lived experiences. As mentioned earlier this study was analyzed using an intersectional feminist lens meaning the researcher must (1) respect and cite the radical roots of intersectionality, or Black feminist theorist honors its genealogy, and (2) engage in research practices that disrupt the political status quo. Both findings chapters utilize the work of Black
feminist scholars to make meaning of the data, also by engaging in Sista Circles, this is, in essence, a political act because it prioritizes the voices of the historically silenced, Black women who have existed in the margins of science education. Lastly, I used intersectional feminist methodology both while asking participants to consider how their interlocking identity markers (such as race, gender, and class) affected their narratives, and I used an intersectional lens when coding data by considering how the overlapping identities (typically being Black and female) influenced each participants’ experience in science education.

The findings chapters are organized as two stand-alone papers in which one (Chapter 4) focuses on addressing the first research question of this dissertation study. The findings and analyses are based on the pre-interview surveys and one-on-one interviews. It describes the experiences of Black women science teachers and how Womanist Pedagogy (Beauboeuf-Lafontant, 2002) comes to life. This chapter focuses on how Womanist Pedagogy is exemplified in Black women science teachers’ classrooms.

The second findings chapter (Chapter 5) addresses the second research question. It is dedicated to the findings from the three Sista Circles. The chapter focuses on how the participants discuss anti-racist teaching in their science classrooms as described in three theoretical frameworks: liberatory pedagogy (hooks, 1994); Historically Responsive Literacy (Muhammad, 2000); and Culturally Relevant Pedagogy (Ladson-Billings, 1994).
Chapter IV: Womanist Pedagogy and Black Women’s Science

Teaching

Abstract

Racism, sexism, and classism at the societal level permeate throughout all levels of education, and conversely, schooling processes reproduce social inequality. These inequities are compounded by the objective, apolitical approach that Black women teachers bring to science teaching and learning. Research shows that Black female teachers continue to be more comfortable and committed to working in schools with Black and Brown students. The Black womanist approach to teaching is both methodical and improvisational. This study presents both quantitative data (n=32) and qualitative (n=21) exploring how Black women science teachers at various levels of expertise discuss and practice Womanist Pedagogy. I argue that Black women science teachers would benefit greatly from learning about the pedagogical practices of Black women teachers from the past, learning that they are not alone in the fight for classrooms built with love and informed by their lived racialized, classed, and gendered experiences. The tenets of Womanist Pedagogy can be used as a tool to showcase the power Black women bring to the science education community.

Keywords: Womanist Pedagogy, Black women teachers, science education
4.1 Introduction

Racism, sexism, and classism at the societal level permeate throughout all levels of education, and conversely, schooling processes reproduce social inequality. These inequities are compounded by the objective, apolitical approach that some teachers bring to science teaching and learning. Students and teachers of color are systematically excluded from enjoying and using science (Brand et al., 2006), often because of the pedagogical practices that still maintain the culture of power of Western Modern Science, such as western “legacy of images that typify the scientists and mathematicians as a white, male, and Eurocentric” (p. 235). Thus, when science is taught in ways that reinforce the social construction that scientists are not people of color or that scientists of color must lose a part of their cultural identity (Brown, 2004), science maintains its culture of power as inclusive for some and exclusionary for most. In other words, “science as white property is a right for the possession, disposition, use and enjoyment for some and not for all” (Mensah & Jackson, 2018, p. 9).

Research shows that Black female teachers continue to be more comfortable and committed to working in schools with Black and Brown students (Fitchett et al., 2017). We continue to impact racially minoritized students through pedagogies of care, other-mothering (Dixson, 2003), counseling (Dixson & Dingus, 2008), and mentorship (Gist et al, 2018). Black women teachers demonstrate their commitment to Black and Brown students when they have challenged school-based peers and supervisors to “challenge their deficit perspectives of minoritized communities” (Stanley, 2020, p. 14).

The Black womanist approach to teaching is both methodical and “improvisational as it responds to the divergent needs of Black youth and seeks to cultivate their diverse brilliance and senses of belonging” (McKinney de Royston, 2020, p. 382). The Black womanist approach to
teaching describes the way Black women teachers bring deep intellectual thought to their lessons while also leaving space in their practice to adapt to the needs of the students in front of them. This ability to bring academic rigor, a culturally specific context to their subject matter, and remain open to shifting lessons based on the relationships built between the students in the classroom is a specific approach to Black women’s teaching (McKinney de Royston, 2020).

Womanist teachers are deeply connected to “their identity as political beings who make parallels between schooling and society, school practices and social reality” (Beauboeuf-Lafontant, 2002, p. 77). Since teaching is rooted in the socio-political reality of Black women teachers, they bring a socio-political consciousness to their classroom practices and their curriculum. Black women teachers are specially positioned to demonstrate the methodical and improvisational approach necessary to encourage future generations of students from all backgrounds, but especially racialized and marginalized students, in science classrooms.

Womanist Pedagogy, as conceptualized by Tamara Beauboeuf-Lafontant (2002), has three tenets—caring/embrace of the maternal, political clarity, and ethic of risk—that give language to what Black women teachers have historically brought to education. These three tenets drive this study, both as a theoretical framework and an approach to building common language amongst the Black women science teachers involved. The levels at which the 32 women involved in this study discussed their ability to display caring, political clarity, and an ethic of risk in their practice is a testament to Beauboeuf-Lafontant’s work (2002), and its place in science education.

Instead of reading mostly about the mass exodus and lack of retention of Black teachers collectively, I add to the research that elevates their voices. Specifically, in the realm of science education, I engaged in the epistemological process of learning from Black women science
teachers while highlighting their assets as science-content experts, hearing their narratives, and learning from their experiences. One of the goals of this study was to “present stories of Black science teachers and contextualize their stories within a content-specific domain” (Mensah, 2009, p. 47). Historically, Black teachers have been studied for their practices in the classroom, specifically surrounding classroom management (Bristol & Mentor, 2018; Griffin & Tackie, 2016), but it is also necessary to honor and learn from how Black science teachers have been able to make the content relatable to all of their students, and how they have been able to play a significant part in the expansion of future scientists of color. The stories were presented to both situate the pedagogical practices of Black women science teachers within the larger tradition of Black women teaching and to inform the curricular and instructional practices of the larger science education community. Womanist Pedagogy gives science education a chance to better understand what Black women science teachers bring to the field and also gives a common language for Black women science teachers who have found themselves teaching as an ‘outsider within’ (Hill Collins, 2000) the margins of science education (Mensah, 2019). This study includes the narratives and educational journeys of Black women science teachers with 1-21 years of teaching experience. With this goal in mind, one research question guided this study:

How do Black women science teachers at various levels of experience discuss and practice Womanist Pedagogy?

4.2 Literature Review

The Historical Pedagogical Beliefs of Anna Julia Cooper and Septima Clark

“We might as well expect to grow trees from leaves as hope to build up a civilization or a manhood without taking into consideration our women and the home life made by them. Let our girls feel that we expect something more of them than that they merely look pretty and appear well in society. Teach them that there is a race with special needs which they and only they can help; that the world needs and is already asking for their trained, efficient forces.” (Anna Julia Cooper)
It is important to know our history and to honor the fact that Black feminist ideologies have been ingrained in Black education in America since enslavement. The legacy of Black women in education and their role in leading social movements in American history is a hidden treasure that shall shed light on future generations of Black women teachers and educators. As examples of Black women who operated within Black feminist or womanist beliefs, I highlight the history of two pioneers: Anna Julia Cooper (1859 - 1964) and Septima Poinsette Clark (1889 - 1987). It is important to learn from Cooper and Clark in particular because of their position in history, teaching during the de jure segregation era. To both empower and dismantle the educational inequities their students experienced “in a highly racialized, violent, and repressive social order” (p. 49), Cooper and Clark developed what Johnson (2017) calls a ‘womanist anti-oppressionist’ teaching pedagogical practices (p. 50). Cooper and Clark displayed a womanist anti-oppressionist perspective by raising their voice against anti-Black racism and remaining politically active in the fight for equal educational access for Black people. It is important to understand how these two women conceptualized race and racism in education during the segregated Jim Crow era, especially since now some of those conditions of segregation have remained for Black teachers and students of color (Tatum, 2007).

As a theoretical perspective, womanism draws on the “critical thoughts and activism regarding oppression and resistance to oppression” (p. 51) that teachers of today use as a pillar of pedagogy development (Johnson, 2017). Womanist epistemology centers on the way that Black women developed their teaching pedagogy to eradicate racist, educational practices that negatively affected their students (Beauboeuf-Lafontant, 2002). Womanist Pedagogy “provides insight into approaches educators can take to create connections with students that are responsive to their material lives” and helps them find purpose and foundation in their future educational
and professional pursuits (Watson, 2019, p. 369). Womanist pedagogy has been exemplified by Black women teachers throughout history (Patterson et al., 2011; Ramsey, 2012). As womanist anti-oppressionist educators, both Cooper and Clark were committed to fighting against racial oppression and saw education as a tool to liberate Black people from racial subjugation.

**Anna Julia Cooper**

Anna Julia Cooper, born in 1859, a product of rape, was born enslaved in the rural South and hoped for freedom and full rights at the closing of the Civil War. She, her mother, and her siblings like many newly freed people were intellectually excited by the personal freedom that literacy and education could offer them. During the Reconstruction Era, formerly enslaved parents, like Cooper’s mother, sought out education for their children because they believed it could “remove the vestiges of slavery, illiteracy, and powerlessness” (Johnson, 2017, p. 53). And it is clear by Cooper’s womanist anti-oppressionist ideologies and actions, such as when she opened a school rooted in self-empowerment and liberation in DC that challenged the inferior curriculum typically provided to Black students in segregated schools, that she agreed (Johnson, 2017). By 1884, Cooper had earned a college degree from Oberlin College (now University) and had formally developed her philosophy on race, education, and the need for racial justice. By this time, unfortunately, the promises of freedom saw the true face of institutionalized racism, lynching, removal of the political right, and segregated public facilities started to become commonplace. Cooper believed that anti-oppressionist education was the way to challenge racism for the elevation of Black people during these turbulent times.

Cooper was an educator for 57 years and was celebrated as someone who instilled “intellectual scholarship, racial pride, and self-actualization” in her students (Johnson, 2017, p. 59). As a womanist, anti-oppressionist educator, Cooper was also known for her scathing critique
of segregated schools that provided an inferior curriculum to Black students. It was believed that Black people should only be trained for a life of servitude. However, Cooper believed that learning for Black children should inspire critical thinking and intellectual freedom. During her time as a principal in Washington, D.C., she made strides to ensure that her school was an exception to ideas of Black inferiority (Lemert & Bhan, 1998), and instead offered classes such as classical arts courses and a standardized curriculum, thus teaching against the white segregationist school districts that thought she should dumb-down her curriculum. Before eventually being fired, her fight for education resulted in her students gaining admittance to prestigious universities. Her students would go on to use their education to become prominent figures in the Black community after attending schools such as Harvard University, Brown University, Oberlin College, Yale University, Amherst College, Dartmouth University, and Radcliffe College (Swain, 2016).

**Septima Clark**

Septima Clark was born in 1898 and 40 years after Cooper. She was born in South Carolina under the legal racial segregation sanctioned by the Supreme Court’s *Plessy v. Ferguson* decision to implement the “separate, but equal” dictum. Not only was separation a method of systemic racism of the time, but with the passing of *Williams v. Mississippi* by the Supreme Court, southern states also were allowed to require Black people to take literacy tests to demonstrate knowledge of minute details of the U.S. Constitution to discourage them from voting.

Born to a formerly enslaved illiterate father, Clark’s family surpassed insurmountable odds to ensure that Clark went to a private, Black college preparatory and normal school in 1913. Her formative schooling experiences there influenced her womanist, anti-oppressionist theories
and her fight to use her knowledge about race, class, and education to eradicate racial
domination. A student of John Dewey, she believed that students learn best when they are
actively involved in the learning process because they learn by doing (Dewey, 1956). Her
experiences and this educational philosophy would guide her journey to use education to uplift
her race.

Both Cooper and Clark received an education from their families and their schools that
instilled in them a commitment to an ethic of socially responsible individualism (Shaw, 1996),
which is “a belief that their education was not just for their own individual development, but one
in which they had a social obligation to their students” and the Black community (Johnson, 2017,
p. 56). As teachers and writers, Cooper and Clark were extremely vocal about fighting against
the racial violence they witnessed personally. Cooper wrote a book in 1892 detailing critical
views of race in America while Clark used her writing to urge Black people to fight and
document their experiences with white racial oppression and institutionalized racism.

Most recognized for her womanist anti-oppressionist work as an adult literacy activist
during the Civil Rights Movement, Clark was in the field of education for 60 years. In the
schools that Clark helped build and fought to establish, thousands of southern Black adults
learned to read, write, comprehend the voting process, and study citizenship. Black voting power
against the state-sanctioned de jure segregation voting structure dramatically increased because
of Clark’s fight and organizing.

As a budding teacher, Clark started to teach in Johns Island, an extremely isolated island
off the coast of South Carolina at the tender age of 18. Clark taught descendants of enslaved
Africans from Sierra Leone and Liberia. Known as the Gullah people, this community lived in
horrific conditions as sharecroppers were forced to work and live in unsafe agricultural fields
which left little to no room for children to learn to read and write. While teaching the Gullah people, she “co-taught 132 students ranging from 5 years to 18 years old in a creosoted black two-room shack with no glass windowpanes” (Johnson, 2017, p. 63). This teaching experience struck an emotional chord with Clark, where she continued to build her awareness of the intersecting politics of race and class oppression. Clark took her rage and knowledge and began to engage in anti-oppressionist education work.

Clark’s pedagogical practices were rooted in honoring, celebrating, and uplifting the culture of her students and the community she served. Her awareness of the Gullah language and traditions informed her teaching strategies such as “cooperative learning, and other student-centered activities that acknowledged, valued, and built upon her students’ Gullah culture and language as a means to teach and empower them” while teaching American Standard English simultaneously (Johnson, 2017, p. 64). To eliminate the confusion students experienced while trying to become academically successful, Clark used aspects of the Gullah language while teaching to help students make connections to the curriculum. The curriculum she developed was also built with specific cultural norms that her students experienced daily. In this way, Clark viewed the Gullah language and traditions as an attribute to her curriculum and classroom practices. Clark’s pedagogical beliefs are best expressed by herself:

Education is my big priority right now. I want people to see children as human beings and not to think of the money that it costs nor to think of the amount of time that it will take, but to think of the lives that can be developed into Americans who will redeem the soul of America and will really make America a great country. (Stokes-Brown, 1986, p. 121)
Teaching during the Jim Crow *de jure* segregation era, Cooper and Clark brought their familial history and childhood experiences to their classrooms. The lives of their students and communities continued to inform their womanist anti-oppressionist teaching practices and curriculum, they explicitly challenged institutional racism by empowering their students with critical thinking skills, self-empowerment, and knowledge. Fighting to eradicate political oppression based on race and class, both Cooper and Clark sought to use education to gain social power in an unjust, racialized society.

From the historical narratives of Anna Julia Cooper and Septima Clark, we learn how their womanist anti-oppressionist approach to teaching helped transform the lives of their Black students during *de jure* segregation. Both Cooper and Clark found ways to use their political beliefs as an avenue for teaching and community uplift, by radicalizing the schooling system in their area, involving key stakeholders in the community, and amercing themselves in the cultural practices they were in service of. As America’s political climate arguably remains the same in terms of racial tensions and segregation, the education community should be honored to learn about how these two women inspired collective action and Black excellence despite governmental and everyday adversity. All educators, but especially Black women educators should see the examples of Anna Julia Cooper and Septima Clark as an example of what is possible and necessary for our students of the present and the future.

**Black Women Mentoring Networks**

Countering the negative portrayals of Black women teachers in the literature, Foster (1991) and Siddle-Walker (1996) used life histories to share the positive teaching practices and philosophies of Black women teachers. According to Foster’s work (1991), Black women teachers create a sense of family in their classrooms and connectedness within the Black
community. Black women teachers weave “together race, gender and intergenerational continuity with the politics of resistance” (p. 261) while building solidarity with their students. Research shows that Black female teachers continue to be more comfortable and committed to working in a school with Black and Brown students (Fitchett et al., 2017). Recent literature that explicitly focuses on Black women teachers has documented the mentoring networks amongst them (Dingus, 2008; Johnson, 2015), their intentions to remain in the classroom (Farinde et al., 2016), and the mass exodus of Black women teachers today (Hill-Jackson, 2017).

Mentoring and professional networks amongst Black women were needed at segregated schools pre-

*Brown* to ensure the needs of Black children were met across ability levels (Siddle-Walker, 1996), and are still needed today to provide community and shared knowledge across school settings and contexts (Hill Collins, 2000) for Black women because of their culturally based orientations and life experiences (Dingus, 2008). Dingus (2008) highlights the necessity and function of professional and personal mentoring networks that Black women teachers seek while teaching. Mentoring networks amongst Black women teachers include elders, veteran, and novice teachers who come together to holistically provide spaces to “redress oppression through affirming relationships” (p. 376).

Johnson (2015) found that Black women teachers developed their own culturally relevant mentoring network or “sista mentoring” network when their principals assigned them white mentors. The traditional one-on-one mentoring across racial lines reveals the lack of recognition of the positionality of Black women thus rendering them invisible. Sesko and Biernat (2009) argued that invisibility is a distinctive type of discrimination. Participants in Johnson’s (2015) study formed their sista mentoring model which included Black women veteran teachers and educators in their own families. Black women-only mentoring spaces allowed the teachers to use
resistance as a tool, develop their pedagogical approaches and, build collective knowledge to be used in oppressive spaces, such as predominantly white-faculty schools (Johnson, 2015).

**Black Women in Science Classrooms**

There is little research that focuses on Black teachers as content-specific experts (Mensah, 2009). The research that specifically focuses on Black women science teachers as in-service teachers (Despenza, 2018; McMath, 2015; Mohorn, 2021; Olitsky, 2019; Wright et al., 2021), pre-service teachers (Sparks, 2018), and/or teacher candidates (Brown, 2000; Mensah, 2019) have peaked over the last few years. In some fashion, this important body of research explores the experiences and needs of Black women science teachers while also sharing the impact their role has played in the lives of their students.

In 2012, only 3% of the secondary science teachers in the United States identified as Black (Banilower et al., 2013). Issues of recruitment and retention for Black women science teachers have been explored in the literature (Depenza, 2018; Olitsky, 2019). Black science teachers experience an internal battle while in the classroom, trying to both serve their students while also considering their long-term goals and self-interests when their school practices are contrary to those needs. Olitsky (2019) considered how Black women’s approach to teaching, a “motherly” approach, is different from the white norm which causes problems in terms of coaching and professional development for Black teachers.

Despenza (2018) centered the narratives of Black science teachers and explored their experience in schools. She found that her participants were initially inspired to enter the classroom because of their connection to a long history of Black women teaching in America. As their experiences in schools became more toxic and unstable over time, the Black women science teachers in her study took the time to reflect on professional desires and chose to leave the
classroom. This finding falls in line with Ingersoll’s (2001) prediction that recruitment is not the problem; it is retention.

4.3 Theoretical Framework

Womanist Pedagogy

Womanist Pedagogy is a term coined by Beauboeuf-Lafontant (2002) that captured the essence of the pedagogical approach of Black women teachers and is an outcome of womanism, a “standpoint epistemology” (Hill Collins, 2000) derived from ‘womanism’ (Walker, 1983) and Black feminism (Hill Collins, 1998). For Geneva Smitherman, a womanist refers to an “African-American woman who is rooted in the Black community and committed to the development of herself and the entire community” (1996, p.104). As discussed by Davis (1989) and James and Busia (1994), using the term Black feminism positions Black women to examine how the specific interlocking issues affecting Black women in the United States are part of issues of women’s emancipation struggles globally. For this study, womanism can be used interchangeably with Black feminism, a theoretical perspective that sees the experiences of Black women as normative, not as a derivation or variation of Black male or white female behavior (Hill Collins, 2000).

Womanist pedagogy exists as a collective ‘standpoint’. U.S. Black women have a collective standpoint that is illustrated by the individual and can also be characterized by Black women’s experiences and ideas as a group (Hill Collins, 2000). For example, “the heavy construction of U.S. Black women in domestic work coupled with racial segregation in housing and schools means that U.S. Black women had common organizational networks that enabled them to share experiences and construct a collective body of wisdom” (Hill Collins, 2000, p. 24).
Womanist Pedagogy has three distinct characteristics to describe the pedagogical practices of exemplary Black women teachers. Those three characteristics are—caring/embrace of the maternal, political clarity, and an ethic of risk. Below I discuss each characteristic in detail and how womanist pedagogy has been utilized in the literature.

The caring/embrace of the maternal tenet describes the communal responsibility Black women bring to teaching, and the maternal image they use as a compass for how to build relationships with students and approach to instruction. Patterson et al. (2011) interviewed alumni from a segregated school that was open for 50 years (1908 - 1958) in Parsons, Kansas. The researchers found that Black teachers gave “affirming messages of racial pride, high expectations…, and the importance of community that were critical to their success in school and later in life” (p. 284). Using both formal education and activities outside the classroom before and during the Civil Rights era (p. 282), the three tenets of Womanist Pedagogy (Beauboeuf-Lafontant, 2002) were exemplified based on the alumni oral histories.

The political clarity tenet is embodied by womanist teachers as they see racism and other systemic inequalities as both social and educational problems. As a result, they view the power in their role as a teacher as an opportunity to undo the “societal stereotypes imposed on children” (Beauboeuf-Lafontant, 2002, p. 77). For example, Ramsey (2012) examined the educational narrative of Black educators in Charlotte, North Carolina during the desegregation movement. They detailed the political actions of Bertha Maxwell-Roddey who demanded support from Charlotte’s School Superintendent when she learned that the white principal of the school her students were being bussed to refuse to accept her elementary students. Sabrina Ross (2021) pushed us to think of the mattering of Black women’s lives outside of their work but in “their inherent worth and full humanity” (p. 224). Womanist Pedagogy is used in her work to consider
ways researchers can highlight the political clarity Black women bring to their work while also pushing Black women to see self-love and healing against racialized and gendered injustices as a commitment to social justice. Black women involved in social justice work are urged to engage in speculative play which re-focuses our narrative and work into “life-affirming social constructions” outside of present realities of white supremacy (p. 231). Self-love for Black women is an act of political clarity.

The ethic of risk tenet describes a womanist teachers’ engagement in social justice despite their understanding that oppressive, systemic inequalities are difficult to dismantle, and understanding they may never see outcomes of systemic change in their immediate work. Watson (2019) described an ethic of risk as a “commitment to fighting for the liberation of all human beings, even when it becomes seemingly impossible” (p. 365). A Black female teacher in her study, Tina, exemplified this tenet by supporting the ‘spiritual growth’ of her special education high school students beyond societal norms. This is done by helping them envision their future successes based on their strengths and not the pre-scribed American Dream of working hard and going to college.

4.4 Methods

Setting and Participants

This study situates the pedagogical practices of Black women science teachers within anti-oppressionist/womanist teaching practices (Riley, 2021). The women in this study were identified through a combination of my contacts, “community nomination” (Ladson-Billings, 1994a, p. 147), outreach via social media (Twitter and Instagram), and science teacher organizational listservs, such as state-wide board members, college faculty, and the National Science Teaching Association.
During the recruitment stage of this study (from July 2020-September 2020), potential participants were invited to participate in the study if they self-identified as Black, female, and were teaching or had taught middle and/or high school science. After gathering responses from teachers who agreed to participate in this study, thirty-two African American female science teachers were participants in this study, they taught either middle or high school science courses (i.e., Physics, Chemistry, Biology) across the United States, with one participant in Qatar and one in Canada. They ranged in age from 22 to 70 years. The following categories were used to differentiate the participant pool; ‘novice’ (0-4 years of teaching experience), ‘veteran’ (5 - 14 years of teaching experience), ‘post-service teacher’ (more than 8 years of teaching experience), and ‘elders’ (currently teaching with more than 15 years of teaching experience).

Table 1.

