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Elementary Science: A Critical Race Perspective of Exemplary African American Teachers

Mario Pickens

ACCEPTANCE

This dissertation, ELEMENTARY SCIENCE: A CRITICAL RACE PERSPECTIVE OF EXEMPLARY AFRICAN AMERICAN TEACHERS, by MARIO TIARRE PICKENS, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree, Doctor of Philosophy, in the College of Education & Human Development, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chairperson, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty.

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ELEMENTARY SCIENCE: A CRITICAL RACE PERSPECTIVE OF EXEMPLARY AFRICAN AMERICAN ELEMENTARY TEACHERS

by

MARIO TIARRE PICKENS

Under the Direction of Gary E. Bingham, Ph.D. and Natalie S. King, Ph.D.

ABSTRACT

The elementary years are a critical time for all students to learn science and 21st century skills needed to function and flourish in a scientifically advanced world. Despite such importance, research consistently documents that students of color have less access to science opportunities and receive lower quality K-12 STEM education (Atwater 2000; Prime, 2019). These factors, along with the low priority generally given to science education at the elementary level, present significant challenges to the field. As the student population becomes increasingly diverse, the teaching workforce continues to remain predominately White. Research reveals that African American teachers play an integral role in advocating on behalf of African American students and creating more equitable science learning experiences that infuse their cultures into the learning environment (Upadhyay 2009; Xu, Coats, & Davidson, 2012). Yet, the voices and practices of exemplary African American teachers of science have not been given enough attention.

Thus, this qualitative, multi-case study employed a critical race theory (CRT) perspective to examine five exemplary African American teachers' instructional and pedagogical science practices to students who share similar cultural and racial backgrounds. These exemplary teachers were identified by snowball sampling using community referrals (Biernacki & Waldorf, 1981). Semi-structured interviews and classroom observations served as the primary sources of data, with fieldnotes and researcher memos triangulating the data. Cross-case analysis (Merriam, 2009) and thematic analysis (Braun & Clarke, 2006) provided robust findings regarding the teachers' philosophical approaches, agency in the classroom, positionalities as extensions of students' families, and deep commitments to the representation African Americans in the science curriculum and classroom. These findings have implications for how narratives around Black elementary teachers of science are constructed and have the potential to inform both research and practice.

INDEX WORDS: African American, Black, Critical Race Theory, Science, Elementary Teachers Culturally Relevant Pedaogy

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A Dissertation

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DEDICATION

I dedicate this dissertation to all the Black and Brown students I have taught in both Dekalb County and Atlanta Public Schools. You all are my why, and I am forever grateful to have had the pleasure of loving and learning from you all.

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First, I must give the highest honor to God for protecting me, guiding me, and ordering my steps all the days of my life. I praise Him and give Him thanks for all He has done, continues to do, and will do. I know that I can do ALL things, through Christ, who strengthens me.

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CHAPTER 1: INTRODUCTION

The elementary years are critical for the development of conceptual understanding and scientific literacy skills of children (NSTA, 2011). Foundational skills learned during this time carry well into the middle, high, and post-secondary years. Tate (2001) argued that the right to a quality science education is a civil right. He included both students and their teachers in his argument advocating that both deserve access to high-quality science education, use, and enjoyment of science in their lives. However, almost two decades after this research was published, and despite reform efforts and documents that use language to promote science for all (NRC, 1996, 2000, 2012), little has changed. Science instruction, particularly at the elementary level remains a challenge in terms of time and quality (Trygstad, 2013; Tate, 1997; Weiss, Palsey, Smith, Baniflower, & Heck, 2003). For elementary urban classrooms serving primarily African American students, science achievement continues to be underwhelmingly low.

Researchers have identified numerous reasons why science is not being taught in elementary schools, which include lack of confidence (Appleton, 2006; Tilgner, 1990), issues with content knowledge (Crawford, 2007; Fulp, 2002), and difficulty teaching diverse populations (Bryan & Atwater, 2002; Lee, Luykx, Buxton, & Shaver, 2007). Additionally, research has pointed to teachers' limited access to and engagement in professional development to receive resources and tools necessary to overcome challenges (Johnson, 2011; Lee, Hart, Cuevas & Enders, 2004). Furthermore, many elementary teachers have difficulty teaching science because they are not content experts and are responsible for teaching multiple subject areas. Research studies that place race at the forefront of science education primarily focus on middle and secondary science teachers (Goldston & Nichols, 2009; Mensah 2009) or approach

the research through forum and positionality papers (Parsons, Rhodes, & Brown, 2011; Parson, 2008). Therefore, a study that addresses the impact of race within elementary science education is needed.

While the literature is growing about the experiences of African American teachers (Foster 1993; 1997; Irvine, 2003; Milner, 2006; Milner, 2012b), there is a scarcity of research that highlights successful experiences of elementary African American science teachers (Mensah, 2019; Xu, Coates, & Davidson, 2012). Majoritarian stories, stories that are accepted as a shared understanding by the dominant culture and accepted as normal which position White, male, middle class, and heteronormative norms as the status quo, have framed much of what is known about elementary science (Solorzano & Yosso, 2002). Roth (2004) notes, "Although there are pockets of excellent elementary science teaching, the larger picture is grim" (pg. 363). This narrative consists of notions of poor teaching quality from elementary science teachers of color. Deficit views of students of color in urban environments add to this majoritarian story and paint teachers of color, including African American teachers negatively (Foster, 1993, Milner, 2006; Upadhyay, 2009). This study hopes to offer a counter-narrative by sharing more of their successful stories, experiences, and instructional practices.