Pre-Interview Survey and One-on-One Interviews Participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Category (Years of K-12 Teaching)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitney Nash</td>
<td>Novice (1 Year)</td>
<td>Bronx, New York</td>
</tr>
<tr>
<td>Shay Neal</td>
<td>Novice (2 Years)</td>
<td>Brooklyn, New York</td>
</tr>
<tr>
<td>Antoinette Newton</td>
<td>Novice (3 Years)</td>
<td>Newark, New Jersey</td>
</tr>
<tr>
<td>Dr. Ashley Nichols</td>
<td>Novice (4 Years)</td>
<td>DC</td>
</tr>
<tr>
<td>Jahnay Noble</td>
<td>Novice (3 Years)</td>
<td>Harlem, New York</td>
</tr>
<tr>
<td>Angel Newman*</td>
<td>Novice</td>
<td></td>
</tr>
<tr>
<td>Ashlee Norris*</td>
<td>Novice</td>
<td></td>
</tr>
<tr>
<td>Angela Norman*</td>
<td>Novice</td>
<td></td>
</tr>
<tr>
<td>Briana Vaughn</td>
<td>Veteran (12 Years)</td>
<td>Bronx, New York</td>
</tr>
<tr>
<td>Ashley Vincent</td>
<td>Veteran (11 Years)</td>
<td>New York and Florida</td>
</tr>
<tr>
<td>Raven Vance</td>
<td>Veteran (13 Years)</td>
<td>Baltimore, MD</td>
</tr>
</tbody>
</table>
Courtnie Vernon  Veteran (13 Years)  Toronto, Canada
April Valentine*  Veteran
Autumn Voss*  Veteran
Keegan Vickers*  Veteran
Jocelyn Victor*  Veteran
Simone Villar*  Veteran
Ariel Valdez*  Veteran
Carter Erasme  Elder (18 Years)  Manhattan, New York
Dr. D’Vona Edwards  Elder (16 Years)  Pittsburgh, New Orleans, DC
Sandra Eaton  Elder (19 Years)  North Carolina
Dr. Zubaidat Evans  Elder (21 Years)  Texas → Qatar
Dr. Ar’Sheill Everett  Elder (15 Years)  New Jersey
Andrea Ellison*  Elder
Stephanie Emerson*  Elder
Dr. Rashidah Petit  Post-Service Teacher (16 Years)  DC
Leslie Phillip  Post-Service Teacher (12 Years)  Queens, New York
Dr. Jasmin Porter  Post-Service Teacher (8 Years)  Brooklyn, New York
 Chrissy Perez  Post-Service Teacher (21 Years)  Detroit, Michigan
Dr. Riley Patterson  Post-Service Teacher (14 Years)  Cincinnati
Charlene Proctor  Post-Service Teacher (11 Years)  Los Angeles, CA; Harlem, New York
Dr. Stephanie Parker  Post-Service Teacher (11 Years)  Atlanta, GA

Note: *Participants who did not participate in phase 2 one-on-one interviews.

Data Collection

In the spirit of Black womanist consciousness, my goal was to “craft stories and personal narratives” that “portray Black women-centered qualitative inquiry as socio-political praxis”
(Evans-Winters, 2019, p. 10). Turning up the volume of those who are historically silenced at worst and merely tolerated at best required questioning taken-for-granted knowledge about the other.

**Pre-Interview Protocol (Appendix A).** Before the one-on-one virtual interviews, I asked all the participants to complete a Qualtrics survey with two open-ended questions. The main purpose of the pre-interview was to know if the participants were familiar with Womanist Pedagogy (Appendix A) according to the work of Tamara Beauboeuf-Lafontant (1998, 2002). The Qualtrics survey was structured so that participants ranked themselves based on various statements before learning that the Likert items were aligned with Womanist Pedagogy. Participants were asked to self-rank according to nine Likert items based on the three tenets of Womanist Pedagogy (3 statements per tenet)—caring/embrace of the maternal, political clarity, and ethic of risk. The ranking options were the following: strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, and strongly disagree. After the participants self-ranked, they were told that the previous statements were aligned with Womanist Pedagogy and were given a brief description of each tenet. The Qualtrics survey did not ask participants to share the number of years they taught or their location, so that information is unavailable in Table 1 if they did not participate in one-on-one interviews.

They were asked two open-ended questions about Womanist Pedagogy, “Would you describe yourself as someone who shares in the womanist tradition of teaching in your science classroom? Why or why not?” and “Do you find it more or less challenging to incorporate these womanist traditions in the science classroom? Elaborate. Teaching science content? Elaborate.” These responses were used to tailor the various interview protocols to the one-on-one virtual interviews.
As shown in Table 2, the five points of the Likert scale were collapsed to three points since there was little variability between the common ranks. For example, “strongly agree” and “somewhat agree” were collapsed to “agree” and “strongly disagree” and “somewhat agree” were collapsed to “disagree”. Participants saw the phrase “neither agree nor disagree” on the Qualtrics survey. Table 2 uses the term “neutral” for spacing.

Semi-structured Virtual Interview Protocol (Appendix B). Before fully engaging in dialogue, participants verified their category, and corrections were made if necessary (i.e., some participants had stopped teaching between the pre-interview survey and one-on-one interview, so their category changed to ‘post-service’ teacher). All the one-on-one interviews were conducted over Zoom with audio and video recording. Each interview lasted about 90-120 minutes. The interview protocol was divided by category based on professional status. There was a general interview protocol that consisted of 12 questions and was shifted for nuance for each group. For example, when asked about their classroom environment goals, novice teachers were asked the question in the present tense, and post-service teachers were asked the same question in the past tense. Each category of professional status had its interview protocol.

Since participants were asked to read a common text before the interview, it became evident that during the interviews the participants were able to make connections to Womanist Pedagogy and describe their pedagogical practices: “How would you describe the classroom environment you strive to create? What informs these decisions?”, “From your perspective, how do you think your intersectional identities markers (race, gender, class, education, which includes your science-degree holder) shaped your experiences as a science teacher?”, What do you know about the pedagogy or instructional practices of Black women from previous generations?”, and “Do you know about Womanist Pedagogy or Black feminist thought?”
The one-on-one virtual, semi-structured interviews were rooted in dialogue and not passive listening. In alignment with Black traditions of conversation, the participants and I engaged in dialogue, rather than an interview without emotional expression. As the researcher, I did not ignore my positionality or the fact that some of our identity markers were similar or interwoven by similar experiences. Responding to questions required them to think critically and reflectively about their identity. In narrative inquiry, the participants must share their narrative first and are given the time and space to gain the “authority and validity” of their own experience, but the researcher is silenced (Connelly & Clandinan, 1990). As an active interviewer, I balanced using the interview protocol while also engaging in dialogue with participants when they shared experiences or questions, they deemed appropriate.

**Researcher Journaling.** After each interview, I engaged in memo-ing focused both on my reflection about initial themes that were discussed and the participants’ memories against my experiences as a science teacher and graduate student. I wrote notes specifically about wisdom I learned from various participants, common phrases, and outlier ideas. The purpose of the memo-ing was also to keep track of which questions yielded in-depth narratives from the participants and to inform my healing through hearing about the experiences of others who are ‘outsiders within’ with me (Hill Collins, 1986).

**Data Analysis**

In this section, I describe how the analysis process took place for the pre-interview survey and the one-on-one interviews. I retrieved the initial transcripts from the Zoom transcription service as a by-product of the Zoom recording. I used tenets of the following theoretical frameworks: Critical Race Theory, Culturally Relevant Pedagogy, Black Feminist Thought, and Womanist Pedagogy to do the initial coding of the data. I used concepts from the
theoretical frameworks as the units of analysis. I started initial coding a word, sentence, or paragraph from the transcripts. That is, I noted any part of the interview transcripts that could represent a concept from Critical Race Theory, Culturally Relevant Pedagogy, Black Feminist Thought or Womanist Pedagogy or an aspect to talk about Black women science teachers’ pedagogical practices and experiences. These initial codes allowed me to identify which interview questions to pull responses from to address the research question.

The coding scheme I used derived mainly from the theoretical frameworks. For example, the code “science as white property” derived from critical race theory literature indicated that students of color have been excluded from the use and enjoyment of science teaching and learning. As another example, I assigned a chunk of text to a particular code that related to the literature. I generated the code “political clarity” from womanism and “science inquiry” from the transcripts once I noticed multiple participants were making connections between the historical silencing of Black and Brown students in their science classrooms and the need to make sure students felt safe to ask questions and make mistakes during labs or investigations. I did that by using the participants’ words and language to generate a code. For example, here is a chunk of text from the transcript of Dr. Parker where she talked about ‘political clarity and science inquiry’

But more than that, like, I brought science fair to them. We actually had kids that were able to go to the State Fair…. we had students that for the first time they were actually they were they were actually advancing to like these, you know, state competitions and so I felt that my pedagogy at the time was teaching kids to be critical of everything that was going around them. Making making science meaningful. (Dr. Parker)
Then in the following excerpt pulled from her transcript, she explicitly shared how her pedagogical practices were influenced by Culturally Relevant Pedagogy even though she did not have the language at the time. I coded this as political clarity and science inquiry: “I was doing like critical consciousness work without even having a title for critical consciousness at the time”, and “…I learned a lot more about like what at the time they call like scientific inquiry…” In this coding example, themes from Culturally Relevant Pedagogy (Ladson-Billings, 1995) and Womanist Pedagogy (Beauboeuf-Lafontant, 2002) were coded.

Next, I searched for connections and inconsistencies in the pre-interview survey. I used the Likert scale to identify if there were any outlier data regarding how participants self-identified according to the Womanist Pedagogy statements. In realizing that the self-grading responses demonstrated no significant outliers in how participants discussed their work in terms of Womanist Pedagogy, I read through the open-ended responses for the 21 participants that engaged in phase two, the one-on-one interviews. Like the coding of the one-on-one interviews, I coded for Critical Race Theory, Culturally Relevant Pedagogy, Black Feminist Thought, and Womanist Pedagogy and found that participants shared similar narratives in the one-on-one interviews. Since the narratives were the same, the pre-interview survey data were mainly used to better tailor the subsequent one-on-one interviews and to help report quantitative data. The open-ended questions data from the pre-interview survey was not reported.

Next, I read through the codes generated from the twenty-one interviews and determined which interview questions produced responses from the teachers in describing their pedagogical practices. Using OneNote for coding, I transferred all the transcripts about the interview questions along with their codes where the participants spoke about their pedagogical practices. I organized OneNote so that the interview questions were separated by professional status (novice,
veterans, elders, and post-service teachers). I then re-read each chunk of responses to a specific interview in order of professional status. For example, I read/re-read how the novice teachers responded to the question, “Do you know about Womanist Pedagogy or Black feminist thought?” and wrote an initial findings section only for the novice teachers before re-reading the veterans’ responses to the same question and writing their initial findings section.

To write the initial findings sections for each group’s interview questions, I read through each participant’s response to the same question and bolded phrases that directly answered the question or shared insight about the question. I then went back to the bolded portions of the transcript to identify how the group responded to the question and wrote the first draft of their findings section. For organizing the codes and themes, I developed a color scheme and used a multi-step approach to reduce to larger categories. I organized them using tables in OneNote (Appendix D). Organizing the initial themes into tables allowed me to identify which themes were shared amongst the different participants, where the tenets of Womanist Pedagogy and how Womanist Pedagogy showed up in their science classrooms increased across the professional status of the teachers.

**Validity and Rigor**

For the coding process, I used the Google Docs and One Note software, where I organized the selected interview transcript as a primary document. This allowed me to effectively compare quotes from participants with different professional statuses. This comparison process helped assist “the researcher in guarding bias, for he or she is then challenging consists with fresh data” (Corbin & Strauss, 1990, p. 9).

While analyzing the data, I continuously sought verification from my advisor and peers with expertise in Critical Race Theory through a process called peer debriefing (Spall, 1998) as
another element of rigor. Monthly, I met with my advisor to discuss my coding process and test themes for reliability. Additionally, I was part of a graduate student group that gathered bi-weekly for a year to discuss our projects and research. I discussed my analysis and findings with the group, who helped me identify biases and underlying themes. In addition, we engaged in discussions related to the assignment of codes to specific quotes. I was able to practice my coding process with samples of the transcripts. We worked on it collectively, and this process helped me to have consistency in the coding process.

In legal scholarship, storytelling has served to tell stories of marginalized, oppressed, and silenced groups to offer differing accounts of dominant narratives. Delgado (1989) called these non-dominant narrative counterstories. Using naturalistic methods, such as storytelling, in science education research has been increasing but is not a quickly accepted method of research in science education (Carlone et al., 2008). Consequently, to use storytelling methods in science education research is to challenge conventional ways of analyzing data and doing research in this field. In this study, I used interviews to collect counterstories of Black women science teachers, bringing storytelling as a research method in science education.

4.5 Findings

In this section, I present both quantitative and qualitative findings that explore how Black women science teachers from various levels of teaching discuss and practice Womanist Pedagogy. Table 2 represents the results of the pre-interview survey as participants (n=32) self-determined their level of agreement on various statements that were aligned with Womanist Pedagogy (Beauchef-Lafontant, 2002). The subsequent qualitative findings are based on the results of the one-on-one interviews.
Quantitative Findings

The five-point Likert scale allowed participants to self-rank based on 9 abbreviated statements as displayed in Table 2. Out of the 9 statements, 100% of the Black women science teachers ranked “strongly agree” or “somewhat agree” to 5 of the statements. Based on the Likert scale results of Table 2, there is no significant difference to indicate that any of the participants disagreed (avg. = 2.08%) with any of the Womanist Pedagogy statements. Averages were calculated by adding the values for each rank (agree, neutral, or disagree) and dividing for the total number of Likert items (nine).

In the Embrace of the Maternal category, the average rate of agreement was 88.5%, 4.16% neutral, and 6.25% disagreement. The statement that received 100% agreement is, "As a science teacher, I have a sense of communal responsibility to care for students so that I resist domination (both patriarchal and racial) in my classroom. The bulk of the variation in the agreement is under the ‘Embrace of the Maternal’ category where 18.75% of participants either held no position or disagreed with the statement: “As a science teacher, I create a classroom learning environment where I educate as well as shelter students from adversity” and 12.5% held no position or disagreed with the statement: “As a science teacher, I use familiar mother-child language when I talk with students; when I talk with others about students; and when I teach students.”

The Political Clarity statements resulted in the most consensus with all three of the statements earning a “strongly agree” or “somewhat agree” self-rank. None of the participants self-ranked “neutral”, “strongly disagree”, or “somewhat disagree” for any of the Political Clarity abbreviated statements. In the Ethic of Risk category, the average rate of agreement was 96.83%, 3.13% neutral, and 0% disagreement.
The five-point Likert scale allowed participants to self-rank based on 9 abbreviated statements as displayed in Table 2. Out of the 9 statements, 100% of the Black women science teachers ranked “strongly agree” or “somewhat agree” to 5 of the statements. Based on the Likert scale results of Table 2, there is no significant difference to indicate that any of the participants disagreed (avg. = 2.08%) with any of the Womanist Pedagogy statements. Averages were calculated by adding the values for each rank (agree, neutral, or disagree) and dividing for the total number of Likert items (nine).

In the Embrace of the Maternal category, the average rate of agreement was 88.5%, 4.16% neutral, and 6.25% disagreement. The statement that received 100% agreement is, "As a science teacher, I have a sense of communal responsibility to care for students so that I resist domination (both patriarchal and racial) in my classroom. The bulk of the variation in the agreement is under the ‘Embrace of the Maternal’ category where 18.75% of participants either held no position or disagreed with the statement: “As a science teacher, I create a classroom learning environment where I educate as well as shelter students from adversity” and 12.5% held no position or disagreed with the statement: “As a science teacher, I use familiar mother-child language when I talk with students; when I talk with others about students; and when I teach students.”

The Political Clarity statements resulted in the most consensus with all three of the statements earning a “strongly agree” or “somewhat agree” self-rank. None of the participants self-ranked “neutral”, “strongly disagree”, or “somewhat disagree” for any of the Political Clarity abbreviated statements. In the Ethic of Risk category, the average rate of agreement was 96.83%, 3.13% neutral, and 0% disagreement.
<table>
<thead>
<tr>
<th>Abbreviated Statements</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embrace of the Maternal</strong></td>
<td></td>
</tr>
<tr>
<td>As a science teacher, I create a classroom learning environment where I educate as well as shelter students from adversity.</td>
<td>81 6.25 12.5</td>
</tr>
<tr>
<td>As a science teacher, I use familiar mother-child language when I talk with students; when I talk with others about students; and when I teach students.</td>
<td>84.5 6.25 6.25</td>
</tr>
<tr>
<td>As a science teacher, I have a sense of communal responsibility to care for students so that I resist domination (both patriarchal and racial) in my classroom.</td>
<td>100</td>
</tr>
<tr>
<td><strong>Political Clarity</strong></td>
<td></td>
</tr>
<tr>
<td>As a science teacher, I have political clarity. I recognize that there are relationships between schools and society that differentially structure the successes and failures of children.</td>
<td>100</td>
</tr>
<tr>
<td>As a science teacher, I see racism and other systemic injustices as simultaneously social and educational problems.</td>
<td>100</td>
</tr>
<tr>
<td>As a science teacher, I understand the necessity of seeing through stereotypes as false representations of children’s realities and possibilities.</td>
<td>100</td>
</tr>
<tr>
<td><strong>Ethic of Risk</strong></td>
<td></td>
</tr>
<tr>
<td>As a science teacher, I understand intergenerational struggle against injustice, believing that although Black people have been oppressed for generations cynicism is not the answer.</td>
<td>96.9 3.13</td>
</tr>
<tr>
<td>As a science teacher, I feel an intimacy with other people that motivates me to see personal fulfillment in working toward the common good.</td>
<td>93.6 6.25</td>
</tr>
<tr>
<td>As a science teacher, because of a sense of interdependence, I establish classroom routines that model mutual responsibility.</td>
<td>100</td>
</tr>
</tbody>
</table>
Qualitative Findings – Caring, Political Clarity, and An Ethic of Risk

**Becoming Aware and Identifying as a Womanist**

The first qualitative result of this study is that across all levels of professional status, the participants had not heard of Womanist Pedagogy before engaging in the pre-interview survey. Of the novice participants, Ms. Nash, Ms. Newton & Ms. Noble were able to make connections to Womanist Pedagogy explicitly and found inspiration in the idea that there was research describing what they were trying to accomplish in their classroom. Previous readings about teaching or coaching from their supervisors had sometimes contradicted what they instinctively wanted to do in their classroom and Womanist Pedagogy was “right on point” (Dr. Evans).

Ms. Nash had previously considered herself a Black feminist but had not seen its place in the science classroom because she thought the science content and relationships should be prioritized. The Womanist Pedagogy article helped her to begin thinking about the connections. She shared, “I need to do more research …. I wasn’t thinking about how I can bring another spin [a] Black feminist lens spin into the classroom….So like, I’m just trying to piece together everything that I’ve been learning.” Ms. Newton named that the tenets of Womanist Pedagogy were something she realized she did in the classroom only after reading the article, and it was not something she did intentionally. She stated, “Oh, I guess I am. I guess I am you know a womanist. …. But subconsciously, not necessarily, you know, it only came to the forefront of my mind while I was reading [the article].”

Most of the elders shared a positive response when asked about Womanist Pedagogy, they explained that they were “fascinated” by the article, that they recognized themselves, some even shared the article with their Black female teaching peers in excitement. Dr. Evans exclaimed, “Oh my God, [it] just spoke volumes to who we are and why we are so important.
Yeah, why we are so important. So yeah, I didn’t know about it until reading through it. But I can say a lot of what is written is true for me.”

Some of the novices revealed that they had previously rejected the notions of “feminism” and wanted to learn more now, while others shared that learning about the term provided validity to what they had already been doing in their classrooms when they followed their instincts. Both Ms. Neal and Dr. Nichols explained their understanding of feminism outside of Black feminist thought or Womanist Pedagogy. Ms. Smith shared:

Personally, I’ve heard more of the feminist learning, and I never identified with that cuz I don’t know, there was just a lot to it, and actually, I didn’t understand or truly align to it, if that makes sense. I feel like it’s [Womanist Pedagogy/Black feminist thought] definitely something to look into now and see how relatable it is to me in the classroom.

For Ms. Vance, the traditional use of feminism did not fit her complex identity markers. She felt compelled to share that she now self-identified as a womanist especially since “the traditional feminist movement exclude women of color and like transgender women, anyone who is not a cisgender standard white woman, traditional feminist movements exclude them. So, I do identify as a womanist [after] reading the article.”

Below I discuss how the participants either discussed or practiced each tenet of Womanist Pedagogy. In some instances, the participants discussed the Womanist Pedagogy article and connections they made to their science teaching, and other times they discussed their pedagogical practices, and I used Womanist Pedagogy as a tool to give a common language to the pedagogical practice described in their narrative. As this is a report of the findings, the reader will notice some participant groups or professional status categories are showcased in some micro-themes more than others. This reflects how participants spoke about their work. This
might suggest that participants in other professional status categories do not agree with the sentiments expressed by others, but instead, they simply demonstrated their depth of womanist pedagogy differently or distinctly.

Caring/Embrace of the Maternal

In this first tenet of Womanist Pedagogy, there were four micro-themes: (1) Caring Environment of the Science Classroom, (2) Culture of Error in the Science Classroom, (3) Politicized Caring through Relationship Building and Teaching Science, and (4) Tough Love of Caring in the Science Classroom. The caring/embrace of the maternal tenet describes the communal responsibility Black women bring to teaching, and the maternal image they use as a compass for how to build relationships with students and approach to instruction.

Caring Environment of the Science Classroom

Novice and veteran participants connected the ‘embrace of the maternal’ womanist tenet to their desire to create a safe space for their students. Ms. Noble looks to her teaching to make connections to what she knows about Black women teachers of the past, and she shares how these things come naturally to her, "so naturally it's important to me, just like building trust just building relationships because I want them to succeed”. She continued that she felt a “deep-rooted” commitment to her teaching, that it was her “due diligence.” Ms. Noble thought of her “due diligence” or commitment to her teaching as a life’s purpose, she considered teaching as a personal calling that required time and effort beyond only what her school expected of other teachers.

Like Ms. Noble, Ms. Newton looked to her practice while referencing the past. Ms. Newton shared that elimination of ego is important to her as a Black women teacher. She remembered things she would express to her students:
I am also learning from you. And you know, we are never too old to learn…We're all in a school and we're learning from each other. There are plenty of things where I'm not perfect. I don't pretend to be perfect. And yes, there are certain things where I'm like, well, let me get back to you on that one kind of thing.

Ms. Neal discussed why a safe environment for all learners (students and teachers) in the classroom is important. Illustrated here, "Figuring out different ways and strategies to keep it [the lesson] engaging is the ultimate goal of my environment, so students know that when they [enter the classroom] they are a part of a family”.

Ms. Nash explained why it was so important that students feel safe by thinking back to her personality. She thought of herself as shy and withdrawn, although she shared a lot if there was a safe space, if not, she would rather remain silent. She continued to share how this self-realization has influenced her teaching:

I try to make everyone feel seen because I know once you feel seen you're going to feel more comfortable in the classroom, and once you feel more comfortable in the classroom, you're going to get it. Once you get it, then everything just kind of comes together.

**Culture of Error in the Science Classroom**

All five novice participants demonstrated a deep level of caring for their students, specifically wanting their students to think of their classroom as a "safe haven" or a "safe environment". Building a safe environment for the novice participants means that a ‘culture of error’, a culture where students feel comfortable making mistakes and questioning the teacher in the classroom. There is little to no tolerance for laughing at mistakes. The novice teachers believe that confronting the myth that "mistakes are for dummies" should be fought head-on.
For Ms. Newton, it was important to "just be humble and be strict while still being warm and making sure that the kids know and feel the love that you have for them". Caring is displayed by the act of humility while still maintaining high expectations and clarity of instruction. Instead of misusing her position of power to showcase that she is ‘in charge’, Ms. Newton chose to position herself as another learner in the classroom by remaining humble, while still making sure students have clear expectations for scientific practices in the classroom. Ms. Neal uses her maternal image to build a culture of error in her classroom. “It’s okay to make mistakes, if someone corrects me, I let them correct me, no one is perfect. We are here to learn, and learning from others’ mistakes is the biggest part of learning".

**Politicized Caring through Relationship Building and Teaching Science**

When asked about their classroom environment some of the veteran teachers discussed politicized caring or politicized mothering (Beauboeuf-Lafontant, 2008) and embrace of the maternal tenets of Womanist Pedagogy to provide language to how they viewed their classroom. Politicized mothering or recently coined ‘politicized caring’ (McArthur & Lane, 2019) reflects aspects of teachers’ authentic caring—their maternal approach to students, the political awareness that shapes such a maternal concern, and the transhistorical and communal vision of social change that sustains their commitments to children (Beauboeuf-Lafontant, 2008, p. 252)

When connecting her womanist ideologies to her classroom, Ms. Vance positioned relationship-building at the foreground of her teaching philosophy and advocated that all students deserved a womanist teacher that cares about their students deeply. She shared:

I'm a womanist teacher just based on reading this article because building relationships is one of the most important things you can do as an educator, it doesn't have to be a deep
relationship where you keep in touch years later, but all students need to feel welcome into your classroom.

Ms. Vance continued to share that it was important to her that her students see her as someone they can communicate with when they are having a rough day and need something outside of the predetermined lesson.

Unlike the novice participants, the veterans connected the importance of their caring approach to science instruction. Ms. Vernon explained that she built an interdisciplinary science course that focused on literacy or experimental design building skills (depended on the purpose of the course), and this allowed her to target the interest of her students and to invite the school and home community to get involved in what is happening in the classroom. She believed in "just building good relationships with students…strong relationships with students and understanding what their interests were that's like the kind of thing that goes throughout all of those teaching episodes and then as well, like the community.” Ms. Vernon specifically demonstrated how she practiced politicized caring by explaining that she engaged in “strong communication with the people in the community, the parents or other members of the community who want to support the kids and having a really rich dialogue about what they could be learning.”

Like Ms. Vernon, Ms. Vincent used teacher-student relationships to teach science content. She shared:

I think I teach more science because of the relationship that I have with my students more than their love of science more than liking me it's all about the rapport that I built with my students in the community that I have in my classroom.
For Ms. Vernon caring helped her engage students in science learning. “I'm just myself, I try to authentically be myself and I don't try to hide. I'm a little kooky and very animated and fun and silly and goofy”. It is important for Ms. Vernon that her students see her be comfortable within themselves while learning science so they can do the same.

**Tough Love of Caring in the Science Classroom**

Some of the elders made connections to caring and the complexity of "tough love". The tough-love discipline style is an important component of historical African American educational practices that emphasize high expectations and care (Siddle-Walker, 2001). The concept of “tough love” can be complex when we consider that some aspect of discipline for Black children is rooted in the fact that Black children who are seen as “rowdy” or “unruly” can be violently accosted by non-Black people (consider Latarsha Harlins or Trayvon Martin) when they leave the school building, and even in the school building. On one hand, Black educators know that these racist beliefs about their students are not true and on the other hand they may have survived this racist society by adjusting to white social norms that helped them survive. In this way, tough love maintains respectability politics to survive (Okello, 2021). Historically Black people have worked with respectability politics to not be socially rejected by or violently accosted by whiteness and white people, for these reasons a specific type of ‘organized anxiety’ (Okello, 2021) has pressured Black teachers to use discipline to prepare their Black students for a world that is trained to not accept them. As said by Dr. Parker, “sometimes our Black mothering is harsh because we know what society …what awaits for our children”. Both grapple with the fact that as Black teachers they must show caring through sternness to push Black and Brown students beyond their preconceived limits.
Dr. Evans and Ms. Eaton discussed the historical paradox of tough love for Black teachers teaching Black children. Dr. Evans connected the tough love approach of caring to her being a mother. As a single mother, she learned specific lessons about perseverance that inform the warm/strict balance she brings to teaching. She thinks back to an occurrence with a student who did not have their assignment by the expected due date:

A lot of it [being a single mom] transferred into my teaching and when [she mimicked the student], ‘Ms. I don't have my assignment today.’ ‘Well, I don't care. What do you want me to do about that?’ [she imitates a student], ‘Well can I turn it in tomorrow?’ ‘Yeah. I mean, what else you gonna do?’ …well, some of it is good and some of it is not so good but that's who I am.

In this occurrence, Dr. Evans is teaching the student how to advocate for what they need (an extension for the due date), versus just naming their excuse with no solution.

Before reading about Womanist Pedagogy, Ms. Eaton thought of the Black tradition of teaching as solely high expectations and tough love but was happy to see something different and more representative of what she does in her classroom. Ms. Eaton remembered:

when you're dealing especially with older Black women and just overall... there's this pressure that is put on you to be tough, precise, and successful, and to be more, and the expectation is higher than everybody else. So you feel that pressure feeling, it just comes in, and for me, I do that. I hope I don't do it to the degree in which it's it's done to me, but it's still that thing you carry on.

Ms. Eaton eventually concluded that Black teachers must find ways for their caring to translate to the future generations of Black and Brown students. She has learned to include the "why"
behind her strictness, or tough love so that students can understand why her caring is sometimes harsh.

The post-service teachers also reflected on the ramifications of tough love in education. As students and teachers, they witnessed some Black teachers as "mean", while understanding why this strict nature may have been necessary or rationalized. The participants questioned the long-term traumatic effects that came along with tough love. Dr. Parker thought about two of the only Black women teachers she had as a student. She recalled being drilled about multiplication tables, "It was my third and fourth-grade teachers [they made us] stand up and do the damn multiplication tables, and I’d never been good with multiplication. I’m still not good with multiplication. But they were terrible." She considered the rationale for her teachers’ behavior:

I think it was very assertive like it wasn't (pauses)...it was mothering. It was the Black mothering that we have that I don't want to admit, but sometimes our Black mothering is harsh because we know what society—like what awaits our children.

Dr. Parker situated the instructional practices of her past teachers in the lived experiences of Black people throughout history, understanding that Black people are hunted and targeted by police and other white people who desire to maintain the status quo or whiteness. Black children do not always have the luxury of making public mistakes and not being the best in all circles. She opined:

I think there's a part of a Black woman that feels that they can make you tough for the world, you know, that you can survive it because we know what awaits us and there's no room for softness in that there's no room for vulnerability in that there's no room for you to let down your guard. So, there are parts of my teaching that were harsh.
When thinking about the impact this "tough love" tradition has had on the teaching practices she reminisced:

So I think of myself as a Black woman having experienced that harshness, a part of me internalized it and a part of me was like I was strict because I thought that I was saving my kids. I think there was an awakening. I'm not sure when that awakening happened. When I realized that like there was some vulnerability. There was strength in softness. There was strength in my feminine qualities as well, you know.

While understanding the rationale and necessity for "tough love" when teaching Black children, Dr. Parker found different ways to get to the same goal of community and racial uplift when she decreased some of the harshness and embraced more of her more vulnerable side in her classroom.

Dr. Porter used her science classroom as a time for more joy and freedom when she noticed that her fellow Black female colleagues had practiced some of the harshness of tough love:

that was my way of teaching science because I kind of felt like— like I'm using the words of the paper (the womanist article) … [your 6th-grade teacher is your maternal figure], I'll be your godmother, or your fun aunt or something, you know, and like, come over to my class. So yes, I did give tough love, but I let them explore a little bit more. I wasn't too strict. Because I saw what they experienced over there. So, I was like, let me loosen it up a little bit.

She shared:
they would pull the kid outside the class, they would yell at them and then get outside of the class and then talk to them with that tenderness and that's what I saw, I would say, like how it influenced me as a teacher.

In her experience, she witnessed the "tough love" archetype as a public façade to keep order in the classroom. She would witness other Black female teachers be very strict, sometimes mean, in the whole class setting but then reveal tenderness and caring when having a private discussion with students in the hallway or after school.

**Political Clarity**

The second tenet of Womanist Pedagogy is political clarity. There were three micro-themes in this section: (1) Working Twice as Hard, (2) Working Against Deficit Mindsets and Low Expectations, (3) Critical Reflection on Practice. The *political clarity* tenet is embodied by womanist teachers as they see racism and other systemic inequalities as both social and educational problems. As a result, they view the power in their role as a teacher as an opportunity to undo the “societal stereotypes imposed on children” (Beauboeuf-Lafontant, 2002, p. 77).

**Working Twice as Hard**

Novice and veteran participants connected their political clarity in the science classroom to the extra effort that their Black and Brown students must demonstrate to be positively acknowledged, while also discussing how as science teachers they must demonstrate extra work to be respected by their white peers. Ms. Noble’s political clarity is informed by her positionality as a Black woman teaching science. She shared:
Being a Black woman in America, you know, I think about my students. I already told them like, we have to work hard, like you have to work hard because there's like so much of a fight out there. We don't get the same opportunities as your white counterparts.

Ms. Noble shared her political clarity with her students unapologetically:

I let them know that like straight off the bat. That's not something that I hide. Even though I teach science, social justice always comes up all the time because they need to know, you know, what lies ahead of them.

Ms. Noble believed that explicitly discussing how race, gender, and class have affected her science is important. For her, she needed to inform her students about the “fight” outside of the classroom to help motivate them to work hard for academic achievement.

The phrase "we have to work twice as hard to get half as much" comes to mind as Dr. Nichols expressed why she must have high expectations for her Black and Brown students. She explained, "So I tried to create an environment of like urgency and high expectations to remind my students that you're going to be looked at with a much finer microscope". Ms. Nichols’ understanding that Black and Brown students are not socially accepted within STEM spaces as easily as their white peers informed her teaching persona. For Ms. Nichols, there was no time to waste. Her students must be prepared to be examined by others who will harshly judge them if they seem unprepared in other science spaces.

Her political clarity shines as she explains why it is important that her Black and Brown students can communicate using scientific jargon better than their [white] peers. She shared, "[I try to] make sure they [use] the proper vocabulary…. We’re really pushing ourselves to write because science literacy is so important to every community."
Having to work twice as hard to get half as much was not limited to the Black and Brown students, the veteran participants discussed experiences that fueled their political clarity. All 4 veterans experienced their peers viewing their racial and gendered identity as a hindrance to their scientific expertise, no matter the economic background of the participant or the community (Black/Brown or white) they served. For example, Ms. Vaughn and Ms. Vincent had witnessed their equally or less qualified (in terms of years of teaching experience or degrees) white colleagues receive a promotion, ability to choose class student roster, or assumed content expertise simply because they were white. Ms. Vaughn shared that a white, female colleague with equal credentials and years of expertise at her school received preferential treatment by being able to select which students she would like to teach each year. Ms. Vaughn's students consistently excelled despite being deemed "low", but this was a burden on Ms. Vaughn's energy and classroom. She shared her frustration:

I get the bottom and then babies pass and so now I'm seen as a teacher who can handle all the tough kids. I'm seen as the teacher who can handle all the "low" kids.” She questioned, “why you are continuously giving me these students like, do you want to see me fail? Why do I have to work so hard?’ And I honestly feel like I am not treated fairly, and I do think it's because of my race.

Despite this yearly treatment, Ms. Vaughn has not been compensated for having results that her white peers were incapable of, instead, Ms. Vaughn was seen both as someone who can be relied on to teach excellently while also seen as someone who can be exploited.

Ms. Vincent shared the same experience but with a different vantage point since she taught white students, thus dealing with white colleagues, leadership, and parents. In her experience, her science content expertise was constantly questioned by colleagues and parents,
so she chose to address the issue at the start of the school year when parents must accept the fact that a Black woman would be teaching their child.

A number of my colleagues on staff don't have a master’s, and I often get asked, you know, ‘what's your background?’”. She questioned, “are you asking anybody else what their credentials are like, why are you asking me what my credentials are?’ and that's stressful because I know that other people don't get asked that.

Ms. Vincent shared that her intersecting identity markers held less weight in her psyche when she taught students with similar backgrounds as her (Black Caribbean, working-class, urban). Working with Black students required less mental work for Ms. Vincent than when she taught her white students. While her representation of "Black excellence" is necessary for both circumstances (predominantly white and predominantly Black classrooms), the result is different. For white students, she was exemplifying the fact that Black excellence simply exists, while for her Black and Brown students she was exemplifying that they also can show up in excellence.

Working Against Deficit Mindsets and Low Expectations

All 14 of the in-service participants tethered their political clarity as a response to the deficit mindsets and low expectations of their white peers. School systems and teacher behavior reveal the low expectations of what Black and Brown students are capable of in the science classroom, and as a result, the participants chose to advocate for their students in various ways.

For Ms. Noble, political clarity is expressed when she pushed back against deficit mindsets that she had heard about students and instead she built a space where everyone is learning from one another. She reminisced, "sometimes teachers think like— like the students, they don't know anything. You know, they're like blank slates, we can go back to that and, you
know like we're giving them all of the knowledge but that's not true”. Considering the assets her students brought to the classroom was imperative to Ms. Noble’s approach to teaching.

The veteran teachers expressed the need for their political clarity as a response to the lack of caring and deficit mindsets from white teachers at their school site. Ms. Vaughn compared her classroom environment to that of her white colleagues to highlight why her approach was so important for her students. While she would not have described herself as "chummy" or as a "pushover", mutual respect served as a bedrock to her classroom environment. She shared:

But it's like a mutual respect. I feel like many of my colleagues who are white, they talked down to our students in a way that they don't deserve and that's why the students push back towards them. You know, I am not a nice, sweet person. I have an attitude, and it's like, me and the students, even if we're butting heads, we have a mutual respect for each other, and they see that I'm very consistent. I have order and structure for kids.

Ms. Vaughn remained true to herself and never talked down to her students which created an environment for learning, unlike in other classes where students felt as though they must defend themselves because of their teachers' low expectations.

Ms. Vance had also witnessed how different racial dynamics could negatively influence the experience of Black and Brown students. Ms. Vance had been working at her school site for over a decade and witnessed the school community shift from a predominantly white to a predominantly Black and Brown student population, but the teaching staff remained the same (mostly white). She explained, "I've been able to see the racial dynamic change. Now we're a predominantly Black school and so I think other [white] teachers [who’ve been there longer than me] are struggling.” While Ms. Vance had positive relationships with her white students before
the racial shift at the school, her white peers were not able to make the same type of adjustment for Black and Brown students.

Like Ms. Vance, Ms. Vincent was one of the few Black women on the teaching staff at her school, but she taught at a predominantly white school. Ms. Vincent understood the importance of her presence and voice for her students of color despite the additional work it might require of her. She shared:

At times I wonder why I take that on... I just feel like I have to do it. Sometimes people ask me why I'm teaching at a private school and honestly, I think I stay because I see how our students of color, or how the students of color that I experience are put in a certain light and how I always have to be there...[to address comments like]...‘why don't you think of it this way?’, or ‘maybe we shouldn't do that because there are some students Black or Brown students that that's not going to work for’, and so I feel as though I'm their voice and so I feel that I'm building almost two communities all the time, like the communities that I have for my students of color and the community in my classroom.

Ms. Erasme’s political clarity was highlighted in advocating for students, where she also mentioned her “maternal instincts” coming out to advocate for them. She shared:

You know this this maternal instinct always kind of comes up, and there are times where I do feel you know and can say, do you realize in this meeting of 150 [teachers and staff that] all of the five kids brought up have been Black or Brown students, you know, and then people kind of shut down a bit. I don't necessarily have the skill to talk through that, but I do feel the need to advocate right and protect them in that way.
In her experience, there were multiple times when staff planned an event and Black children were singled out or overly punished or reprimanded, while her white peers were silent about this obvious difference in treatment.

Dr. Edwards shared that despite the surge in teachers’ postings on social media about reading "anti-racist" literature, teachers in her professional settings were resistant to engage in critical reflection about their teaching practice. She discussed experiences in professional spaces where she as a Black woman was not the norm. “Even with all this talk this summer (Summer 2020) about social justice and abolitionist teaching and equity, like do you want to talk about how you're purposely keeping kids out of these classes?” She shared that for years she witnessed her white colleagues provide obstacles for Black and Brown students to join honors or AP science courses. Year after year, her white colleagues required Black and Brown students to get recommendations to enroll in their AP classes even if they have qualifying grades. Dr. Edwards recalled that after writing the letter of recommendation for Black and Brown students, her white peers would question her. She retold one instance between her and one of her white male science colleagues: "He [a white male teacher] brings my little letter of recommendation form that he forces kids to get signed and says, ‘Are you sure? Oh, well, do you really think he's capable? Do you really think he can it's your first year here? Are you really sure?'”. Dr. Edwards referred to these experiences to discuss when she needed to advocate for her students when her peers hold low expectations for why she continues to teach today.

Dr. Evans shared that sometimes advocating for her students as one of the few Black teachers at the school meant putting the science curriculum to the side to regain alignment and community with her students. The soft bigotry of low expectations (Pearson & House, 2016), the act of ignoring Black and Brown students when they have misbehaved because you believe that
cannot do any better, sometimes resulted in teachers not seeing the humanity in their Black and Brown students and taking less time to acknowledge when something is not going right. Dr. Evans even "backed off" of teaching the science curriculum despite being observed by her white supervisors:

Getting them (her students) to see you and trust you, it’s not always about the teacher.

And when the admin comes in and says, ‘what are y’all doing today?’ ‘We are having a discussion today. The science will come’…And then once everybody's on the same page, right, you want me to talk about atoms. Okay. Yeah. Then we can go there now, you have their undivided attention.

Dr. Evans was willing to take the time to reset the class through discussion when she addressed issues students were having outside of the science content. While her peers may have just ignored the students who were off, because she had high expectations, she chose to address students directly even when her white supervisors might expect her to only focus on the science curriculum and ignore when lost the attention of some students.

**Critical Reflection on Practice**

Dr. Parker, Dr. Patterson, and Ms. Phillip, some of the post-service teachers, reflected on the oppressive practices they either regrettably participated in or worked against during their K-12 teaching experience. Dr. Parker shared that she engaged in Culturally Relevant Pedagogy (Ladson-Billings, 1994) before learning about the concept formally:

Before I knew about Gloria Ladson-Billings, I knew that I couldn't, I could never water down the curriculum for students…. [I knew that] lowering the bar for them is not going to help them be successful, you know, and so that's what I wanted for them. I wanted them to be successful. I wanted them to use their language, not have to check their code,
what I call now checking your cultures at the door. I didn't want them to feel that they have to check who they were just to be successful. They have to use the white man's English for me to understand what they were trying to say.

As a Haitian American teacher, she knew what it was like to feel "othered" because of her linguistic practices, so she wanted to create a space where the home language was science language for her Black American students.

Dr. Patterson discussed how she observed oppressive practices such as tracking in her school. In her experience, her less prepared white peers taught white students to make things easier for them:

I can say these words now because back then it was like you guys [are] just racist, but it was they did not have cultural competence…. So, they had tracking in their school so you could just tell the difference between one of my bells [class sections]'’. They had a lot of white students in it and those were the upper echelon students, and by the end of the day, I got kids trying to throw kids out of the window. But even in that class, you go sit down and we gonna do doggone science. So, my learning environment was always about creating a safe space regardless of whether or not the school culture supported it.

Although students who had been disregarded by the school and considered disruptive were the only ones enrolled in her class, Dr. Patterson continued to hold high expectations and have students engage in labs.

Ms. Phillip provided concrete examples for how she incorporated Culturally Relevant Pedagogy, specifically in her science curriculum. She regretfully remembered:

the whole school, the whole district is Black, the students, the teachers, the administration, our superintendents, everybody um school staff, the lunch lady like
everybody everywhere you go, we look pretty much you know the same, but that wasn't necessarily embedded in our teaching, and it wasn't necessarily always embedded in our curriculum.

Ms. Phillip chose to ignore the pressure of sticking to the science on the 8th grade NYC state exam and instead, she explained how she changed the curriculum to be more culturally relevant, with teaching science from a broader cultural perspective:

You know, I wanted kids to understand that there was science in Africa. There was science in the Caribbean. There's science that you know in Brazil, there's science everywhere in India. It's not just this European timeline that we that we teach all the time. I hung a poster on my door. That was a map of Africa. That had over it, I had a sentence strip that said, ‘Some of the earliest scientists came from’ and it was just like the map, and I would put like index cards up every week.

When thinking about why political clarity was so important in the science class, Ms. Phillip thought about her students and what they were not getting in their education:

They [her students] really have no idea [about African history in science]. And we're not telling them. And that bothered me, and it made me feel inadequate. Actually, I felt like I failed. I failed them by not telling them because nobody told me, and I should have known better.

Ms. Phillip thought it was paramount for her students to learn the truth about science history and debunk the myth of science as European or white property or see science as white property (Mensah & Jackson, 2018) that they can only borrow. Instead, science was their inheritance, it was theirs to own, mold, use, and enjoy.
Ethic of Risk

The third tenet of Womanist Pedagogy is the ethic of risk. There were two micro-themes in this section: (1) Collaboration and Community and (2) Positionality Informs Ethic of Risk. The ethic of risk tenet describes a womanist teachers’ engagement in social justice despite their understanding that oppressive, systemic inequalities are difficult to dismantle, and understanding they may never see outcomes of systemic change in their immediate work.

Collaboration and Community

The elder and post-service teachers gave language to how the ‘ethic of risk’ womanist tenet could be embodied in the science classroom. After years of teaching, Dr. Edwards accepted the fact that teaching was for the long haul, and it is rare to see your seeds bloom during the year that you teach a student and that sometimes some seeds won't bloom. There was a deeper meaning behind the classroom environment that the elders strived to create for their students. The elders prioritized building informed and active citizens for the future although they know they will never see the fruits of that labor. She reminisced:

You can work really hard, but you don't know [how things will turn out]. It is not always going to like pan out right away or that you might be like pushing this brick that's not going to move. [I didn’t realize this until some of them came] back and told me things that they experienced with me or things that they knew that I was influencing them, but I don't think I really realized that part.

Dr. Edwards has continued to hold onto this lesson as she continues to teach. She believed collaboration and community were integral to her classroom she shared:

I feel like it goes back to the need for the kids to have these skills … Very core skills that are applicable, not just in science, but applicable in history, English, and politics, no
matter what it is that they're reviewing. [They need] the ability to make informed decisions and have informed ideas and understanding…. I think what better way to sharpen those skills than to kind of develop this community where they're really talking through it and writing through it together.

Connected to collaboration was also decision-making. Making informed decisions is a long-life skill that goes beyond remembering science content. Dr. Edwards believed that allowing students to solve problems in her science classroom is integral to who her students will be in the future. She stated:

I also want them to feel like what they learned in my class is something that helps them to solve [problems and be the master of their] world. I helped you figure out these things, but you use this knowledge to figure out things about like being a good citizen doing good in the world. Figuring out how this information helps you to get there and that sort of thing. And so, I try to help them to see that through what we learned in class.

Doing good in the world can and should begin in the science classroom.

*Positionality Informs Ethic of Risk*

Dr. Patterson discussed how she saw her positionality as a motivator to teach for the goal of producing informed and active citizens of the future. For example, Dr. Patterson believed that how she presented science content was directly connected to her positionality as a Black woman, because being a Black woman science teacher “impacts how I teach, it impacts how I present science information, and then it impacts how [my] motivation or strong motivation to students to know like science is important and you need to be in it”. While, of course, Dr. Patterson would love it if all her students became science majors in college, what was more important was how they used their science knowledge as active citizens and future voters:
I don't just deliver content. I could go through and say let's memorize the periodic table, whatever, but I try to get them to understand that science impacts your life, you are citizens, and this will constantly be a part of the conversation.

Dr. Patterson’s science teaching was informed by the fact that science information could be used against marginalized communities:

Because you go hear people say stuff about science and you have to make an educated decision… I'm supposed to find out research, ‘does that even sound reasonable?’, not only because you got somebody in a white coat saying it. That doesn't make it true. So for students, I tried to make sure I create [informed] citizens. Use everything about me to make them STEM-conscious citizens.

In summary, Black women science teachers discuss and practice the tenets of Womanist Pedagogy in various ways. All 21 of the participants discussed how they showcased their caring when they described the safe environment and strong relationships they built in their science classroom, maintaining a culture of error in their class or when they discussed their reflections about tough love to teach Black students. Political clarity was discussed by the participants as they considered how the phrase “we must work twice as hard to get half as much” manifested in their science classroom and their teaching experience, how they tackled deficit mindsets and low expectations from their peers or when they engaged in critical reflection on their practice. The ethic of risk tenet was discussed by the elders and post-service participants as they discussed the importance of collaboration and discussion in their science classroom and how their positionality informed their desire to teach with their students’ future selves in mind.
4.6 Discussion

What we learned about Black women science teachers’ pedagogy is consistent with the literature on exemplary Black educators previously cited. This discussion section of the findings focuses on addressing the question: “How do Black women science teachers at various levels of experience discuss and practice Womanist Pedagogy?”. Beauboeuf-Lafontant’s (2002) framework further enables me to see not only the nurturing of Black women science teachers but also the political aspects of their pedagogy that could have gone unnoticed and even misinterpreted. The three tenets of Womanist Pedagogy help explain why and how the participants approach their science teaching.

While none of the participants had heard of this teaching philosophy and few are well-versed in the traditions of Black women teachers before them, all connect with and share teaching narratives that demonstrate their embrace of the maternal, political clarity, and ethic of risk of Womanist Pedagogy in their science teaching. Upon discussing what they learned about Womanist Pedagogy [based on reading the Beauboeuf-Lafontant (2002) article], participants reveal both a sense of belonging and validation—feeling that finally, someone has put words to what naturally came to them while teaching science. Most share they typically feel isolated from other teachers, or their white teacher peers who do not share in their approach to science teaching and are inspired by the acknowledgment of what they bring to science education.

Caring

These findings suggest that there is a new language for the teachers to describe the pedagogical practices of Black women science teachers. Despite repeatedly being othered (Hill Collins, 2000) at their school site and other professional spaces, the Black women science teachers in this study find a way to view their science content knowledge through a Womanist
Pedagogy framework (Beauboeuf-Lafontant, 2002). The novice and veteran participants resonate with the idea of ‘embracing the maternal’ when they discuss how and why they cared for their students, and when they display deeply personal energy that they pour into building relationships with their Black and Brown students. The relationships they build with their students are rooted in the classroom but extend beyond the science content into caring for the interest of the students and the communities they serve. Since the participants ground their teaching in caring about the students individually and collectively, they make their science content relevant, thus helping their students see themselves as scientists.

The novice and veteran teachers discussed creating a ‘safe space’ for their students. It is important to distinguish between a safe space for the student and that for the teacher. hooks (1994) shares that many educators think their class is a safe space when the “professor lectures to a group of quiet students who respond only when they are called on” (p. 39). The Black women science teachers in this study make sure to demonstrate deep care in their teaching by demonstrating that students and teachers are there to learn from one another and that the classroom is not just a place for academic learning. The classroom can also be a place where students come to get the things they need—like Ms. Noble who provides haircare products and snacks to eat. The participants embrace their maternal instincts by helping students feel safe and confident while working hard in the classroom. For the participants in this study, a safe space also includes “making the classroom a democratic setting where everyone feels a responsibility to contribute” (hooks, 1994, p. 39). Developing a ‘culture of error’ where teacher and student are seen as learners and equal participants in the science classroom was displayed by Ms. Newton and Ms. Neal.
Considering the historical significance of education in the Black community, Johnson (2017) considers the historical erasure of Black people in the science field and concludes that those who persevere can, unfortunately, feel pressure to be perfect. In some instances, tough love has been the response to push Black students past insurmountable odds in a racist society. The elder and post-service participants reflected on their own experiences and past teaching that could have inadvertently discouraged students. With time and experience, some of the elder and post-service teachers discuss an awakening that allows them to embrace softness and vulnerability in their science classroom. This finding falls in line with the literature about the ‘organized anxiety’ of Black educators (Okello, 2020) who shared that “Black folks, who continue to show up in predominantly white spaces, are the very embodiment of grit, sometimes to their own detriment” (p. 16). While the rationale for “why” tough love is necessary, such as lack of inclusion and persistence in the science field, and low expectations from other teachers, the more seasoned can alter this form of “tough love” so that their students could better receive the message and be encouraged by the challenge. This nuance fits within McClellan’s (2020) work where some of the students in the study were not able to always interpret their teachers’ actions as tough love and sometimes believed the actions to be too harsh and not uplifting.

**Political Clarity**

Like Black women teachers who teach other disciplines, “political clarity serves as praxis” for the participants, “as they practice enactments of their distinct ways of knowing about teaching and learning within an anti-Black society” (McKinney de Royston, 2020, p. 380). The participants demonstrate political clarity in their science teaching by seeing themselves as advocates for their Black and Brown students by speaking up in staff meetings when implicit bias or explicitly racist ideologies are shared. Political clarity, one of the tenets of Womanist
Pedagogy, details the motivation for why Black women teachers choose to acknowledge the historical silencing of Black and Brown people and use that knowledge to enact liberatory practices in their classrooms. Sociopolitical consciousness/critical consciousness, a tenet of Culturally Relevant Pedagogy, details what Black women teachers do with that political clarity on the lesson-level, how a teacher might transform a lesson so that students are fighting against the white status quo through activism, social awareness, and/or community uplift. Both tenets, political clarity and critical consciousness, explain how the motivations of the teacher affect the student while political clarity describes why the teacher makes specific decisions and critical consciousness describes what the teacher, and subsequently her students, does. For these reasons, these two tenets were coded interchangeably. For Black teachers, caring is not a private endeavor but a public and political act that involves advocating for Black students and working for social justice (Beauboeuf-Lafontant, 2005; Mensah, 2019). Witnessing deficit mindsets and low expectations from white peers fuel the need of Black teachers to advocate for their students both within and beyond the science classroom.

The teaching practices and classroom environment of a Black woman's classroom are not magical because her students just mystically listen and feel comfortable with her. The work is "deeply intellectual, part method and part improvisation" (McKinney de Royston, 2020, p. 384). For example, when Ms. Vaughn purposefully engages with her students with mutual respect and personality in her classroom, she creates an environment for learning science unlike classrooms of her white colleagues. Instead of being defeated by the fact that Ms. Vaughn’s white colleague pre-selected the ‘top’ students for her class, Ms. Vaughn used her ability to deeply connect with her students and connect the science to her students’ interests. This connection of practice, student, and content results in her students surpassing expectations in state test scores year after
year. Ms. Vaughn’s actions live within a long history of Black teachers doing more with less. By adopting a sense of accountability for their students, Black teachers in segregated schools modeled a motto of "you have to better than good if you want to succeed" (Siddle-Walker, 2000, p. 267). While Ms. Vaughn is not fighting against the status quo notion that poor, Black, and Brown students cannot achieve and persist in science, she uses this idea as motivation for the hard work and extra time she puts into her science teaching.

Advocating for the success of Black and Brown students outside of the classroom is not enough for Black women science teachers. They also advocate for their students to experience science for themselves. This mode of advocacy is an example of dismantling the notion of ‘science as white property’ (Mensah & Jackson, 2018). Thus, dismantling the notion of ‘science as white property’ (Mensah & Jackson, 2018) includes explicitly teaching science for students to enjoy for themselves. The teachers are also sharing political clarity with students as an act of empathy and high expectations. From pushing students to take AP science courses with teachers who express a lack of confidence in their students’ abilities and telling students they do not have the right to learn science, the participants provide tools to their students that help them try to survive in science learning spaces despite unfairness and systemic inequalities they will continue to experience.

**Ethic of Risk**

The participants in this study demonstrate an ‘ethic of risk’ by acknowledging that their teaching goes beyond the science content or the academic year to build STEM-conscious citizens. In this study, only the elders and post-service teachers explicitly showcase the ethic of risk tenet in their teaching. According to McKinney de Royston (2020), the ethic of risk tenet is "expansively understood to include personal growth, that is on-going, lifelong, and divergent" (p.
383). With more teaching experience and personal growth, the participants were able to showcase why using their teaching for the future lives of their students should be prioritized, developing STEM-informed citizens can lead to systemic change as they vote.

In the Patterson et al. (2011) study, teachers from the 1960s “inspired their students to believe they were integral to future influences of social justice in their school and also in their community .... they could collectively confront the segregated conditions and racism in the larger society” (p. 282). While at face value conditions for economically poor people of color have changed, segregation is illegal, disparities are arguably the same through resegregation (Wells, 2018). Dr. Evans continues the tradition of helping students see their potential influence in making systemic change by challenging their students to use their science knowledge to become politically aware.

Remarkably, Black women science teachers instill lessons, habits, and love in their students, knowing they may never see truly fulfilled in their students. With time and experience, the elder and post-service participants can embrace and understand that they may never see the fruits of their labor. Exemplifying the goals of the elder and post-service teachers, Dr. Edwards wants her students to be able to solve the problems of the world. This future preparation is done by teaching problem-solving and decision-making skills in the science classroom. The teachers who also know these skills are beyond just science learning. They set up their classrooms for collaboration, debates, and minds-on/hands-on science activities. They teach for developing active and informed citizens of the future. The participants point to how socio-scientific issues, such as responses to COVID-19, might have fared differently if their students were the ones making decisions in this country.
Implications and Conclusion

While many of the Black women science teachers in this study share their experiences of success in their classroom—such as helping their students master science concepts and skills and building strong and meaningful relationships with their students—the participants still express feelings of isolation, silence, and apprehension due to working in silos. I argue that Black women science teachers, and other historically marginalized teachers, would benefit greatly from learning about the pedagogical practices and theoretical views of Black women teachers from the past, such as learning about Womanist Pedagogy (Beauboeuf-Lafontant, 2005; Siddle-Walker, 2000). This will give them more insights and connections to what they are doing in the present, and the assurance of what they are going is grounded in Black women’s teaching philosophies. It also sends the message “you are not alone.” You are not alone in your advocacy to call on key figures in the community to attend the science fair, to push against “sticking to the script in the science textbook, or to link agricultural practices of today to the agricultural practices of African communities before enslavement. The Black women science teachers in this study are not alone but add to the lineage of pioneers in education who worked tirelessly for our collective good.

Teacher education and teacher professional development are key places for change in this effort to let pre-service and young in-service teachers of color know that they are not alone in their womanist practices. Thinking back to figures such as Anna Julia Cooper and Septima Clark, and many more as models for self-efficacy and confidence in the classroom, teacher educators can use these historical Black women teachers to support novice teachers as they fight against today’s racial oppression in the classroom and larger community. I argue that their narratives should be championed in teacher education, especially for Black teachers. Novice and veteran science teachers are learning too late, or not at all, about the practices that encourage racial uplift
for Black and Brown students and communities (hooks, 2015, p. 66), that can be supported and practiced in science classrooms.

While existing within the margins of science education, Womanist Pedagogy gives language to the magic experienced in Black women science teachers’ classrooms. Black women science teachers embrace their instinctive desire to demonstrate caring for their students, to advocate for their students, and to root their efforts in dismantling systemic inequities. With a Womanist Pedagogy guiding science instruction, the Black women science teachers in this study are encouraging and building STEM-informed citizens of the future. Students of color and white students alike can greatly benefit from these pedagogical practices. The science teaching and learning community have much to learn from the ways Womanist Pedagogy is displayed and discussed in this study.
Chapter V: “Things Your History Teacher Won’t Teach You:
Science Edition”: A Case for Historically Relevant Science Teaching

Abstract

Marginalized communities cannot and do not have decontextualized experiences with how socio-scientific issues, such as exposure to COVID-19 as frontline essential workers, high Black infant mortality rates, air pollution leading to respiratory problems, and other issues, affect their community. As K-12 science teachers and teacher educators strive to dismantle oppressive practices in their classrooms and curriculum, it would be helpful to learn from Black women science teachers who have been engaging in anti-racist practices before the racial awakenings of Summer 2020. In this study, three different virtual focus groups, or Sista Circles, were conducted with 18 Black women secondary science teachers. These Sista Circles had a wide range of experience, ranging from 1 to 22 years of experience, with teachers across the country, including international participants in Canada and Qatar. Black women science teachers enact antiracist science teaching by bringing something new to the community; using NGSS standards within the context of the community; teaching at the intersection of history, culture, and science learning and teaching; and building critical consciousness in the science classroom. When considering how science teaching and learning can be used within culture-based frameworks, I offer the term ‘historically relevant science pedagogy’ as an anti-racist framework for the science classroom.

Keywords: Black women science teachers, anti-racist science teaching, Culturally Relevant Pedagogy
5.1 Introduction

Marginalized communities cannot and do not have decontextualized experiences with how socio-scientific issues, such as exposure to COVID-19 as frontline, essential workers, high Black infant mortality rates, air pollution leading to respiratory problems, living in food deserts, etc., affect their community. Thus, students in marginalized communities cannot have a decontextualized, ahistorical science curriculum (Zembylas, 2005). Unfortunately, many K-12 teachers and teacher educators have not been prepared for the diversity found in K-12 classrooms which can result in a science curriculum that only maintains the white, status quo (Mensah, 2019; Underwood & Mensah, 2018). After the racial awakenings of Summer 2020, the education community, including science educators, have been grappling with how to meet the call for “anti-racist” practices and curriculum for all students, but especially students of color.

As the call for anti-racist practices has come to the forefront in our classrooms, some teachers have gotten stuck in using “culturally relevant pedagogy” or “liberatory pedagogy” or “culturally responsive” and “culturally sustaining pedagogy” as buzzwords without a deep understanding of both the critical self-reflection and curriculum shifts required to truly make these frameworks come to life and become impactful for their students. Teachers of color, especially Black women teachers, have a long-storied history of bringing anti-racist/anti-oppressionist pedagogy to life in their classrooms and curriculum (Johnson, 2017). As K-12 science teachers and teacher educators strive to dismantle oppressive practices in their classrooms and curriculum, it would be helpful to learn from Black women science teachers who have been engaging in anti-racist practices before the racial awakenings of Summer 2020.

For this study, anti-racist practices are used as an umbrella term for liberatory pedagogy (hooks, 1994/2015), Culturally Relevant Pedagogy (Ladson-Billings, 1994), and historically
relevant literacy (Muhammad, 2020). hooks (1994) noted, "for Black teaching—educating—was fundamentally political because it was rooted in antiracist struggle' (p. 2). Anti-racist practices within culture-based frameworks of science teaching are imperative for the growing population of diverse students since "un/knowingly, teachers perpetuate the misconception that science is hard for students who are non-white and/or who may not succeed on standardized examinations" (Dunac & Demir, 2016, p. 32). While researchers and activists have repeatedly argued for science education reform, their argument typically falls on deaf ears because science is treated as culture-free and objective (Karin et al., 2021). Science teachers "frequently misperceive culturally relevant teaching to be appropriate for language arts, social studies, and fine arts, but not for the so-called 'hard sciences'" (Boutte et al., 2010, p. 2).

5.2 Literature Review and Conceptual Framing

The Black women science teachers in this study demonstrate an art of science teaching that can be captured using the language of three culture-based frameworks of anti-racism — liberatory pedagogy (hooks, 1994/2015), Historically Responsive Literacy (Muhammad, 2020), and Culturally Relevant Pedagogy (Ladson-Billings, 1994). The following section is a combined literature review and conceptual framework where I discuss these frameworks and the literature that has used them. I discuss these frameworks in education as a preview for how the Black women science teachers in this study discuss anti-racist practices in their classrooms within the collective group of the Sista Circles.

Liberatory Pedagogy

Liberatory pedagogy, as conceptualized by bell hooks (1994/2015), can be exemplified by what hooks experienced from her Black female teachers as a child. Teachers involved in liberatory pedagogy understood that their work was political and exceeded the knowledge shared
in prescribed textbooks. Instead, these teachers taught a "worldview that would enable us to see ourselves not through the lens of racism or racist stereotypes but one that would enable us to focus clearly and succinctly, to look at ourselves, at the world around us, critically" (hooks, 2015, p. 49). Liberatory pedagogy is a "commitment to transforming the lives of Black people, to 'racial uplift', to ending racial domination" (p. 66) when students either take the space or are given the space to challenge and critique lectures, lessons or concepts that have been widely accepted by and maintain the status quo. hooks states, "that is the very essence of liberatory pedagogy" (2015, p. 66).

According to Castillo-Montoya et al. (2019), racially liberatory pedagogy is comprised of four central ideas: (a) affirming and sustaining culture, (b) raising critical consciousness, (c) centering relationships, and emotions, and (d) emphasizing intersectionality. In a class that is practicing liberatory pedagogy, students' lived experiences and cultural practices are viewed as valuable and should be used to "aid in their navigation of white, dominant culture, and support academic learning" (p. 1128). That academic learning must be used to inform students' political existence outside of education (critical consciousness). While in the classroom, the teacher supports equitable and mutual relationships that are rooted in caring while acknowledging and embracing the emotions that come along with being human. Practicing critical consciousness requires breaking the silence on issues that have been traditionally accepted and sometimes fighting to be heard. Teachers and students need to be supported during the emotional journey of the learning process that comes along as historically marginalized people find a voice in previously silenced spaces such as school buildings and classrooms (hooks, 1994). Lastly, emphasizing intersectionality within liberatory pedagogy includes raising the veil on multiple oppressive forces that marginalized groups face. For this study, liberatory pedagogy (hooks,
1994/2015) and racially liberatory pedagogy (Castillo-Montoya et al., 2019), which is a framework built on work by bell hooks, are being used interchangeably.

While exploring the science identity construction of Black women science teachers, Mohorn (2021) found that one of her participants exemplified liberatory pedagogy as she advocated for her students. Taking on the role of activist Keisha, the participant, “taught her students how to resist oppressive instructional structures that did not benefit them” such as the frequency of standardized testing (p. 105). As this participant strengthened her science identity, they were able to extend their acts of liberatory pedagogy by writing curriculum and facilitating professional development with activism at the forefront. Speaking regularly against injustice took time for this Black women science teacher but was imperative for her to her work.

**Historically Responsive Literacy**

Historically responsive literacy (HRL) is a framework rooted in the understanding that "we have largely withdrawn from the historical excellence of Black education" and the framework intends to influence "what we actually do in classrooms and schools" after hearing the narratives of Black teachers from the past (Muhammed, 2020, p. 21). HRL honors the literary presence that Black people have had in the United States since its inception. Black people did not want to passively exist here, instead, they found a literary presence by sharing their narratives orally. Historically responsive literacy is situated within 'culture-centered theories and frameworks' such as Culturally Relevant Pedagogy (Ladson-Billings, 1994) and Culturally Responsive Pedagogy (Gay, 2000) and specifically "draws on and responds to the histories, identities, and literacy and language practices of students for teaching and learning" (p. 49). HRL responds to the ahistorical and decontextualized approach to teaching culturally and linguistically diverse students that typically occurs when educators ignore the past practices of
Black educators. Like other culture-centered theories, HRL requires that teachers examine their history and biases so that they are better equipped to honor and more clearly see the political and social environments that marginalized communities exist within.

For this study, it is important to highlight the ways that HRL defines "criticality" and what it means to be "Critical". Muhammed (2020) urges readers to understand the role criticality plays in literacy education. It enables students to be "able to see, name, and interrogate the world not only to make sense of injustice but also to work toward social transformation" (p. 120). The goal is for students to be "Critical." Being Critical with a capital "C" is "connected to an understanding of power, entitlement, oppression, and equity", and not just thinking deeply about something with lower case c as "critical". For any teacher who considers themselves to be anti-racist, they must bring criticality to their schooling practices and their approach to curriculum.

While there are no studies that develop a Historically Responsive Literacy for science, a model has been developed with a focus on reading and mathematics (Muhammed et al., 2021). In this article, the authors problematize traditional reading and math research and practices to highlight the contexts in which students come to know and understand mathematics and to show how reading has been ignored. Thus, a Historically Responsive Literacy model can be used to better provide "explicit language around equity, anti-racism, and culturally responsiveness" (pp. 4-5). In their model of Historically Responsive Literacy, they provide three sample interdisciplinary lessons that have an anchored text that centers people of color, suggestions for images of people of color, and identifies which literary and mathematical skills students could practice while engaging with the text. The description of the lessons supports teachers making connections to students' home culture which allows for criticality in the lesson and for there to be joy embedded in the process of learning. While the examples use Black scientists as subjects of
representation in their examples, there are no lessons that allow students to practice their scientific skills and deepen their science knowledge.

**Culturally Relevant Pedagogy**

Originally developed in the early 1990s, Ladson-Billings (1995) defines Culturally Relevant Pedagogy as "a theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (p. 469). Over the years, Culturally Relevant Pedagogy has been theorized in classroom teaching (Tate, 1995; Morrison, et. al., 2008; Young, 2010; Esposito & Swain, 2009); teacher education (Allen & Hancock, 2017; Howard, 2003; Jackson & Bouette, 2018); and professional development (Brown & Warner, 2016; Christ & Sharma, 2018; Guerrero et al., 2017; Ladson-Billings, 2008; Johnson, 2011), but Milner (2017) argues that some have ignored race while focusing on this popularized pedagogy. Milner explains that for educators who claim to be culturally relevant teachers, explicitly focusing on race is the best way to address the needs of Black students on an instructional level.

Culturally relevant pedagogy (CRP) focuses on three tenets: critical consciousness, which challenges inequitable school and societal structures; cultural competence, which locates excellences within the context of the students’ community and cultural identities; and academic excellence, which is not based on cultural deficit models of school failure (Ladson-Billings, 1994), but on the cultural and linguistic assets that Black and Brown students bring to the classroom and curriculum.

In the last decade, CRP has been explicitly theorized in science education (Mensah, 2011; Mensah et al., 2018; Mensah & Jackson, 2018; Mensah & Underwood, 2018), with a few who prioritize sociopolitical consciousness of both the science teacher and the science student and its
influence on the science curriculum (Madkins & McKinney de Royston, 2019; Mensah, 2011; Mutegi, 2011). Sociopolitical consciousness is especially important in science education, "if we seek to change the historical hegemonic experiences of students of color" because as science teachers, "we need to address issues of race relations as they relate to science, society, and classroom" (Dunac & Demir, 2016, p. 38).

Boutte et al. (2010) argue that culturally relevant science teaching will “bridge distances between school instruction and ways of knowing and realities within the homes and communities” of Black students (p. 2). In their study, one teacher attempted CRP in their science lessons where students were able to develop cell cycle analogies using cultural references, connect DNA extraction findings to data and statistics in the Black community, and use the story of Madame C. J. Walker (the first Black woman millionaire in America who made a fortune thanks to her homemade line of hair care products for Black women) while learning about the integumentary system. The authors provided commentary on the lessons sharing that only some of the lessons fully represented the critical consciousness tenet, and those that did “connect science to other disciplines such as history” which can “propel students to take reflective action to address global problems in their classrooms and in society” (p. 9).

Brown (2020) has helped the science teaching community identify how to view our work at the intersection of culture, language, and science. Brown situated the experiences of Black and Brown students at the intersection of race, class, and language in the science classroom by challenging science teachers to appreciate the various ways in which Black and Brown students use their home language to make sense of scientific phenomenon and to use that skill as an asset. Brown urges his readers to take a “careful stance on how language impacts learning” (p.45) so that domain-specific science vocabulary is not a hindrance to science learning but instead simply
a different word to conceptually describe what they already know on some level. Culturally relevant pedagogy charged science educators to step back from the status quo and envision STEM of the future that is not only diverse in population but diverse also in thought and linguistic practices.

Madkins and McKinney de Royston (2019) position a Black male teachers’ political clarity as paramount in understanding how he enacted CRP with “the aim of developing his students’ sociopolitical consciousness” (p. 1333). Mr. Coles, the participant in their study, used references to racialized stereotypes to give students both the chance to consider power dynamics in how they are perceived and to take pride in their work as an act of resistance. Mr. Coles found ways to casually, yet pointedly demonstrate to students that they are fully capable of engaging in scientific inquiry but also that the world needs their [Black students] creativity and innovation. The findings in this study suggested that “a science teacher can use the subject matter to incorporate their clarity while developing their students’ critical consciousness” while also engaging students in naturally rigorous and engaging science phenomena (p. 1340).

In the above section, I defined three anti-racist, culturally based models of teaching that were inspired by and built by Black women educators. I also outlined how those frameworks have been used in the classroom and highlighted sociopolitical/critical consciousness as an undertheorized tenet of Culturally Relevant Pedagogy in science education. Taken together, these theoretical and conceptual underpinnings focused my study on ways that Black women science teachers promoted anti-racist practices in their science curriculum and their practices.

**Research Question**

By understanding the expertise and passion that Black women teachers have historically brought to their practice, it is important to learn how they have shifted their classroom and
curricular practices to be anti-racist in the science classroom. The research question for this study was: *How or in what ways do Black women teachers talk about their implementation of anti-racist practices through their science teaching?*

### 5.3 Methods

*Those of us who stand outside the circle of this society’s definition of acceptable women; those of us who have been forged in the crucibles of difference; those of us who are poor, lesbians, who are Black, who are older, know that survival is not an academic skill. It is learning how to stand alone, unpopular, and sometimes reviled, and how to make common cause with those others which we can all flourish. It is learning how to take our differences and make them strengths. For the master’s tools will never dismantle the master’s house. They may allow us temporarily to beat him at this own game, but they will never enable us to bring genuine change.* (Audre Lorde, 2018, p. 79; a 1979 panel presentation)

**Research Approach**

This study followed an intersectional qualitative methods tradition (Esposito & Evans-Winters, 2020). Black women teachers have learned how to stand alone simply because of their presence, but also because their approach to teaching has been “unpopular and reviled” as expressed in the Audre Lorde quote. Narrative inquiry with an intersectional lens was utilized in this study to give space for Black women science teachers to come together and share their stories and to also learn from the unique and brilliant ways they have enacted anti-racist practices in their work. Using intersectionality as an analytical framework and narrative inquiry as a methodological tool allowed me as a Black feminist researcher to focus on shared stories in the Sista Circles and to search for meaning behind the stories participants shared as it related to their overlapping identity markers, such as Black, female, and science teacher.

For researchers with an intersectional lens, narrative research can be used to “defy historical and contemporary racial oppression” (Tyson, 2003, p. 24), because reality is told from the perspective of the marginalized. Anti-racist teaching in science education is a form of
resistance. The lived experiences of the participants led them to enact anti-racist practices in their science classrooms thus defying the accepted norms of what is and what is not science education. Collecting these narratives in Sista Circles allowed for rich discussions amongst participants as they shared stories and examples.

**Setting, Participants, and Data Collection**

*Semistructured Focus Group Protocol (Appendix C: Sista Circle)*

This study occurred after 21 Black women science teachers engaged in one-on-one interviews where they discussed how their teaching practices connected with Womanist Pedagogy (Beauboeuf-Lafontant, 2002). During the one-on-one interviews, each participant was invited to participate in a focus group interview, which I refer to as sista-circles. Sista Circles regard “Black women’s experiences and wealth of knowledge as power. Black women participating in Sista Circles empower one another through the sharing of their wisdom and experiences” (Johnson, 2015, p. 48). The Sista Circle intended to “offer an opportunity for conversation to happen in a shared social setting that for some may feel more comfortable than the one-on-one conversation” (Edstrom, 2018, p. 46).

Rooted in African-based oral tradition and Black culture, the sista circle provided another space for participants to share their story with a “high degree of support for invoking dialogue as a dimension of Black feminist epistemology” (Hill Collins, 2000, p. 262). Knowledge was co-produced by the participants, rather than just by me and one participant (Chapter IV findings from individual interviews). The Sista Circles approach can reduce the researchers’ influence on findings more than one-on-one interviews (Edstrom, 2018).

Like the one-on-one interviews, the Sista Circles were held virtually. To schedule the Sista Circles, each participant was sent a Google Form and asked to rank which of the three
provided dates worked best in their schedule. The Sista Circles were also mixed by professional status to facilitate a “more interesting conversation” (Esposito & Evans-Winters, 2020, p. 100).

The Sista Circles were organized by participant availability and professional status. The goal was to have mixed professional status Sista Circles for as much as possible (Table 3). My advisor, Dr. Felicia Moore Mensah, a Black woman science educator, also joined each sista circle and engaged as a researcher-participant as well. Three of the participants who engaged in one-on-one interviews did not respond to the request to be involved in the Sista Circles.

Table 3.

*Sista Circle Participants*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sista Circle #1</td>
<td></td>
</tr>
<tr>
<td>Chrissy Perez</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Raven Vance</td>
<td>Veteran</td>
</tr>
<tr>
<td>Courtnie Vernon</td>
<td>Veteran</td>
</tr>
<tr>
<td>Dr. Jasmine Porter</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Briana Vaughn</td>
<td>Veteran</td>
</tr>
<tr>
<td>Dr. Ar'Sheill Martinez</td>
<td>Veteran</td>
</tr>
<tr>
<td>Sista Circle #2</td>
<td></td>
</tr>
<tr>
<td>Dr. Riley Patterson</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Ashley Vincent</td>
<td>Veteran</td>
</tr>
<tr>
<td>Charlene Proctor</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Dr. Stephanie Parker</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Antionette Newton</td>
<td>Novice</td>
</tr>
<tr>
<td>Leslie Phillip</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Sandra Eaton</td>
<td>Elder</td>
</tr>
<tr>
<td>Sista Circle #3</td>
<td></td>
</tr>
<tr>
<td>Whitney Nash</td>
<td>Novice</td>
</tr>
<tr>
<td>Dr. D’Vona Edwards</td>
<td>Elder</td>
</tr>
<tr>
<td>Dr. Rashidah Petit</td>
<td>Post-service teacher</td>
</tr>
<tr>
<td>Dr. Zubaidat Evans</td>
<td>Elder</td>
</tr>
</tbody>
</table>
Three Sista Circles took place over two months from October 2020 to November 2020. The sister circles lasted on average 120 minutes, and were conducted in Zoom, and recorded. During the Sista Circles, there were only two open-ended questions which were revealed at the top of each hour. Before each sista circle began with presenting the questions, the Black women science teachers were asked to engage with one another as they saw fit, and instructions were given that the interview questions were seen as a guide. If the conversation ventured off, then that was the beauty of a sista circle and should be honored.

During the first hour of the sista circle, participants were asked to introduce themselves and then discuss: “In what ways does caring or mothering, political clarity and/or ethic of risk show up in your teaching style? Where is there tension?” and during the second-hour participants were asked, “Thinking about Culturally Relevant Pedagogy or other anti-racist instructional theories, what curriculum shifts have you made, or do you imagine making that would be rooted in social justice or liberatory science instruction?” Each sista circle concluded by asking participants to choose a sentence starter for a concluding thought, “I am excited by...”, “I am still grappling with...”, or “I wonder....”

Data Analysis

In this section, I describe how the analysis process took place for the sista circle interviews. All three of the Sista Circles were transcribed initially using the Zoom software. I looked through the transcriptions while listening to the video recording to catch any chat messages that contributed to the discussion and non-verbal communication such as snapping fingers, showing affirmations through head nods, and laughing. After transcription errors were removed and corrected, initial coding began using the OneNote software.
I used Critical Race Theory, Black Feminist Thought, and Womanist Pedagogy as initial conceptual frameworks during the initial coding process. The initial conceptual frameworks I began with did not directly connect to the responses of all the participants, so while some participants brought up issues of ‘myth of meritocracy’, ‘colorblindness’, racism in endemic’ from Critical Race Theory and ‘the need for Black women to self-define’ from Black Feminist Thought, I decided to code the data more broadly by interpreting the participants’ responses. Interpretations were mainly written as my understanding of what the participants were teaching each other or sharing. For example, the following response was pulled from Dr. Everett, who participated in sista circle #1:

With science teaching … I'm all about connecting it to their real-life so that they understand that life is science and science is life and that kind of like connection that even if you're in a language arts class or in social studies class or whatever, like those concepts are all interconnected and that means that, like all things related to humans are interconnected.

Parts of this excerpt were coded as Wisdom and Interdisciplinary: Science is life and life is science (wisdom). Concepts are all interconnected (interdisciplinary). During the initial coding process, I read through each sista circle transcription searching for general statements, pieces of advice, and/or narrative sharing.

Next, I read through the codes and looked for umbrella themes that emerged from all three Sista Circles. Using the OneNote software, I developed tables for each emergent theme and re-read through the sista-circle transcriptions to find chunks of texts that fit under the theme. During this process, I color-coded responses based on the sista circle (i.e., sista circle #1 responses were light pink, sista circle #2 responses were regular pink, and sista circle #3
responses were highlighted with dark pink). This allowed me to identify which voices and where the emergent themes came from all three spaces. Three emergent themes captured voices from all three Sista Circles, “anti-racist/liberatory practices in the science classroom”, “lip service anti-racist work”, and “what is it like being a Black women science teacher?” After reviewing these three umbrella-emergent themes, I chose to pause analysis of the “What is it like being a Black women science teacher?” since participants had engaged in self-definition and discussions of their pedagogical practices in the first manuscript (Chapter IV).

After the “anti-racist/liberatory practices in the science classroom” and “lip service anti-racist work” emergent themes were chosen, I developed new tables to find descriptions of these themes for further analysis. For each of these two emergent themes, I pulled the responses under each theme and added a rightward column for the description. For example, the following transcript fit under the ‘anti-racist/liberatory practices in the science classroom’ emergent theme:

And they’re scared because they don’t want to seem like they’re that white teacher doing it [anti-racist teaching] with Black and Brown kids so I’m like, it's okay to bring it [race and racism] up. But that’s, that’s how I get through to [my white pre-service teachers] Like I bring up something as big as [the Flint Water Crisis] which still is going on. And letting them know about it and then teaching their kids when they're in the classroom (Dr. Porter, sista circle #1).

For this transcript, based on a discussion of the Flint Water Crisis, I assigned both a sub-theme name and description. The sub-theme and description allowed me to make sense of what the Black women science teachers in each sista circle had to say about teaching science and implementing antiracist practices. Within the Sista Circles, teachers added to and expanded on the conversations by giving examples of their practices, how they were making shifts to their
curriculum to be more “anti-racist”, “liberatory”, or “culturally relevant”, while also discussing how they had experienced their mostly white teacher peers reacting to “anti-racist” agendas because of the racial awakenings of Summer 2020.

For the next step in the coding process, the sub-themes and descriptions were separated to identify both general statements amongst the participants and nuanced statements. For instance, for the ‘Example of CRP in science’ sub-theme, there were several descriptions, such as “place-based examples in Detroit”, “best practice in liberatory science teaching (NGSS done well)”, and “teaching at the intersection of history, culture, and science.” With the sub-theme, description, and transcription in one row, I was able to identify and group the transcript for further analysis (example can be found in Appendix E).

As a last step in the analysis process, I re-evaluated the sub-themes by identifying which sub-theme titles and descriptions spoke to one another. For example, three descriptions spoke to how participants believed that it was important for science students to bring their culture with them as they learn science processes, in other words, using the NGSS (Next Generation Science Standards, 2013) within the context of the community. Those three descriptions were: (1) constructing explanations about natural phenomena in their neighborhood, (2) crosscutting ELA into science by using storytelling as an entry point, and (3) asking questions and asking critical questions in the context of the students' reality with science. All chunks of texts that fit under these descriptions were placed in one column to generate and finalize the themes. The data analysis process resulted in four themes discussed below.

Validity

Validity is the accuracy or credibility of a conclusion or interpretation (Maxwell, 2005). According to Maxwell, validity should be incorporated into the research design and is comprised
of the strategies used to identify and eliminate inaccuracy. Maxwell identified collecting “rich”
data and member checking as procedures to increase the validity of conclusions. “Rich” data
refers to “data that is detailed and varied enough that they provide a full and revealing picture of
what is going on” (Maxwell, 2005, p. 110). To obtain rich data, I asked participants to provide
details about specific events or occurrences and asked additional questions to receive
clarification or more information. Member checking is requesting feedback about my
interpretation of data (Maxwell, 2005). During member-checking, participants were asked by my
advisor and myself to clarify what they meant by a specific work or I paraphrased my
understanding of something a participant said and asked her to verify my accurateness.

During the data analysis process, I continuously engaged in peer debriefing (Spall, 1998)
with my advisor and a peer to verify how I developed sub-themes from the raw data and how I
connected different theoretical frameworks to themes that were emerging from the data. While
developing sub-themes, I met with my advisor and a peer monthly to support me as I organized
themes in the various Sista Circles. After verifying specific themes, my advisor supported me by
encouraging me to use specific anti-racist frameworks (specifically Liberatory Pedagogy and
Historically Responsive Literacy) as a tool to analyze my emerging themes. Furthermore, to
increase consistency, I verified my final themes with my advisor as we considered the tenets of
each theoretical framework.

5.4 Findings from the Sista Circles

In this section, I present an answer to the research question: How or in what ways do
Black women teachers talk about their implementation of anti-racist practices through their
science teaching? The findings are grounded in my analysis of the Black women science
teachers’ participation in Sista Circles and their examples of anti-racist practices in their science
classrooms as described by liberatory pedagogy, Historically Responsive Literacy, and Culturally Relevant Pedagogy. The following four themes emerged across participants’ science teaching from the Sista Circles: Black women science teachers enact antiracist science teaching by (a) bringing something new to the community they are serving while also honoring the norms and culture that is already present, (b) using NGSS standards within the context of the community, (c) teaching at the intersection of history, culture, and science learning and teaching, and (d) building critical consciousness in the science classroom.

Based on the conceptual framing of anti-racist practices, each theme is developed through evidence from three Sista Circles to bring key teaching goals, ideological tools, and activity into focus. Multiple examples are included in each theme to acknowledge the variation in teaching within each theme. In the findings section, I use collective language such as “we” and “us” when sharing the wisdom from the participants. As a researcher-participant, I was part of the sista circle discussions too.

Bringing Something New to the Community

Anti-racist practices in the science classroom include teachers bringing something new to the community they serve while also honoring the norms and culture that are already present. The participants did not view themselves as a ‘savior’ for their students, but instead saw and honored the assets, realities, and histories of their communities while teaching science. When we discussed how we engaged in anti-racist practices in our careers, Dr. Porter and Dr. Petit discussed bringing something new to the community. For example, Dr. Porter took students outside of their Brooklyn, New York community so they could engage in more natural phenomena. Where her peers were apprehensive in taking their students out of the classroom, Dr. Porter made this a core aspect of her middle school science class. She explained, "no one was
really doing that at the school. They [the mostly white teachers] were scared, and no one was renting a coach bus going to fly fish and [even when we went to] an art museum, I related everything to science." Where Black and Brown students are typically confined by place and space due to white teachers' apprehension, Dr. Porter believed that camping outside of New York City and getting to simply explore were worth the extra work.

While teaching in Newark, New Jersey, Dr. Petit organized science fairs year after year at her school and received little support. She thought of the science fairs as "an opportunity [for her students] to become experts as well as really delve into topics that they might be interested in." During the seven years that Dr. Petit facilitated science fairs, she started to bring external organizations to the school such as NASA. Throughout the years, her students participated in science fair competitions. She started to notice that the only group with students of color (Latinx) present was her students. She introduced students to science fairs to share new things with students and to build social capital within the school. Students who attended science fair competitions would come back to school to share and inspire others to do the same.

Using NGSS standards Within Context of the Community

In each of the Sista Circles, Black women science teachers identified various ways they made cultural and socio-political connections to science while using the Next Generation Science Standards (NGSS, 2013) science and engineering practices and connections to the Common Core English Language Arts (ELA) and literacy standards. The participants specifically identified ways they have had students construct explanations about natural phenomena in their neighborhood, how they have embedded ELA into science by using storytelling as an entry point to their lessons, and having students ask critical questions in the context of the students’ lived experiences with science.
Ms. Phillip helped us understand that "science is a cultural endeavor." We cannot engage in the science process authentically when as marginalized groups we are asked to leave our culture outside the science classroom door. She continued "you bring your culture with you when you ask a question, you bring your culture when you look at the data, [and] you bring your culture when you make an explanation.” Others in the sista circle agreed with Ms. Phillip by adding comments in the chat space and nodding their heads. Ms. Phillip spoke about what we shared as anti-racist practices in the science classroom.

Several participants discussed the NGSS standards (2013) explicitly in various ways. The participants elevated the usefulness of the NGSS standards, and they believed the standards provided instructional tools that required high levels of student thinking. The participants also said that while the NGSS standards were a good step in the right direction, using the NGSS standards without the context of the students in the classroom was unacceptable. Ms. Vance, for example, shared her critique of the lack of 'equity' embedded in how science educators have used the NGSS standards: “What have we been doing in this almost 10 years? We've been writing a new curriculum to build NGSS. So, everyone's like ‘equity equity equity’, ‘anti-racist teaching,’ but nothing has changed. So, to me, it's just lip service.” Contrary to what they have observed from their peers, the participants identified ways they honored the cultures, realities, and experiences of their students while using the NGSS standards. Exemplified by Ms. Perez below.

Ms. Perez helped us see that some anti-racist practices are naturally embedded in the NGSS (2013), but the content also must be made relevant to the community. NGSS practices that include the context of students help with building informed citizens, especially to refute false information running rampant, such as not needing masks while fighting an air-borne illness or listening to misinformation that vaccinations are made to control people. She reflected:
We implemented the Next Generation Science Standards, and I found by implementing them that it gave the students more agency, and what they were struggling with was asking questions and part of being a good citizen is, you know, asking questions. You know, using claim evidence and reasoning which we know we need in the world right now, with all these false claims that are around. So, I would say any curriculum that promotes student agency, the ability to ask and answer questions and carry out investigations that are in the NGSS, I have found to be helpful, but the curriculum has to be relevant to the student.

Encouraging students to ask questions is imperative for Black and Brown communities because sometimes asking questions is viewed as disrespectful. But asking questions in science can be tied to social justice because science is typically presented as facts and facts have historically hurt marginalized groups when not questioned. Consider the Tuskegee Syphilis experiment of 1932 to 1972 or the results shared from the Eugenics movement of the 20th century. We must start questioning what we perceive to be facts in science in the K-12 setting.

Dr. Porter supported the idea of asking questions as an imperative practice for Black and Brown students. "I feel like depending on how you grew up. Right. Um, you don't question anything sometimes like you're just like, okay, it's science like it's a fact like you know?" Dr. Porter continued to share that students need to ask simple questions about what would happen when a variable is changed in a scenario, so she could support them as they gained the confidence to ask more Critical questions of the world and how science has been used in it. She wanted their voices to no longer be subdued.

Ms. Vernon helped us make connections between Common Core ELA/Literacy practices and science by using storytelling as an entry point to a lesson. In her work, Ms. Vernon used
storytelling as an entry point to a lesson before giving students the chance to ask scientific and sociological questions. After students generated questions, they would go outside to explore evidence to answer their questions. For example, in her class Ms. Vernon had her students imagine they entered a space where there was blood and feathers everywhere. She asked them, "'what questions do you have about what happened?' … we started to think about what a scientist's questions would be, what a sociologist would ask or like grouping those, and I'm like, ‘well, we're all asking questions. It's important for everything’”. For her students to feel free to use and enjoy science, Ms. Vernon believed science should be explored within their community by asking questions. Dr. Patterson also believed in the power of connecting ELA/Literacy and science. She shared that when she worked with the ELA team at her school "it really opened up people to understand how robust science is." Students were able to engage in project-based learning while using a story or narrative as a guide for their projects.

**Teaching at the Intersection of History, Culture, and Science Learning and Teaching**

In the Sista Circles, participants discussed how they have shifted their curriculum to incorporate anti-racist practices. Some of the examples and explanations revealed that their work lived at the intersection of history, culture, and science learning and teaching. We could think of this as "things your history class won't teach you: science edition,” said Ms. Phillip. Ms. Phillip helped us learn that there is so much history missing in science. She shared:

Everyone knows about Newton and Einstein and still, there are so many people missing in between these names and faces. …. What are we doing, right, like what are we doing to fill that in [so that our students' cultures are filled in and that our students are future faces in the timeline]?
The teachers felt it was important to not only fill in the timeline with erased knowledge of Indigenous and African contributions to science but also to diversify the future of science by sharing a more complete history of science. She provided an example to illustrate how she shifted her curriculum to incorporate anti-racist practices:

I had a map of Africa on my door. And above it, I had like a sentence strip that said the ‘first scientist came from’, and I used to put like little index cards on the map with different things that were, you know, scientific ideas that came from Africa. Sometimes students would respond in disbelief.

I had kids that were like, ‘oh no I thought science was Greek, and I thought, you know, that that's where it came from.’ And that's, and I was like, ‘oh my God, baby. Where do you think they got it???’.

Ms. Phillip extended this teaching at the intersection of history, culture, and science learning and teaching to her science education courses. Even as a teacher educator and informal science educator today, she revealed one of the main reasons African people were enslaved and dragged to America—for their agricultural skills:

You know, I work in a garden and agriculture. Hello. That's why we're here. That's why we're [points to her Black skin] here—agriculture because they couldn't figure out how to do it themselves when they got here. But we don't necessarily own that as a thing of pride right like that. That's us. We knew how to do this. We grew rice. So, they went and got us took us ...to South Carolina and said, 'grow this rice'.

Teaching at the intersection of history, culture, and science learning and teaching can include more contemporary events. Dr. Porter pushed her white pre-service science teachers to bring this intersection into their future classes. She had discussions about the Flint water crisis of
Detroit, Michigan, and how to bring the topic into the science classroom. As the instructor, she encouraged her pre-service teachers to engage in anti-racist instructional practices because she believed all (teachers of color and white teachers) must get the job done. She shared, "and they're scared because they don't want to seem like they're that white teacher doing it with Black and Brown kids.” Dr. Porter makes sure to push the pre-service teachers beyond their comfort, “Like I bring up something as big as that which still is going on. And let them know about it and then teach their kids when they're in the classroom.”

According to the participants, teaching at this intersection typically did not fit within the school-based science curriculum. We talked about what the purchased curriculum prescribed and how it failed to meet the needs of our students. Since the racial awakenings of Summer 2020, school officials and curricular providers have consistently used the buzzwords, such as "DEI", "equity" or "anti-racist", but the participants were finding that they must work in direct opposition to their schools to teach the way they thought was indeed from beliefs of equity. Dr. Edwards shared that she had to ignore guidance from her school when they instructed teachers to ignore the realities of their students. We cannot ignore the effects of COVID-19 and events like Katrina on Black and Brown communities. While thinking back to teaching during the 2019-2020 school year, Dr. Edwards shared that she had a student whose caregiver died of complications due to COVID-19:

I can't tell her how she needs to deal with this, right, but I can make the space in my room for her to be able to experience and to learn and to figure out what she needs to do and what she wants to do as a result of this and knowing that her life is not going to be the same. And so, I think that you know, I felt that also in New Orleans when we had a hurricane. I was there.
For Dr. Edwards, teaching at the intersection of history, culture, and science learning and teaching included not ignoring the realities students had experienced when living through a historical event. She taught in this way, despite her school officials who told her to lie. She said, "Our administrator told us like, ‘you have to tell them, everything's gonna be okay and everyone's going to be back.’" She did not feel this was honest. Instead, she allowed space in the classroom for students to talk about painful historical events and connected them to science in later lessons.

Ms. Nash shared that she was gaining the confidence to ignore her school officials to make room for the needs of her students. Her goal was for her curriculum to also live within the intersection of history, culture, and science learning and teaching which required her to go "rogue". She admitted, "I literally every week, I go through and shave some things away. I don't talk to the administration about it anymore because before it was a fight, but now I'm like, my kids are first, our students are first." Although her school administration used the right buzzwords, they were not supportive of her in making the appropriate shifts to her science curriculum:

So, if I keep listening to them [the administration], then at the end of the day I wouldn't be the teacher that I would want to be. So, I just put in my representation and changed the curriculum. Going rogue has been really helpful for my kids to be more connected to the science curriculum and for my class to still be invested in science.

Dr. Patterson advocated for the intersection of history, culture, and science learning and teaching to be highlighted outside of Black History Month. She opined, "It's not just Black history month. We incorporate history with the periodic table … with ecology … it's no longer just memorizing the scientists who came up with the theory or the law." Instead of relegating
Black science representation to one month, Dr. Patterson asked us to consider with students, “‘why did that happen?’ 'what team were they a part of?’, 'who else did they work with?'' to help students uncover silenced and erased people from science history.

Dr. Stephanie Parker gathered universal support through head nodding and affirming responses when she summarized the following:

We know that we need to give our students exposure to those things (science and history-centered projects) because we need to have them. We need them to tap into or develop their critical consciousness. We need them to challenge why things are the way that they are, and you cannot do that by reading a book and memorizing standard history.

The participants agreed that discussions of socio-political issues in the science classroom were a necessary aspect of their teaching philosophy.

**Building Critical Consciousness in the Science Classroom**

In the Sista Circles, the participants shared their understanding of why building critical consciousness for students is imperative in a science classroom. The participants reflected on their past practices and identified that hands-on activities, such as labs, did not always mean that students were retaining information, and students needed more to achieve a conceptual understanding. Conceptual understanding required students to repeatedly come back to a concept and ask questions to develop a strong claim, evidence, and reasoning. This is connected to social justice because our students need to be able to disaggregate between false claims and information that has the best interest of our community.

An example of building critical consciousness for conceptual understanding in science classrooms included place-based teaching. When teaching in Detroit, Ms. Perez taught about diabetes, a disease that heavily affected Black people in the community. She encouraged students
to ask questions about the socio-political factors in the community that created these conditions, such as redlining and food deserts. She shared:

I had the greatest success with a diabetes unit that I did, and that's because so many of the students were impacted by the fact that they had family members, with that being so, they were very interested in that.

While watching video clips from Detroit, her students were pointing out, “Oh, I know that place. I know that place.” Students were given space to make connections to their community also and ask questions before developing evidence-rich claims about issues. Students were able to continue to practice asking scientific questions when she introduced a unit on floods.

Supporting students to build their critical consciousness was imperative for the teachers. Ms. Newton questioned her science instructional coaches about what were people teaching before the uprisings: "were people not doing this kind of thing [before]? So for me, I was just like, ‘yeah, this is really a waste of my time because this is what was coming to me naturally.’"

Ms. Newton’s comment pushed us to consider, "What were y'all (the science education community) doing before you saw multiple Black people have their lives taken on screen?", "How were you all talking to your students before?” What a privilege to have been able to ignore the realities of Black and Brown communities before Summer 2020. The Black women science teachers in the Sista Circles did not choose such a privilege.

Dr. Parker shared why building critical consciousness with her science students was important for her. Debunking the myth of meritocracy (Delgado & Stefancic, 2017) is so important amongst Black educators in science. “Yes, your bootstraps worked for you, but you cannot outwork systemic oppression” (Dr. Parker). She shared that for the few Black educators who have been successful in the science field, we needed to fight against the tendency to believe
that because we worked extremely hard that we must build that same grit in our Black and Brown students. When Black science educators fall into the cycle of continuing oppressive practice with our students, "we oppress our kids because it worked for us because we ‘outworked’ (participant emphasis) ourselves to be successful in science. She added, “You can't outwork systemic oppression. There's no amount of work that you can do that's going to outwork these [white] people.” Dr. Parker was helping us understand that being a Black teacher in the classroom was not enough. Because racism is endemic, we need to have community amongst ourselves to help us identify when the smog has entered the room. In general, as Black educators, and specifically as Black science educators, "we need to buck the system, and it can't just be one person alone in their room using anti-racist pedagogy for Black people, because sometimes Black people adopt those beliefs about our children” (Dr. Parker). We are working for systemic change; sometimes even Black teachers enact racist ideologies in a school system.

As a science teacher educator, Dr. Mensah, a researcher-participant in the Sista Circles, shared examples of historical events that connected science and Black and Brown communities to white pre-service teachers. She said she wanted her pre-service teachers to be informed so they can teach historical events: After talking about a socio-scientific topic, she said:

Then I turn to say now you know, because I told you and showed you examples, so you have to continue to do this. And continue to get professional development on it, and I let them [her pre-service teachers] know this is a lifetime project, but the moment of trying to do it is now.

Now that the pre-service teachers in her class know about the issues, she would teach them that they can no longer hide behind the excuse of ignorance. Too many of our students will have teachers who ignore the realities of how science has affected marginalized communities. While
she encouraged her students to engage in supporting the critical consciousness of her students, she helped her pre-service teachers see that "children are continually going through the educational system, yet you have the one class or the one grade, but students are continually going through." Teachers must teach and prepare students for that year they have students in their class. White teachers must take on the charge to support their students so that having a well-rounded anti-racist science education does not only happen the few times the student has a science teacher of color.

Discussion

The purpose of this article was to examine ways in which Black women science teachers discuss implementing anti-racist practices in their science classrooms. Although participants did not always explicitly name which anti-racist framework they were working under Liberatory Pedagogy, Historically Responsive Literacy, or Culturally Relevant Pedagogy, they enact the foundations of these culturally based frameworks in their science teaching practice. In other words, Black women teachers answer the call for how anti-racism can be modeled in a science classroom by displaying various acts of criticality, an understanding of power, entitlement, oppression, and equity and its role in education (Muhammad, 2020). In this section, I summarize the findings to the research question by highlighting how three anti-racist frameworks used in this study can be merged in the context of science teaching and learning.

Critical Consciousness or Criticality

Critical consciousness or criticality is a tenet that lives in each anti-racist framework and all four themes from this study. Bringing new experiences to students of color, while also honoring the assets in their community is an act of criticality (Theme 1). An underlying component of Theme #1 includes bringing joy into the classroom by extending their science
learning experiences outside of the classroom and into their communities. Racially liberatory pedagogy (Castillo-Montoya et al., 2019) and Historically Responsive Literacy (Muhammad, 2020) share joy as a tenet in their frameworks. In the Sista Circles, the participants discuss bringing joy to the classroom environment in many ways, but they specifically discuss science fairs and field trips as a source of joy for their students.

In the Sista Circles, participants discuss science fairs and field trips to expose their Black and Brown students to scientific inquiry that would have been impossible by only looking at a textbook. These new experiences are developed in a way that involves student, family, and community participation while also building students’ social capital—a person’s current and potential social networks (i.e., formal, informal) and resources that include knowledge and accomplishments that can be utilized to succeed in social institutions (Yosso, 2005). Facilitating and planning for science fairs and class trips require parent involvement because of the overnight nature of the activity. The schools never gave students these opportunities, so trust needed to be built. Community members are always invited to participate in science fairs and a sense of community is built amongst students and staff as they travel outside of the city for science trips. For example, Dr. Petit displays her criticality for several years building the science fair program at her school. Eventually, her students were invited to NASA science fairs where they were the only Latinx students present, showing both the NASA community and the students themselves that they deserved to be in these spaces. With joy and honor, students return to their school and home community with additional clout science knowledge to share with their classmates from engaging in this external activity.

**Giving Space to Ask Critical Questions**
Giving space for students to ask critical sociological and scientific questions (Theme 2) is an act of criticality. Critical consciousness requires "awareness and understanding of sociopolitical structures and issues shaping the experiences of Black people” (Castillo-Montoya et al., 2019, p. 1128). The National Research Council’s (2012) Framework and NGSS (2013) identify eight science practices that are useful and essential for all students to learn. The first of these practices — asking questions — encourage teachers to give students the space to clarify and describe how nature works in the world around them and to examine those questions within the constraints of their classroom or their surrounding environment (Madkins & McKinney de Royston, 2019).

A teacher who is using their informed political clarity to influence how they use criticality in the classroom understands that this “inclusive notion about what resources are needed to do and understand science is critical for contexts where students grapple with sociopolitical realities and inequalities in and out of schools” (Madkins & McKinney de Royston, 2019, p. 1323). The Black women science teachers in this study exemplify critical consciousness using their political clarity to highlight aspects of the NGSS framework (2013) that require their students to practice critiquing the pre-established scientific concepts daily, seeing themselves as science-producers.

Critical analysis, inquiry, and dialogue about scientific topics can position students as teachers and learners, which “connects science to other disciplines such as history...and can propel students to take reflective action to address global problems in their communities and in society” (Boutte et al., 2010, p. 9). Using historical knowledge to make sense of socio-scientific issues today (Theme 3) is an act of criticality. Examples of socio-scientific issues typically address cloning, gene therapy, embryo selection, xenotransplantation, action over the
environment, disposal of waste, conservation of energy (Levinson, 2006), and more recently topics such as the “allocation of scarce medical resources revealing common themes that included fairness; pragmatism; emotive reasoning, utility; and theological issues” (Zeidler et al., 2019, p. 8). While these socio-scientific issues are important for students to investigate, they do not require students and teachers to use their racialized, classed, and gendered lived experiences as contexts for the scientific topic. Racialized, classed, and gendered connections to socio-scientific issues cannot be ignored (Akbulut & Demir, 2020).

Freire (1970/1996) defined critical consciousness as 'learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality” (p. 17). Teaching at the intersection of history, culture, and science learning and teaching is a display of critical consciousness when teachers use their political understanding of socio-scientific issues to challenge and encourage their students to provide awareness to their community, engage in social activism for change and/or become an expert on socio-scientific issues for future purposes that positively affect the community. In the Boutte et al., (2010) study, two examples show how science teachers used CRP in their classroom. In one of the examples, the teacher uses historically significant events to support students in building their sociopolitical/critical consciousness. In another example, the teacher had students engage in a science research project on extracting DNA which could lead to “very complex dialogues of genetics and history (e.g., how African Americans genealogies were affected by the trans-Atlantic slave trade and related ethical issues)” and where students could also discuss the racially-charged controversy surrounding the death of Dr. Charles Drew, a Black inventor who “established the American Red Cross blood bank… and who organized the world’s first blood
bank drive” (p. 9). These examples illustrate ways teachers can teach at the intersection of history, culture, and science teaching and learning.

Participants discuss project-based learning in conjunction with using history as a focal point in science learning. The participants in this study have already started to reposition everyone in the classroom as teachers and learners (Freire, 1970/1999) by viewing students as a source of information by letting them research topics. Teaching at the intersection of history, culture, and science teaching and learning for the participants is a manifestation of their epistemology as Black women science teachers. The participants choose not to ignore the racialized, classed, and gendered connections that students can make to the science content in their classroom. Sometimes they allow students to exist at this intersection through daily tasks, such as adding new historical facts to the “scientific ideas came from Africa” wall or engaging in longer research-based projects such as learning about a water crisis in Detroit, examining conditions that create food deserts, or tapping into the erased history of Black and other disregarded scientists in American history.

**Bringing Critical Consciousness to the Science Classroom**

Building critical consciousness in the science classroom is an act of criticality that requires shifts both in the curriculum and self-reflection to ensure neither is maintaining the white status quo (Theme 4). This finding falls in line with recent literature that reveals “developing students’ sociopolitical consciousness relies upon the [political] clarity of science teachers as enacted through instruction” (Madkins & McKinney de Royston, 2019, p. 1325). This last theme, bringing critical consciousness to the science classroom, is an overarching theme that provides the rationale underneath why the participants choose to bring new experiences to their students, have students ask Critical questions, and why they teach at the
intersection of history, culture, and science learning and teaching. The most distinguishing factor of the final theme includes the act of self-reflection and how it influences the classroom for the participants.

The participants in this study recognize how their students' forms of knowledge are positioned in and out of schools to reproduce systems of inequality that privilege forms of knowledge of white, middle-class students over those of racially and economically minoritized students. For these reasons, the participants engage in Critical self-reflection to consider ways in which the myth of meritocracy (Delgado & Stefancic, 2017) shows up in their narratives that they unknowingly may share with their students. They advocate for themselves when their schools do not support the expression of their critical consciousness and shift their curriculum to be community and place-based, so connections are more palpable for students.

**Implications**

Muhammed (2020) shares the motivation behind building the Historically Responsive Literacy (HRL) framework. She hears "that teachers and school leaders understand culturally relevant/responsive education as a theory and understand its meaning" but there is "confusion about what to do exactly" (p. 49). One of the goals of the study is to share insight on how to embody HRL and other anti-racist frameworks within the context of science education. hooks (2015) shares that her past Black female teachers "offered us a legacy of liberatory pedagogy that demanded active resistance and rebellion against sexism and racism" (p. 50). This demand for active resistance and rebellion is the same call for critical consciousness embodied in the work of Ladson-Billings (1994). Often ignored is the third tenet to Culturally Relevant Pedagogy, sociopolitical consciousness or "the ability to take learning beyond the confines of the classroom using school knowledge and skills to identify, analyze, and solve real-world problems" (Ladson-
Billings, 2014, p. 75). Black science teachers see this as an important part of their antiracist science teaching.

In science education, we can use the language of criticality as explained by Muhammed (2020) to make sense of how we can transform our curriculum in the pursuit of liberation. Instead of teaching facts, we must teach truths. While "facts do not capture the full narrative of people but are taught in schools as the histories of people of color", for example, COVID-19 disproportionately resulted in the death of Black and Brown people in America and around the world, in turn "truths, are the realities and lived experiences of persons experiencing the moment, which equally contribute to the same narrative" (p. 120). The death of Black and Brown people was not due to a moral failing but to systemic conditions that left marginalized communities with few options to stay home and remain safe. Our science curricular practices must hold truths that "move toward listening and honoring the voices of the marginalized person" (p. 121).

Given the focus of this study, I offer a theoretical contribution that merges and distinguishes three differential anti-racist educational frameworks: Culturally Relevant Pedagogy (Ladson-Billings, 1994), Liberatory Pedagogy (hooks, 2015), and Historically Responsive Literacy (Muhammed, 2020). With this body of work in mind, I conceptualize how these three frameworks complement each other and how they can be used in the service of science education, a field that can benefit from using these frameworks. When considering how science teaching and learning can use these three frameworks, I offer the term ‘historically relevant science pedagogy’ as an anti-racist framework (displayed in Figure 1). This anti-racist framework fits in a storied history of Black teachers that "developed a unique instructional style that blended teaching the required white school curriculum with fostering an understanding and pride in Black culture and history " (Patterson et al., 2011, p. 269).
Below is an example of how the three frameworks can fit together. I share how science teaching and learning exemplified by the participants fits with the newly conceptualized historically relevant science pedagogy. Muhammed (2020, p. 30) shares the following three ways to engage literary pursuits in the classroom:

1. Engage students with texts that create social action and cause them to think differently as a result of what they read.
2. Create an environment that affords students the opportunity to shape their own ideas through acts of literacy.
3. Structure opportunities for critiquing and evaluating what students read and write about within the instruction.
These three ways of engaging literary pursuits are essentially CRP's sociopolitical consciousness tenet and racially liberatory pedagogy's (Castillo-Montoya et al., 2019; hooks, 1994; hooks, 2015) by raising critical consciousness and emphasizing intersectionality tenets in action in the ELA and history classroom. Not only is the teacher tapping into their sociopolitical consciousness by opening their curriculum to teach within the context of the community they are serving, but the curriculum is also encouraging students to engage in social action and practice as active citizens. They have the power to create change and can use the content of their class to spark community activism.

Historically relevant science teaching as a framework for this study affords students the same opportunities through daily acts such as asking sociological and scientific questions about a natural phenomenon and engaging in longer research projects that result in social action. Research projects can include, but are not limited to, high diabetes rates in Black neighborhoods because of predatory marketing and food deserts; increases in asthma in urban areas because of air pollution; examining the effects of coronavirus on communities of color; studying the history of indigenous medicine. All these projects allow students to dig deeper into how a socio-scientific concept operates in the real world and give them a chance to engage in social action by sharing with their school and home community, organizing protests, etc. In this study, Black women science teachers have students engage in literary pursuits by having them create visuals to display the contributions Africans and Black people have made to the science community over history, and they use a story to start a science lesson that encourages students to Critically ask questions.

Another instructional practice described by Muhammad (2020) is building literary character, which connects to Theme 1: Bringing new experiences to the community. The
participants share how they build confidence in students by having them engage in and experience new things in and out of their community, such as science fairs and science-based school trips. Building literary character in the classroom is described in the following ways:

1. When literary pursuits are enacted, students will become thinkers and resilient beings.
2. Students will have confidence in reading, writing, and sharing their ideas.
3. This confidence will transfer to other spaces in and out of the classrooms.

Within the science context, historically relevant science pedagogy would shift literary character to address the following instructional practice:

1. When engaging in science practices outside of the classroom, students will build innovative science and engineering designs.
2. Students will build confidence in collecting, evaluating, and defending their evidence while building knowledge about a scientific phenomenon.
3. Confidence in science practices will transfer to asking sociological and scientific questions outside of the classroom, including demanding that public officials use science knowledge when influencing local, state, and national policy.

These three ways of building literary character are connected to liberatory pedagogy (Castillo-Montoya et al., 2019; hooks, 1994, 2015), specifically centering relationships and emotions.

Teaching at the intersection of history, culture, and science learning and teaching requires seeing the students and honoring their student identity and emotional selves all at once. When Ms. Perez shared that she continued to use the NGSS practices (2013) because she saw it "gave the students more agency", she is sharing that science is important but what is more important is that her students build confidence and eventually feel self-sufficient in their ability to research and seek well-informed answers to complex questions. Ms. Perez is bringing criticality to the
realm of science and how she uses the NGSS standards. Criticality provides students "spaces to name and critique injustice and ultimately have the agency to build a better world for all" (Muhammed, 2020, p. 120). This development of student agency is both important in the classroom as students engage in inquiry-based and project-based activities but is also useful outside of the classroom with false information being shared so frequently in our 21st-century world.

In terms of science education, science teachers that teach within the realm of anti-racist practices use the politized nature of science in context as a focal point in their lessons. They do not shy away from how socio-scientific issues affect marginalized communities. Historically relevant science pedagogy is exemplified when the Black teachers share lesson topics such as, gathering information on the Flint water crisis, evaluating redlining practices that created conditions for high diabetes rates in low-income neighborhoods, having students create a periodic table of Black scientists from the past, and connecting America’s agricultural practices today to enslavement. For science teachers to engage in anti-racist practices, their work must be an "education for critical consciousness" (hooks, 2015, p. 50). Liberatory pedagogy "requires critical consciousness about the inherently political nature of education" at the curricular level and "its ability to marginalize or engage people in liberatory practices within the larger sociopolitical context" (Castillo-Montoya et al., 2019, p. 1128). A science teacher who is enacting anti-racist practices uses their curriculum to provide examples of how science has been used socially, meaning how science has positively and negatively affected communities and how science has been used as a mechanism to further subjugate marginalized communities while the dominant group benefits.

5.5 Conclusion
The Black women science teachers in this study reveal our critical consciousness when discussing how we have expanded our science curriculum to include systematically excluded perspectives while maintaining the adopted science standards and principles in the field. This study offers insights into how the critical consciousness of Black women teachers can be represented in the science classroom. The Black women science teachers’ political clarity in this study shows how a science education community can deliberately attend to racial, gender, and class inequalities. I argue for a historically relevant science teaching framework in science education. Historically relevant science pedagogy aligns with Culturally Relevant Pedagogy (Ladson-Billings, 1994), Liberatory Pedagogy (hooks, 1994), and Historically Responsive Literacy (Muhammad, 2020) within the context of science teaching and learning. As a result of the study, we learn that Black women science teachers shift their curriculum to live within the intersection of history, culture, and science learning and teaching. Meaning, with or without school support, Black women science teachers find ways to bring culture and science together in the science classroom. They create classroom environments that allow them to learn with and from their students and to build relationships with them and tailor their curriculum to the racialized and political realities of their students. All of this is in the pursuit of the racial uplift of their students and their communities within and outside of the context of science. This practice, teaching for the uplift of the community, fits within a long-storied history of Black educators in America. The power and necessity of Black women teachers are paramount in science classrooms specifically because of the neutral, apolitical ways science teaching has been approached in the past.
Chapter VI: Discussion, Implications, and Conclusion

In this study chapter, I look back to the research questions that guide this investigation, summarize the findings, and present a discussion of the major findings. I designed this study to answer the following research questions:

1. How do Black women science teachers at various levels of experience discuss and practice Womanist Pedagogy?
2. How or in what ways do Black women teachers talk about their implementation of anti-racist practices through their science teaching

Summary and Discussion of Major Findings

To discuss the pedagogical practices of Black women science teachers, the tenets of Womanist Pedagogy give a common language to how the participants approach their work (Chapter 4). In Sista Circles, the women discuss how they have experienced and exemplified anti-racist frameworks in science teaching and learning (Chapter 5). Overall, we learn that Black women science teachers use their racialized, classed, and gendered experiences to inform how they approach their science teaching unapologetically by enacting anti-racist practices. Despite having to advocate for acknowledgment of their science knowledge in mostly white spaces of their schools and to fight for their students’ right to have a robust and rigorous science education, Black women science teachers bring joy and innovation to their practice in ways that the larger science teaching and learning community must learn from.

Importance of Common Language for Black Women Science Teachers

There is power in being able to name oneself. Several of the participants shared appreciation for being allowed to read about Womanist Pedagogy and space to make connections to their practice. Participants felt seen and heard based on learning that there was language for
their instinctual actions in the classroom. Participants reported not hearing about the pedagogical practices of Black women teachers before engaging in this study, or if they did, they were not very familiar with the language and theory.

Being able to have a language to identify your pedagogical approach is especially important for Black women teachers who teach in a field that has historically been viewed as neutral and apolitical, such as science education. Where some science educators may view their positionality as irrelevant to their science teaching, these Black women teachers—across differing positional statuses—found purpose, community, and a sense of heritage based on learning that they work within a long history of Black women teachers, and they are not alone. After this study, Ms. Perez, who taught for 20 years, earned a middle school teacher of the year award and referenced the Womanist Pedagogy (Beauboeuf-Lafontant, 2002) article in her acceptance speech. She shared “reading the article helped me articulate my heart”.

Normalizing discussions about the pedagogical practices of Black women teachers of the past in professional development spaces and science teacher education spaces can help build the confidence of budding teachers, so they are not waiting 20 years before being able to articulate their approach to teaching. Engaging in discussions about Womanist Pedagogy could support novice teachers as they advocate for themselves in daily activities, such as justifying why they have a closet with hair supplies for their students. It could support them in larger ways, such as advocating for work that prioritizes political clarity, such as professional development that centers Culturally Relevant Pedagogy at their school sites.

For teachers of color, “there is great power in collectively reimagining what schools can look like—in the curriculum, in school culture, and through teacher organizing” (Kohli et al., 2021, p. 100). Black women are assets in science teaching spaces and should be treated as such.
One of the many ways to recruit and retain Black women science teachers is to honor their instinctual approach to teaching and give them the space to make sense of their place, particularly if there are few to no other teachers of color in their schools. Then, they need to be in a community with others who share their philosophies. This argument falls in line with Kohli et al.’s (2015) call for critical professional development where educators engage in a cooperative dialectical process, where they are communicative and responsive to each other’s needs and goals. Critical professional development is especially for Black women science teachers as we use “education as a vehicle for equity and justice” (Kohli et al., 2015, p. 22).

**Womanist Pedagogy in Science Teaching**

Black women science teachers embrace their instinctive desire to demonstrate caring for their students, advocate for their students so that they may experience joy and persist within science learning spaces, and are encouraged by building STEM-informed citizens of the future. The participants share narratives that exemplify all three tenets of Womanist Pedagogy at varying degrees, showcasing that Black women are not monolithic. The framework is a tool to explain how they approach their craft.

The number of years in education influence how the participants discuss or exemplify the “caring/embrace of the maternal” tenet of Womanist Pedagogy. While all participants would probably agree with each other's reflections and implementations of caring in the classroom, the type of experience shared is based on time in the classroom or the ability to reflect after leaving the classroom. Participants with less than eight years of teaching experience discuss caring about their students in terms of developing a safe space for their students, while the elders and post-service teachers share reflections about the unintended consequences of tough love in their K-12 experience and their classrooms.
Both novice and veteran teachers discuss caring in terms of creating a safe space. Novice teachers speak more about the overall classroom environment, not yet identifying how their caring is connected to science instruction. The novice teachers demonstrate their deep caring by discussing the importance of mistakes, the culture of error with their students, and being diligent about making sure students feel safe to take risks. The novice teachers are also reflective about why caring is so important in their classroom, thinking back to their own experiences and what they may have needed to feel safe and willing to take risks in the classroom.

The veteran teachers consider how a safe space for their students and caring supports them in identifying what students are interested in for future lessons. The veterans also demonstrate politicized caring (Beauboeuf-Lafontant, 2008) by sharing how they view the community they teach in as an aspect of their classroom, speaking with community members and parents to bring them into what students are learning and making learning a community effort. The veterans have been able to connect their deep caring to the level of investment in their students and their learning science. They share that their students are intrigued by the science content because the teacher is being themselves in the classroom and helping them feel comfortable and safe enough to do the same.

**Tough Love.** ‘Tough love’ is not a cut and dry concept. On one hand, tough love is a necessary tool for Black teachers as they are trying to support and shape Black and Brown students who exist in an unsafe, heavily policed world outside of their classroom (Siddle-Walker, 2001). On the other hand, tough love is a manifestation of the high expectations that Black teachers have for their students (Irvine, 1989). Tough love is mainly considered as a negative attribute to Black teaching in comparison to the ‘soft bigotry of low expectations’ (Rubel & McCloskey, 2019, p. 113) of white colleagues. The positive intentions and impacts of tough love
for Black and Brown students cannot be ignored. The teachers in the study questioned the consequences of their display of tough love.

Black children do not always have the freedom to make mistakes or seem threatening. The issue is that this is completely out of their control. Black and non-Black people have been socialized to believe that Black children are inherently flawed and threatening to the social order (Todd et al., 2015), so Black teachers (and Black parents) do what they can (i.e., tough love) to support Black children as they navigate this harsh society. Black teachers (and Black parents) historically have taught and raised their children cautiously when outside of the safety of their classroom or home (Lareau & Horvat, 1999). Personally, my parents have reflected on how they instinctively made sure I was always calm, seated, and unnoticed while in public places such as a bank or restaurants to lower the possibility that any white person would find a reason to reprimand or judge me. Black teachers, who were once Black children, bring this awareness that at any moment their freedom can be taken from them as they teach children with tough love.

Historically, Black teachers have “had high expectations for their students, passion for teaching, and the capacity to empower students with knowledge” (Griffin & Tackie, 2016, p. 1). When discussing the importance of high expectations and why low expectations might be a common practice of white teachers, a Black teacher participant from the Griffin and Tackie text (2016) reported:

When you don’t have the same background, and I can say white sometimes, you tend to feel sorry for that student because you see what they’re going through, they might be in poverty. And sometimes when you feel sorry for a person, you make excuses … Even though I sympathize with you, I’m still going to challenge you, and I’m not going to be afraid to make you do what you’re supposed to do. (p. 5)
High expectations for Black and Brown children can be a determining factor in their ability to see themselves as intelligent, problem-solving critical thinkers. Without the challenge to rise to the rigorous demands of the classroom, they may never actualize their real potential. Black teachers understand the power and necessity of high expectations and honor their students’ brilliance by not being afraid to push them past a moment of discomfort or hesitancy to achieve.

The elders and post-service teachers consider the negative effects of ‘tough love’ on themselves as young Black girls and on their past students. While understanding the historical significance of ‘tough love’, and how some of those realities are true today, the more experienced participants still grapple with the long-term effects of displaying sternness without rationale or joy could have on students. Historically, tough love has been important to teach young Black students about the power of persisting beyond their preconceived limits in a white-dominated world (Williams, 2018). Black children must see themselves as powerful despite implicit and explicit messages that state otherwise. The more seasoned participants still practice sternness or tough love in their classrooms by teaching students how to advocate for themselves or striking the balance of warm-demanding (Acosta, 2019), but they also have learned to provide a more explicit rationale to their students, so the message is better received.

The novice and veteran teachers speak specifically about their lived experiences of needing to “work twice as hard, to get half as much” in their jobs. These lived experiences spark their political clarity about how they approach their teaching. Participants shared that having a clear understanding of their positionality as a Black women science teacher in combination with teaching Black and Brown students encourages them to speak about issues of social justice and systemic racism—“We don’t get the same opportunities as your white counterparts” (Ms. Noble). For the participants, their political clarity also informs the high expectations they uphold.
while learning science. Participants share that because Black and Brown students are more easily criticized when speaking in science communities, they support students in using scientific jargon in a safe space such as their classrooms. This practice of honoring the home language of Black and Brown students during a learning cycle to help students demonstrate their preconceptions and emerging thoughts first before adding scientific jargon fits within Brown’s (2020) description of Culturally Relevant STEM Education.

The participants themselves also unfortunately must work twice as hard in their work environment. Some of the participants share that their white peers have a preference on what students they would like to teach, or their white peers question their science knowledge despite working in the same positions as them or even longer. This issue persists whether the participants teach predominantly Black/Brown or white populations. Black women are not seen as content experts (Mensah, 2019), instead solely valued as disciplinarians (Acosta, 2019). For example, Ms. Vaughn shared that the other Biology teacher at her school has consistently been able to refuse to teach the ‘tough students’ every year, while Ms. Vaughn teaches the rest and still outperforms. Ms. Vincent shared that her peers question her science knowledge, but she reminds herself to demonstrate “Black excellence” in front of her white students so that one day they may not do the same to their peers of color. Ms. Vaughn and Ms. Vincent along with the other Black women science teachers should be valued and honored for their ability to use their content expertise as a tool of student engagement that yields student achievement. The participants’ work in the science classroom is not magical or based solely on discipline, their practice is rooted in content expertise and the ability to intellectually adapt to meet their students’ needs.

Novice, veteran, and elder participants discuss the rationale for why political clarity is necessary when considering the lack of caring and deficit mindsets that some of their peers bring
to the work. Teaching with mutual respect, maintaining decades-long relationships, staying in predominantly white schools with a few Black/Brown students, and advocating for students to be in AP science classes are some examples of how the in-service participants demonstrate political clarity. These actions happen both because of the lack of caring from their white peers, and from building strong relationships with their students. In this way, the participants showcase their politicized caring (Beauboeuf-Lafontant, 2008) through maintaining an asset-based mindset about their students.

Some of the post-service teachers demonstrated their political clarity when they reflected on the oppressive practices they either regrettably participated in or worked against during their K-12 teaching experience. Examples of honoring the linguistic and cultural backgrounds of their students, maintaining high expectations despite tracking, and bringing Culturally Relevant Pedagogy to the science content were shared as post-service teachers reflected on ways they demonstrated their political clarity in their former classrooms.

According to the findings in this study, the longer you teach the more important the ‘ethic of risk’ tenet becomes for the participants. While I am sure that the less seasoned participants would agree with this statement, only the elders and post-service teachers shared examples that could fit under the tenet. The elders and post-service teachers prioritize building informed and active citizens of the future although they know they will never see the fruits of that labor. The examples shared by the participants reveal that they believe doing good in the world can and should begin in the science classroom. The elder and post-service participants connected student-centered scientific inquiry, rounds of student-student feedback, and student-student collaboration as ways to produce informed and active citizens of the future.

Toward a Theory of Historically Relevant Science Teaching
While in Sista Circles, participants were asked how they shifted their curriculum to support anti-racist science teaching. Their practices fit under three culturally based frameworks: liberatory pedagogy (hooks, 1994); Culturally Relevant Pedagogy (Ladson-Billings, 1994); and Historically Responsive Literacy (Muhammad, 2020). While there are multiple tenets that Liberatory Pedagogy, Culturally Relevant Pedagogy, and Historically Responsive Literacy share, criticality or critical consciousness is most salient when discussing how the participants approach anti-racist practices in their science classroom. Critical consciousness or criticality is a tenet that lives in anti-racist frameworks and all four themes from this study. In science education, we can use the language of criticality as explained by Muhammed (2020) to make sense of how we can transform our curriculum in the pursuit of liberation. Bringing new experiences to students of color, while also honoring the assets in their community is an act of criticality (Theme 1). Giving space for students to ask critical sociological and scientific questions (Theme 2) and to use historical knowledge to make sense of socio-scientific issues today (Theme 3) are acts of criticality. Lastly, bringing critical consciousness to science education (Theme 4) by ensuring neither their curriculum nor self-reflection maintains the white status quo is an act of criticality.

The participants reveal their critical consciousness when discussing how they have expanded their science curriculum to include historically underrepresented perspectives and joy while maintaining the adopted science standards and principles in the field. The participants also reveal how often they choose to use their critical consciousness to advocate for their Black and Brown students in various professional settings. These findings led me to consider how the three aforementioned frameworks could be merged to showcase how they exist with science teaching: thus, historically relevant science pedagogy. I offer historically relevant science pedagogy as a theoretical contribution to the science teaching and learning community. I argue for an anti-racist
connection to science that is historically relevant and connects students’ scientific knowledge not only to their ability to engage in scientific practices but also to their historicized experiences across identity, criticality, and joy. Historically relevant science pedagogy can be a tool for educators as they consider the various ways anti-racism can be displayed in their school practices and curriculum. Historically relevant science teaching as described in Chapter 5 affords students opportunities to practice their critical consciousness through daily acts, such as asking sociological and scientific questions about a natural phenomenon and engaging in longer research projects about socio-scientific issues that result in social action.

**Limitations**

The purpose of the study is to first learn if there are connections between the pedagogical practices of Black women science teachers and Womanist Pedagogy. Reading the Womanist Pedagogy (Beauboeuf-Lafontant, 2002) article was optional before engaging in the one-on-one interviews. This meant that providing a dedicated time to read and annotate the article was deprioritized. With that said, some of the participants may not have read the whole article before engaging in the one-on-one interviews which could have skewed the results to highlight more aspects of “caring/embrace of the maternal” since it is the tenet discussed in the article. If participants ran out of time, they may not have deeply considered examples of ‘ethic of risk’ in their practice since it is discussed later in the article.

The Sista Circles were established to create organic, free-flowing discussions which meant participants were not consistently asked to specify or clarify their thoughts. There were times where participants asked each other questions for clarity, but there were instances where participants could have been asked to expand, explain, or offer examples and more details on their thinking to make findings clearer.
Implications

For some of the participants in this study, although they show up in grace, power, and excellence, walking into their school site is a warzone where they are met with microaggressions about their content expertise, where they are overworked, and where they watch their undeserving white peers earn promotion over them. Supporting Black women science teachers in schools must include opportunities for promotion, space to be acknowledged for content expertise with leadership roles, and Sista Circles as spaces for healing and support. Black women science teachers (particularly veteran and elder teachers) who have demonstrated an ability to support students beyond preconceived limits in the classroom should be celebrated for their content expertise, not their ability to manage classroom behaviors. Making science content relatable and worthy of students’ attention is an act of intellectual strength that is rooted in their deep content-specific knowledge (Mensah, 2009). Celebrating these teachers can look like giving them space to lead science professional development for peers and being promoted to leadership roles. Sista Circles are also imperative for Black women science teachers at schools since microaggressions from peers and leaders are ever-present. While schools must tackle the racist and misogynistic comments and actions that create an unsafe space for Black women science teachers, Sista Circles are for Black women and built by Black women to help them communicate, heal, and develop.

Teacher education programs have the daunting task of preparing an 80% white teaching force to teach in communities of color where most teachers have little experience or knowledge (Causey et al., 2000). Teacher education programs also must address the differing needs of teachers of color based on their differing racialized, classed, and gendered experiences (Hudson-Vassell et al., 2018; Mensah & Jackson, 2018). Specific to science teacher education, we must
“radically change the current model of all teacher education programs by making race and cultural studies an integral part of teacher preparation” (Dunac & Demir, 2016, p. 41) by developing more urban science education programs. One of the many structures that can be included in urban science education programs is racial affinity spaces. Racial affinity spaces in urban science education can be used for teachers to confront their struggles in the field, as well as to have these spaces where “wisdom, love, joy, and creativity that they embody” (Pour-Khorshid, 2018, p. 326). Sista Circles as displayed in this doctoral study exemplify what could be possible in racial affinity in science education. Below I argue for why racial affinity spaces are necessary for Black women in general and Black women science teachers specifically.

A Need for Black-Women-only Spaces and Services

Lorde proclaims that “Black feminism is not white feminism in blackface” (1979, p. 60) to disprove the belief that people in similar physical situations are experiencing the same psychological realities. Lorde’s statement helps push the feminist community to understand that the differences between the experiences, histories, and narratives of Black women are important and need their level of care, intervention, and collective action. The difference matters. Placing a Black woman teacher in a science classroom without embracing her ideologies and classroom philosophies does not create a psychologically safe environment for that teacher or her students. Nayak (2015) states:

An ideology does not become a Black ideology by painting a blackface on it. A white, Eurocentric ideology or intervention does not convert to a Black version by having black faces in the literature, conferences, institutions, or service provisions. Any ideology, radical movement, or force for social change does not become Black by increasing the
representation of a pigmentation. So, it has nothing and everything to do with the color of skin. (p. 52)

To think deeply about the advantages that Black women-only spaces could bring to Black women science teachers, it is important to consider the differences of psychological welfare of Black women in comparison to other social groups in general, in schooling and education, and the context of science education. Here I build mostly from Nayak’s (2014) *Race, gender and the activism of Black feminist theory* that urges the critical psychology field to embrace Black feminist ideology by learning from Audre Lorde and others who argue that “racist social structures create racist psychic structures” and that Black women-only spaces “operate differently for white women, white men and Black men” (p. 51). Kohli et al. (2019) also argue for critical professional development which allows teachers of color the space to use education as a vehicle of social justice that prioritizes “humanization, joy, and cultural sustainment” (p. 99).

Race and racism create social structures that enforce limits on the progress of groups of color and poor, white groups with differing effects. Those social structures, such as race, gender, sexual orientation, and class, used to oppress groups are not experienced alone but, instead, are intersectional. According to Crenshaw (1991), the originator of the term “intersectionality”, intersectionality as a methodology is intended to disrupt the tendencies to see race and gender as exclusive or separable. The once-accepted single categorical axis of identifying people’s power and positionality is not possible when considering the multiplicity of oppressive experiences that folks, such as Black women, queer and trans folks of color, and other groups live daily. Those lived experiences based on their social structures also greatly create and inform their psychic structure, for example, a Black woman in a college science classroom would have a different psychological experience than other marginalized groups, such as Black men, and white men,
and white women. “Thus, in a patriarchal power system where white skin privilege is a major prop, the entrapments used to neutralize Black women and white women are not the same”” (Lorde, 1980, p. 118). In a white woman-dominated field such as K-12 education where Black women’s voices are silenced and positions of power are limited, this difference in experience should be acknowledged as an important and complex context for understanding Black women teachers.

Black women-only spaces are necessary for schooling and science teacher education, like any other social environment. Patel and Siddiqui (2010) posit that “barriers cannot be broken unless the victims themselves recognize that the source of help is coming from the same community and background as they do” (p.121). To shed light on systems and practices that are corrosive, teachers of color need to build a community that embraces the differences amongst them as a group and create plans for collective action that will dismantle the racist practices and systems that affect all marginalized peoples.

The Sista Circles in this study were Black-women-only spaces that add to the existing literature about the need for affinity spaces in teacher education and school-based professional development. Ms. Eaton shared that “being in the Sista Circle still impacts to this day. The role of TOC [Teachers of Color], especially Black women in STEM, coming together is so powerful” a year after her Sista Circle. Although not an explicit finding from Chapter 5 it is easy to conclude that the participants in the study were willing and eager to share their anti-racist practices and thoughts about the ‘lip service’ of their peers because they were in the Sista Circle setting. At the beginning of each Sista Circle, participants were asked “what they would like to gain from the space?” as an opening question. Ms. Perez said, “I'm here to see more people that look like me.” Ms. Vaughn shared, “I'm excited to see so many people that look like me in this
field like I did not know that it was this many and this is amazing to me. I'm taken aback and I just want to absorb all of this moment.” Ms. Nash said, “I will just love to get more from a safe space of Black educators, Black women in science or who were in science because I'm not used to seeing that, especially in my school.”

As displayed in Chapter 5, Sista Circles can be offered as a service for Black women science educators who are looking for a space that focuses on collective healing and prioritizes their psychological safety. As discussed in the literature review, Mosely (2018) reports that “racial affinity-based professional development decreases isolation and increases retention for Black teachers” (p. 267). Black women science teachers and other teachers of color deserve a service rooted in understanding the power of an intersectional approach (May, 2015) that allows members to self-define and to find community while existing outside the margins (Hill-Collins, 1998) of their chosen profession. Chapter 4 also reveals how Black women science teachers were allowed to self-define by reading about Womanist Pedagogy (Beauboeuf-Lafontant, 2002), they were allowed to self-rank statements that gave language to their pedagogical approach which helped them honor and give voice to their expertise as science teachers, something that their school-based peers took for granted or did not appreciate. Using common texts rooted in womanism or Black feminism supports Black women teachers as they silence the psychological warfare they experience in schools and (re)member (Dillard & Neal, 2020) the role in the racial uplift of the Black community.

6.1 How This Study Extends Previous Studies

This study extends previous studies in several important ways. In Black Teachers on Teaching, Foster (1997) shares the narratives of Black teachers with various teaching expertise and the impact segregation and desegregation had on the lives of Black teachers over
generations. Following that model, this study shares the narratives of Black women science teachers with various professional statuses to allow their narratives to be in conversation with each other so they can build shared and collective knowledge and one day hopefully heal and change.

One of the goals of this study is to “present stories of Black science teachers and contextualize their stories within a content-specific domain” (Mensah, 2009, p. 47). This study situates the pedagogical practices of Black women science teachers within the larger tradition of Black women teaching, or Womanist Pedagogy to inform the curricular, instructional practices, and professional development of science teachers. While situating the current pedagogical practices of Black women science teachers within the larger tradition of Black women teaching practices, this study is heavily informed by Beauboefuf-Lafontant (2002)’s work. There is an “ideology of whiteness applied to science” that must be confronted by Black women entering and transforming this space (Mensah & Jackson, 2017, p. 4).

As a continuation of Moore’s (2008) work, this study shares the narrative of Black science teachers. Moore shares that professional development “with a focus on positional identity should include the teaching and learning of multiple perspectives that seek to understand, critique, challenge, and change oppressive and inequitable social structures” (p. 701). Adding the narratives of this study aims to further influence schools to implore this model by adding Sista Circles as an option for future critical professional development for Black science teachers.

Mensah’s (2019) study employs Critical Race Theory as a theoretical framework and uses the voice of a Black woman science teacher as a counter-story. This work positions the voice of a Black woman elementary science teacher in a groundbreaking fashion. Mensah
gathers that “marginality of women of color is evident in science and experienced by their location and their cultural construction as women of color in science, or specifically who gets to be a science teacher” (p. 37). As one of the goals of that study, Mensah (2019) uses counter-storytelling to critique “normalized dialogues that perpetuate racial inequities and stereotypes and challenges privileged discourses in teacher education” (p. 31). This current study aims to continue to push science education by adding more narratives from secondary, in-service Black women science teachers to provide a more holistic view of their experiences and teaching.

6.2 Reflections for Future Work

Before beginning this doctoral study, I had several assumptions I brought to the project. Most that I’ve since forgotten, but mainly that all Black women science teachers would share in my socio-political belief that my classroom and teaching practices can and should encourage students to engage in social action/social activism. Social action can manifest in several ways, but I mostly think of it as students showcasing their criticality or critical consciousness (Ladson-Billings, 1994; Muhammad, 2020) by questioning how science is used to inform policy that affects marginalized communities, using their science knowledge to bring more awareness to their home communities, and students taking to the streets when they’ve witnessed injustices in policy that is informed by science. For this study, I desired to engage in more discussions about how our pedagogy as Black women science teachers could be used to influence the social activism of our students. At the same time, my desire to first learn what Black women science teachers think and what they do to create organic discussions in Sista Circles was paramount in comparison.

It must be noted that I am extremely proud of the findings from this doctoral study, bringing the foundational work of Womanist Pedagogy (Beauchef-LaFontant, 2002) to the
science education community, and including historically relevant science pedagogy to a list of anti-racist frameworks is no small accomplishment. Participants did discuss teaching to develop STEM-informed citizens with considering Womanist Pedagogy’s ‘ethic of risk’ tenet, and we did discuss how to use anti-racist frameworks in science teaching, but there is the next step. I am still left wondering why in a presuming safe, low-stakes environment like Sista Circles, Black women science teachers who have already shared their political clarity and commitment to the work for marginalized communities did not dive deeply into what our students could do with their science knowledge outside of just being knowledgeable about the injustices. I’m continuously wondering, how often are teachers of color given the chance to discuss critical race theory or our critical consciousness in formal or informal settings? Since the Sista Circles, mass media and U.S. politicians have chosen to smear the work of Critical Race Theory. With this outcry for knowledge of what Critical Race Theory is from teachers, I am confident that if these Sista Circles were to occur again, the Black women science teachers in this study would be more eager to discuss student activism in and outside of their classrooms.

Of the participants in this study, only the participants with doctoral degrees spoke specifically about how critical race theory and other frameworks informed their study and subsequently their K-12 teaching. I don’t intend to imply that without the formal language of CRT, teachers of color do not know the principles of CRT (we live and witness them daily), but common language gives us the confidence to speak truth to our experiences and build with others. It gives us the confidence to use frameworks such as Critical Race Theory and Culturally Relevant Pedagogy to inform our work, defend our practices, and spark critical consciousness in our students. Even issues of race/racism are rarely discussed in teacher education, let alone, science education (Mensah, in press). I hope that increasing discussions of critical race theory
and anti-racist frameworks will lead to teachers using their political clarity to encourage social action in and out of their classrooms. In science education, student social activism has always felt important, but with the COVID-19 global pandemic, the results of a policy that is ill-informed by science are in students' faces in ways the teaching community cannot begin to understand.

In considering why a framework such as historically relevant science pedagogy specifically or critical pedagogy broadly is important in science education, we must consider one thing: Racism kills. This is true in terms of the continued lynching of Black men and women in America, and it continues to be true when the medical field uses Black people as experimental subjects or ignores them altogether. In the context of science education, when I say racism kills, I don’t speak metaphorically or symbolically, such as the force of the bullet from a cop murdering a Black man is the cause of death, but quite literally.

Consider Deborah Gatewood (age 63), Gary Fowler (age 56), or Rana Mungin (age 30), all Black people turned away three or more times from hospitals when reporting coronavirus symptoms; they would all die soon after (Harper, 2020; Robinson, 2020; Shamus, 2020). Consider Amber Isaac (age 26), a woman who died right after childbirth, ignored repeatedly by her doctors when voicing her concerns (Olumhense, 2020). Consider the vast number of Black babies who are born prematurely because of poor access of their theirs mothers to quality health care in their community. Consider doctors who are more inclined to ignore people they view as second-class citizens outside of the hospital room. It’s a complex solution to a complex problem, but the more we can get doctors in the room that are willing to understand what it is to be disregarded and ignored, the greater the chances of supporting the countless folks who need someone on their side. Lastly, consider if there were more Black teachers in high-need science
classrooms whose pedagogical practices include and move beyond academic achievement, would there be more Black and Brown students to enter science and science-related professions?

**Future Work in Teacher Education and Teacher Professional Development**

As I continue to embark on different research projects, I would like to engage in more work that transforms science teacher education practices and opportunities for teacher professional development. I am also excited to work with K-12 students as research practitioners in youth participatory research projects (YPAR) that connect to the development of a historically relevant science curriculum. Please see some emerging ideas that could influence my work outside of the data I have already collected.

- A conference of Black women science teachers for co-creating lesson plans and units based on the historically relevant science education framework; with piloting these lessons in science classrooms with young people as co-developer and co-researchers.
- Collection of data and reporting of findings on youth participatory action research (YPAR) with students in science classrooms that prioritize socio-political consciousness.
- Professional development centered on regular meetings of Sista Circles and/or platicas (Fierros & Delgado Bernal, 2016) to learn about teacher identity development and critical consciousness development.
- Collection of data and reporting of findings on teacher self-reflection based on discussions of “science as white property” (Mensah & Jackson, 2018) in a science methods course.
- Collection of data and reporting of findings on how learning about the pedagogical practices of Black teachers in America since enslavement affects the teaching practices of
science teachers of color today. These studies would follow the research models provided by Foster (1997) and Siddle-Walker (1996) with science teachers.

- Engagement of students’ science identity and socio-political consciousness development from participating in a Science in the City: Culturally Relevant STEM Education (Brown, 2020) book club.

While my research interests can be vast, the goal is to engage in works that both empower teachers to use their power to dismantle systemic inequities and to support students as they build their critical consciousness. There is plenty of work to be done within and outside of science teacher education, and I hope to continue the charge for a socially just future with this doctoral contribution to the field.
Policy Brief

Background

The demands of society’s call for diversity in the science field require systemic change in the urban science classroom. Today’s science students in high-need, racialized schools need more access to rigorous science content and a teaching staff that supports the whole child. Historically, Black women teachers’ pedagogical practices inspire their students to excel beyond the oppressed constraints put on them by society (Beauboeuf-Lafontant, 2002). There are simply not enough well-equipped teachers to influence systemic change. Tragically, today Black women make up only 5% of the teaching force (Hill-Jackson, 2017). In 2012, only 3% of the secondary science teachers in the United States identified as Black (Banilower et al., 2013). Due to their positionality, Black science teachers are “especially motivated to instill a sense of importance in the STEM discipline” and are readily able to name race as a motivating factor for teaching science, in comparison to white teachers (Morettini, 2017, p. 172).

Investing in the Retention of Black Women Science Teachers

As their experiences in schools became more toxic and unstable over time, the Black women science teachers in Despenza’s (2018) study took the time to reflect on professional desires and chose to leave the classroom. This finding falls in line with Ingersoll’s (2001) prediction that recruitment is not the problem; it is retention. Mosely (2018) reports that “racial affinity-based professional development decreases isolation and increases retention for Black teachers” (p. 267). Black women science teachers and other teachers of color deserve a service rooted in understanding the power of an intersectional approach (May, 2015) that allows members to self-define and to find community while existing outside the margins (Hill-Collins, 1998) of their chosen profession. The findings of this study support the demand for investment in racial affinity spaces both in science teacher education and in school-based professional.
development. Funds are needed to protect and support the mental well-being of teachers of color, including Black women science teachers, who demonstrate deep investment in teaching historically excluded students at personal risk to themselves. Funding for racial affinity spaces in science teacher education would be used to pay trained culturally relevant/anti-racist experts to facilitate discussions that yield both collective healing and empowerment for their future science classrooms. Funding for culturally relevant professional development at schools would be used to pay practitioners who already engage in anti-racist curricular development to train others and pay trained facilitators to give teachers a critical professional development (Kholi, 2018) experience.

**Anti-Racist Science Curriculum**

The Next Generation Science Standards have encouraged inquiry in science classrooms (NGSS, 2013) while ignoring diversity in terms of culture and race (Rodriquez, 2015). The political awakenings of 2020 included a demand for anti-racist science education. To meet this demand, we must invest in developing NGSS-aligned curricula that are taught within the context of the United States’ marginalized communities. Policymakers in science education must take a political stance in how we choose to teach science since all students have experienced various degrees of a global pandemic. Investing in anti-racist science education that still prioritizes science and engineering practices will yield STEM-informed citizens of the future who can use their political power and scientific knowledge to ensure that we do not repeat the turmoil of 2020/2021’s COVID-19 pandemic.

**Recommendations for Supporting Black Women Science Teachers**

The novice and veteran Black women science teachers in this study shared that their school-based supervisors did not support them as they attempted to use criticality to make shifts
in their science curriculum. Investment in culturally relevant professional development is necessary to make space for novice and veteran teachers to be supported and to explore their critical consciousness in their science classroom. It is also needed to decrease the amount of resistance from peers and supervisors. Novice and veteran Black women science teachers are interested in learning from elder and post-service Black women science teachers who can help them develop ways to use their disciplinary expertise and critical consciousness to the benefit of their students.

To continue the healing of all Black women science teachers, we must look to our elders to hold space to teach about our legacy and allow for innovation in the classroom. Elders and post-service Black women science teachers must be placed in positions where their disciplinary expertise and experience with using critical consciousness in their science classrooms are shared and used for professional development. This requires funding practices that prioritize freedom for elder and post-service Black women science teachers to escape the white status quo and facilitate professional learning spaces as they see fit.
References

https://doi.org/10.1177/0022487118808512


navigation of multiple epistemologies. Science Education, 94(6), 1008-1026.


https://doi.org/10.1177/0042085918794802


Civis. (1993). The public school in its relation to the Negro. In J.D. Smith (Ed.), *The benefits of*


Cumberbatch, P. (2009). What ‘the cause’ needs is a ‘brainy and energetic woman’: A study of


Davis, R. C. (2012). Examination of factors which may contribute to the underrepresentation of African American teachers certified in science (*Doctoral dissertation, Tennessee State University*).


Foreman, P. G. (1990). The spoken and the silenced in incidents in the life of a slave girl and
our nig. *Callaloo*, 13(2), 313-324.


Hill-Jackson, V. (2017). …. And then there were none: Reversing the exodus of Black women from the teaching profession. In Black Female Teachers. *Emerald Publishing Limited.*

*Unpublished manuscript, University of Calgary.*


https://doi.org/10.3102/0028312038003499


https://doi.org/10.1080/00131946.2021.1878179


https://doi.org/10.3389/fpsyg.2021.671481


https://doi.org/10.1080/19415257.2020.1814387


https://doi.org/10.17763/haer.84.1.p2rj131485484751


https://doi.org/10.1080/00405841.2020.1773186


Mutegi, J. W. (2011). The inadequacies of “science for all” and the necessity and nature of a
socially transformative curriculum approach for African American science education.


https://doi.org/10.1002/tea.20410


 https://www.rand.org/pubs/reports/R3928.html


 https://doi.org/10.1177/0013124519873676


https://doi.org/10.1016/j.jesp.2009.10.016


Shamus, K. J. (2020, April 20). *Family raved by coronavirus begged for tests, hospital care but was repeatedly denied.* USA Today.


Watson, W. (2019). We got soul: Exploring contemporary Black women educators’ praxis of


perspectives of exemplary African American science teachers. *Teachers College Record*, 114(7), n7.


## Appendices

### Appendix A

Pre-Interview Open-Ended Questionnaire:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do you identify as a Black woman?</td>
</tr>
<tr>
<td>2</td>
<td>How many years have you taught science? Are you still teaching?</td>
</tr>
<tr>
<td>3</td>
<td>Are you an elementary or middle/high school science teacher? (If elementary, “thank you for being willing to participate, for the purposes of this study middle and high school teachers are a better fit, but will you keep your name on record for future projects. Thank you again.”).</td>
</tr>
<tr>
<td>4</td>
<td>As a child, what did you enjoy about science? Did science play a role in your student identity?</td>
</tr>
<tr>
<td>5</td>
<td>Please describe yourself in your role as a teacher/science teacher.</td>
</tr>
</tbody>
</table>
| 6 | Instructions: Using the following scale please rate the following statements (0 = Strongly Disagree; 1 = Disagree; 2 = Neutral; 3 = Agree; 4 = Strongly Agree)  
As a science teacher, I create a classroom learning environment where I educate as well as shelter students from adversity.  
As a science teacher, I use familiar mother-child language when I talk with students; when I talk with others about students; and when I teach students.  
As a science teacher, I have a sense of communal responsibility to care for students so that I resist domination (both patriarchal and racial) in my classroom.  
As a science teacher, I have political clarity as a science teacher. I recognize that there are relationships between schools and society that differentially structure the successes and failures of children.  
As a science teacher, I see racism and other systemic injustices as simultaneously social and educational problems.  
As a science teacher, I understand the necessity of seeing through stereotypes as false representations of children’s realities and possibilities.  
As a science teacher, I understand intergenerational struggle against injustice, believing that although Black people have been oppressed for generations cynicism is not the answer. I choose to care and act although there is no guarantee of success.  
As a science teacher, I feel an intimacy with other people that motivates me to see personal fulfillment in working toward the common good.  
As a science teacher, because of a sense of interdependence I establish classroom routines that model mutual responsibility, for example, students are responsible to the greater community, and student groups ensure that students are never left out. |
Following the tradition of Black feminism, in her study about teaching practices of “exemplary” Black women over time, Beauboeuf-Lafontant (2002) describes “womanist” teaching. The previous nine statements you responded to captured major components of womanist teaching practices. Essentially, Black women teacher throughout history have (1) embraced the maternal role they sometimes play in their classroom and students’ lives, (2) have political clarity about their importance as a Black woman teacher, and (3) have an ‘ethic of risk’ understanding that teaching is a way to combat decades of oppression and will not be solved or eradicated immediately. Womanist caring encourages educators to see their actions as a humble, yet essential, contribution to an extensive, collaborative, and enduring project of social change.

Now that you have gathered a full picture of the womanist tradition, please share your reflections:

Would you describe yourself as someone who shares in the womanist tradition of teaching in your science classroom? Why or why not?

Do you find it more or less challenging to incorporate these womanist traditions in the science classroom? Elaborate.

Teaching science content? Elaborate.

Would you be willing to participate in a 60 to 90-minute one-on-one interview?

Would you be willing to participate in a sista-circle with other Black women science teachers to discuss Womanist Pedagogy? Sista Circles regard Black women’s experiences and wealth of knowledge as power. Black women participating in Sista Circles empower one another through the sharing of their wisdom and experiences. The goal of Sista Circles is to provide space for healing from traumas some of us have experienced and to spark collective action to change the oppressive climate we all experience. Why do you think this is especially necessary for a group of Black women science teachers?

Here is a link to the Beauboeuf-Lafontant (2002) article, please read this article before our interview and take some notes for us to discuss both during our individual interview and during the sista circle.

Any other thoughts or questions you’d like to share?
### Appendix B

**Interview Protocol for ALL:**

<table>
<thead>
<tr>
<th>All</th>
<th>1</th>
<th>In your pre-interview, you said that science played the following role in your life..... Why do you think these memories stick out to you? Was there anything else you’d like to add?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>What was your experience like as a college student and a science major? Any moments stick out?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What were your experiences like as a science major?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In your teacher education program, how could your professors have supported you in fulfilling your vision of being your full, authentic self as a student?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What about in your school and in your classroom?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What suggestions do you have for teacher peers and administration to allow you to be your authentic self?</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>As a science teacher, how do you bring your content expertise to the classroom? How do you make the content in your classroom come to life and understandable for your students?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What do you find to be one of the hardest concepts in your area of science to teach?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How do you teach this to enhance student understanding?</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>How would you describe the classroom environment you strive to create? What informs these decisions?</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>How are your teaching practices influenced by your being a Black woman?</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>From your perspective, how do you think your intersectional identities markers (race, gender, class, education, which includes your science- degree holder) shaped your experiences as a science teacher?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In other words, does it matter and to whom that you are a black female science teacher?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As a Black woman, what does it mean to be your full, authentic self at your school and your science classroom? Have you been able to achieve that?</td>
</tr>
<tr>
<td>Question</td>
<td>Answer</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td><strong>What do you know about the pedagogy or instructional practices of Black women from previous generations?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you have Black teachers growing up, K-12, or college?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What was their teaching style or practices? Did any of their practices influence your work? In what ways?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Do you know about Womanist Pedagogy or Black feminist thought?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If so, are these practices included in your own personal, teaching pedagogy? If so, in what ways?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>If you could write your educational obituary, how would you want students to remember about you?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Do you feel like you are meeting the needs of your Black and Brown students in the science classroom? If so, in what ways? If not, what do you think you need?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What professional development opportunities have you had or participated in as a science teacher?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>What kinds of professional development opportunities do you feel you need to support you as a Black science teacher?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How could professional development planners at your school better fit your needs as a Black woman science teacher?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thinking about other Black female science teachers and our many intersectional identities (race, gender, class), what supports do you think teacher education programs and professional development developers should implement to meet our needs?</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Novice (0 - 4 years) Teacher Questions</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2b</strong></td>
<td>Tell me about your transition from your teacher education program/graduation to your first year of teaching?</td>
</tr>
<tr>
<td></td>
<td>What challenges and supports did you have as an early career science teacher?</td>
</tr>
<tr>
<td></td>
<td>How could your former teacher education program support you as an early career teacher?</td>
</tr>
<tr>
<td>Questions</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Are there specific things you need, and why, to support you as a science</td>
<td></td>
</tr>
<tr>
<td>teacher?</td>
<td></td>
</tr>
<tr>
<td>Would this be different from supporting you as a Black science teacher?</td>
<td></td>
</tr>
<tr>
<td>9c  How long do you plan to stay teaching? What has influenced that</td>
<td></td>
</tr>
<tr>
<td>decision?</td>
<td></td>
</tr>
<tr>
<td>Veteran (5 - 14 years) Teacher Questions</td>
<td></td>
</tr>
<tr>
<td>5b  From your perspective, how do you view your role with students and</td>
<td></td>
</tr>
<tr>
<td>education now, in comparison to when you first started teaching?</td>
<td></td>
</tr>
<tr>
<td>5c  How do you view science teaching now in comparison to when you first</td>
<td></td>
</tr>
<tr>
<td>started?</td>
<td></td>
</tr>
<tr>
<td>How have you grown as a science teacher? What areas or in what ways?</td>
<td></td>
</tr>
<tr>
<td>5d  What experiences or moments do you think stick out in your classroom</td>
<td></td>
</tr>
<tr>
<td>when you’ve been able to meet the needs of your Black and Brown students</td>
<td></td>
</tr>
<tr>
<td>beyond the science content? Are there times when you’ve fallen short?</td>
<td></td>
</tr>
<tr>
<td>11a Do you believe your voice is heard at your school? What experiences</td>
<td></td>
</tr>
<tr>
<td>inform your answer?</td>
<td></td>
</tr>
<tr>
<td>11b What keeps you teaching in the science classroom? How have you</td>
<td></td>
</tr>
<tr>
<td>remained motivated?</td>
<td></td>
</tr>
<tr>
<td>11c How long do you plan on teaching? What influenced that decision?</td>
<td></td>
</tr>
<tr>
<td>Veterans or Elders who are</td>
<td></td>
</tr>
<tr>
<td>no longer teaching (must have taught 8 years or more)</td>
<td></td>
</tr>
<tr>
<td>4b  What kept you teaching in the science classroom for as long as you did?</td>
<td></td>
</tr>
<tr>
<td>4c  Why did you choose to leave the science classroom? Did you leave</td>
<td></td>
</tr>
<tr>
<td>education altogether?</td>
<td></td>
</tr>
<tr>
<td>5b</td>
<td>What experiences or moments do you think stuck out in your classroom when you were able to meet the needs of your Black and Brown students beyond the science content? Were there times when you fell short?</td>
</tr>
<tr>
<td>11b</td>
<td>Do you believe your voice was heard at your school? What experiences inform your answer?</td>
</tr>
</tbody>
</table>

| ‘Elder’ (15 or more years) Teacher Questions | |
| 4b | From your perspective, how do you view your role with students and education now, in comparison to when you first started teaching? |
| 4c | How do you view science teaching now in comparison to when you first started? |
| 5b | What experiences or moments do you think stick out in your classroom when you’ve been able to meet the needs of your Black and Brown students beyond the science content? Are there times when you’ve fallen short? |
| 5c | Please describe times you’ve been able to thrive in your career, versus times when you’ve only been able to survive? |
| 5d | What keeps you teaching in the science classroom? How have you remained motivated? |
| 12b | How long do you plan on teaching? What has influenced that decision? |
| 12c | If you could sit down and speak with your science professors or school leaders and share suggestions for the next generation of Black women science teachers what would you say? |
Appendix C – Sista Circles Interview Protocol

In what ways does caring or mothering, political clarity, and/or ethic of risk show up in your teaching style? Where is there tension?

Thinking about culturally relevant pedagogy or other anti-racist instructional theories, what curriculum shifts have you made or do you imagine making that would be rooted in social justice or liberatory science instruction?

Appendix D - Sample of Coding Tables in Chapter IV

Influence of Intersectional Identity Markers on Science Teaching -

<table>
<thead>
<tr>
<th>Novice</th>
<th>Veteran</th>
<th>Elder</th>
<th>No Longer Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Racial microaggressions (name-calling, questioning science knowledge)</td>
<td>Positionality is motivator</td>
<td>Politicized care</td>
<td>Differing SES led to relationship building</td>
</tr>
<tr>
<td>Lack of desired mentorship</td>
<td>Teaching Black/Brown students vs. white students</td>
<td>Advocates for Black/Brown students (against teachers with low expectations and in mostly white classrooms)</td>
<td>Positionality is motivator</td>
</tr>
<tr>
<td>Representation doesn't equal Relationships</td>
<td>Mistreatment from peers (taking on white peers' workload)</td>
<td>Advocating to teach equity-oriented science to white students</td>
<td></td>
</tr>
<tr>
<td>Political clarity - Infusing history in science curriculum</td>
<td>&quot;Black mom&quot;</td>
<td>Putting the curriculum to the side</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Social justice approach to teaching science (fighting science as white property)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Classroom Environment goals
<table>
<thead>
<tr>
<th>Novice</th>
<th>Veteran</th>
<th>Elder</th>
<th>No Longer Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caring</td>
<td>Politicized caring</td>
<td>Philosophy of teaching science</td>
<td>Philosophy of teaching science</td>
</tr>
<tr>
<td>Political clarity</td>
<td>Embrace of the maternal</td>
<td>Importance of student collaboration</td>
<td>Reflection of past oppressive practices</td>
</tr>
<tr>
<td>Safe environment</td>
<td>Importance of teacher-student relationships</td>
<td>Organized chaos</td>
<td>Classroom is a community</td>
</tr>
<tr>
<td>Advocating for Black/Brown students by fighting against deficit mindsets</td>
<td>Positionality as a motivator for welcoming/empowering environment</td>
<td>Connections - science learning &amp; informed/active citizen</td>
<td>Culturally relevant pedagogy</td>
</tr>
<tr>
<td>Advocating for Black/Brown students against white teachers' low expectations</td>
<td>Ethic of risk - Teaching science goes beyond the science content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix E - Sample of Coding Tables in Chapter V

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description of the theme</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP in science</td>
<td></td>
<td>Dr. Jasmin Porter: no one was really doing that at the school. They were scared, No one, renting a coach bus going to like fly fish and you know They are an art museum of state like I related everything the science.</td>
</tr>
<tr>
<td></td>
<td>field trips outside of the city.</td>
<td>INDOW. This helps with building informed citizens, especially since there is so much false information out right now.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chrissy Perez: We implemented the next generation science standards and I found by implementing that it gave the students more agency and what they were struggling with was asking questions and part of being a good citizen is, you know, asking questions. You know, using claim evidence and reasoning which we know we need the world right now. But all these false claims, rather than around. So I would say Any curriculum that promotes student agency, the ability to ask and answer questions and carry out investigations that are in the NGSS I have found that to be helpful, but the curriculum has to be relevant to the student and the unit that I had the greatest success with were a diabetes unit that I did. And that's because so many of the students were impacted by that they had family members, with that being so, they were very interested in that and then another unit was on floods and I use the video clip from Detroit and the students were pointing out. “Oh, I know that place. I know that place is” it they can be like to the video so The question asking to me is essential.</td>
</tr>
<tr>
<td></td>
<td>Liberatory practices are naturally embedded in the NGSS but the content also has to be made relevant to the community. .... This helps with building informed citizens, especially since there is so much false information out right now.</td>
<td>Courtnie Vernon: what's going to happen now like they are born into all of this blood and despair. What are they going to think and I was like, What kind of questions do you have? If you were to come. So I set up like a little crime scene or so impromptu but I was like, you came and you saw feathers and blood, what questions you have on what</td>
</tr>
<tr>
<td>CRP in science: Encouraging students to ask questions is imperative for Black and Brown communities because sometimes asking questions is viewed as disrespectful, ALSO asking questions in science is tied to social justice because science is typically presented as facts and these facts have historically hurt marginalized groups when not questioned so it is imperative that we start questioning what we perceive to be facts in science early.</td>
<td>Dr. Jasmin Porter, I feel like depending on how you grew up. Right. Um, you don't question anything sometimes like you're just like, okay, it's science like it's a fact like You know so. So thinking about, you know, developing these questions. What if um, you know, if we change a variable like so. That helped them to also talk. ...... And to me that's what I wanted for my students, I wanted to hear their voices, because sometimes there's subdued. You know, for whatever reason, like they have just not heard And sometimes when you what that debate to how it affected their community and like, you know, I started a garden cleanup. So things like that. Like they when they start caring about their community. And questioning things to me that was social justice at the time.</td>
<td></td>
</tr>
<tr>
<td>CRP in science: You can not ignore your culture when engaging in science.</td>
<td>Leslie Phillip: science is a cultural endeavor. It's, it's You bring your culture with you when you ask a question, you bring your culture when you look at the data, you bring your culture when you. You're right. When you make an explanation or you construct the conclusion you are using your culture.</td>
<td></td>
</tr>
</tbody>
</table>
| CRP in science: There is much missing in the timeline history of science. How can we help ourselves and students get knowledgeable enough to fill the gaps in the timeline? | Leslie Phillip: you know, Newton and Einstein and all these things. And I'm like, Okay, so if I plotted all this stuff on a timeline. There are so many people missing in between these names and faces. ....What are we doing right like what are we doing to fill that in. So that could see how do you put your kids’ faces in between
<table>
<thead>
<tr>
<th>CRP in science: The possibilities in an interdisciplinary course with humanities and science.</th>
<th>Dr. Riley Patterson: So when you start working outside of your just your discipline your content area. And start incorporating history into it, working with the history teacher, working with the English teacher to have students do these robust projects while using these different disciplines. And I think that was the only time when I saw teachers actually working together and students, parents, it took some time now. It's not like it happened overnight. But it really opened up people to understand how robust science is...</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP in science: This can not just be relegated to Black history month</td>
<td>Dr. Riley Patterson: Black History Month is it's not just Black history month we incorporate history with the periodic table with ...Ecology with like it's no longer just memorizing the scientists who came up with the theory or the law. It's why did that happen? what team were they a part of? who else did they work with? We brought in genders, different people from different continents. It wasn't just America. It wasn't just, you know, it's this. I really love project-based learning because it it really opens up the curriculum</td>
</tr>
<tr>
<td>CRP in science: Why critical consciousness needs to be developed in Black and Brown students.</td>
<td>Dr. Stephanie Parker: We know that we need to give our students exposure to those things (project-based learning) because we need to have them. We need to tap into um or develop their critical consciousness. We need them to challenge why things are the way that they are and you cannot do that by reading a book and memorizing standard history.</td>
</tr>
<tr>
<td>CRP in science: Preach! When your pedagogy is not anti-racist you are engaging in the master script, thus teaching 'white science'.</td>
<td>Dr. Stephanie Parker: I'm just sick of people thinking that culturally responsive pedagogy teaching Is lowering the standards like it like Gloria Ladson-Billings clearly states that students must experience academic success. So, um, that's like number 1010 at one. So I think the problem is People have a narrow view of 1) What is academic success because if you're only looking at it from your lens. Of course, you have a narrow perspective of</td>
</tr>
</tbody>
</table>
what is academic success, especially when students don't connect to the curriculum, it's not relevant. It's not going to help them in anything that they need. To be successful is not going to free them from the oppressive system. So that's like number two. And then number three people are unwilling to change their pedagogical practices to be inclusive of different ways of knowing and doing. All science learning is cultural so if you are refusing to bring students into the classroom. Every time they come in, they have to check their cultures at the door. How successful do you really think students are going to be, whether that be kindergarten or Graduate school. You know, like, people come with who they are. They come with their cultural reference. So if you're not using that to impart knowledge or to explain why this is even relevant or why they need this so that they can that these are tools to understand the master script and how do we use the same tools to now dismantle it like if you don't teach from that lens, then you are upholding the systems of oppression, you're doing exactly what the curriculum is designed to do, like, well, he will say, Oh, the curriculum is not culturally responsive. Yes, it is. It's culturally responsive for who it was designed to be, um, who was designed for that culturally responsive to us. You know what I mean, like the practices that they use and culturally responsive to us, but it's doing exactly what it was intended to do. And I think if you want to changing those ideologies means getting to those professors and making them understand that the curriculum is doing exactly what it's supposed to do. And by you. Not using anti-racist pedagogy, you're doing exactly you are helping them, you know, helping that what I what I call white science,
in the Black community and who we choose to represent us as a response to the white gaze. This could also connect to Bryan Brown's CRP in science by allowing students to use their language to make sense of science content. We need to be very intentional about that. And even in the science field when we think about like the bootstrap mentality, who we think is good enough as Black people to portray the face of Black scientists even Black young kids, I think that all ties into it as well. Like, I think we need to be careful about Who we're not advocating for because they don't fit the image, whether that be The person that's supposed to be the spokesperson for sitting on the bus rather than supposed to be the spokesperson, though, who gets to represent your class at a district event.

CRP in science: science fairs and opportunities outside of the community, to bring back to the community. Dr. Rashidah Petit: I think for me the biggest change that I made after my dissertation was the science fair just really allowing students to become experts as well as really delve into topics that they might be interested in. So I started, I think I did that science fair I did it for years. And I remember for seven years. And, you know, each year, I would build on it and it was amazing.
Appendix G: Recruitment Flyer

RECRUITING VOLUNTEERS FOR A STUDY ON
Black Women K-12 Science Teachers

TEACHERS COLLEGE, COLUMBIA UNIVERSITY

COMMITMENTS:
Participants will be asked to share their experiences through a written, open-ended questionnaire, an individual 60 - 90 minute confidential virtual interview, and a focus group discussion.

QUALIFICATIONS:
Self-identify as "Black" and "female", and fit into one of the following criteria:
- Currently teaching secondary science in the U.S. or abroad
- No longer teaching but formerly taught science for 8 years or more

If so, you are eligible to participate in a dissertation study on the pedagogical practices of Black women science teachers. This study aims to inform the instructional practices of teacher education programs and training in K-12 schools.

LINKS:
Open-Ended Questionnaire Link
For additional access, please email AR3774@TC.COLUMBIA.EDU

CONTACT:
ALEXIS RILEY, PH.D. CANDIDATE
TEACHERS COLLEGE, COLUMBIA UNIVERSITY
AR3774@TC.COLUMBIA.EDU

QUESTIONNAIRE | INTERVIEW | SISTA CIRCLES