Problem

Despite rhetoric that promotes scientific literacy for all students and the notion that all students receive equitable opportunities to engage in rigorous science learning, research shows that students of color have less access to science opportunities and receive lower quality K-12 science education than their White counterparts (Atwater 2000; Prime, 2019). Presented as the persistent achievement gap in science education, also known as the opportunity gap by scholars who take a different philosophical stance (e.g., Ladson-Billings, 2006; Milner, 2012), is a

significant problem for African American students. The position in stance has much to do with the need to recognize African American students' racial and cultural identity as a non-negotiable aspect of their educational success (Gay, 2000; Irvine, 2003; Ladson-Billings, 2005, Mutegi, 2011; Prime, 2019). Ladson-Billings (2006) stated, "The achievement gap is one of the most talked-about issues in U.S. education" (p. 3). Making its way into everyday language, the achievement gap refers to the persistent gap in achievement between minority and disadvantaged students compared to their white counterparts. Ladson-Billings (2006) noted that the term has focused heavily on standardized test scores, which does not capture the complete picture of disparities in achievement between white students and students of color. Similarly, Milner (2012a) stated, "When we focus on achievement gaps, culturally diverse students can be positioned through conceptual deficits in the minds, practices, and designs of analysts such as researchers, theorists, and practitioners" (p. 697). He further posited that such thinking could be adopted by consumers of this research and trickle down to instructional practices used with students.

Instead, these researchers identify gaps in opportunities for students of color. These "opportunity gaps" are influenced by policy versus teacher practices and perpetuate lower educational aspirations, achievement, and attainment for students of color (Ladson-Billings, 2006 p. 3). Realizing that social context is important, opportunity gaps differ from the achievement gaps by addressing alternative explanations for disparities in academic achievement amongst diverse populations in P-12 educational settings. Furthermore, comparing students of color to the "norm", which oftentimes means "White", does a disservice to students from diverse backgrounds because it suggests that all students live and operate in homogeneous environments with equality and equity of opportunity afforded to them (Ladson-Billings, 2000; Milner &

Williams, 2008). Irvine (2010) challenges educators and researchers to explore additional gaps in education such as gaps in curriculum, teacher quality, affordable housing, healthcare, income, etc., that mask themselves as the achievement gap. Oftentimes, gaps in so-called "achievement" can be reduced once other gaps are addressed.

Research has shown the importance of teachers attending to students' cultures as it relates to reform-based science education (Barton, 2002; Fusco, 2001; Johnson, 2011; Lee et. al, 2004; Milner, 2011). However, traditional ideas about teacher-centered pedagogy and the objectives of science education still dominate elementary science classrooms. Elementary science content is taught in a way that conforms to ideas of instruction that are typically identified as White, male, and middle-class (Sadker & Zittleman, 2009). As it relates to urban science classrooms, research has shown that many urban elementary students learn science ideas and topics decontextualized from their abundant sociocultural and socio-historical experiences making science learning less meaningful and less connected (Buxton, 2010; Emdin, 2016; Ladson-Billings, 2014). Memorization of facts and rote instruction have been prioritized over more authentic types of instruction (e.g., culturally relevant and inquiry-based). As a result, students' interest in science has been reduced with increased disengagement in science thus leading to fewer students pursuing science related professions. The instructional and pedagogical choices of elementary teachers of color, particularly African American teachers, during science instruction are critical and have lasting effects on student outcomes including conceptual understandings and achievement.

Theoretical Framework

The theoretical framework is an essential part of the research. According to Merriam and Tisdell (2015), it provides "the underlying structure, the scaffolding or frame of [a] study" (p.

85). Due to the types of research questions and context, this study is framed by a Critical Race Theory (CRT) framework that argues that race is at the center of many decisions made in society that have an adverse impact on African Americans. CRT is a theory that attempts to explain the connections between race and power and to influence positive social change that aids in improving the quality of life for all people of color. CRT emerged in the early 1970s after the civil rights movement of the 1960s. There were lawyers and activists involved who saw racism change and become less overt. As it manifested in subtler ways, they felt the injustice grew towards African Americans (Delgado & Stefancic, 2012, p. 4).

Although variation exists in the way that scholars articulate the tenets of CRT, the CRT framework comprises five major tenets: (1) the permanence of racism, (2) interest conversion, (3) Whiteness as property, (4) counter-storytelling, and (5) critique of neoliberalism. The first major tenet of CRT is that racism acknowledges racism as normal in American society. Racism appears normal to people in our society due to historical structures, institutional privileges, and schooling practices, in the United States that perpetuate racial hierarchies. Additionally, Delgado & Stephancic (2012) described it as the common shared experience of most people of color (p. 7). The second tenet is that racism exists because it serves a purpose for the dominant culture, also known as interest convergence. The dominant culture behaves as if race does not matter in most situations unless the situation is overt and unavoidable (Delgado & Stefancic, 2012, p. 8). The third tenet of critical race theory is the idea of Whiteness as property. Due to the embedded racism in American society, Whiteness can be considered a property interest (DeCuir & Dixson, 2004). As a result, this idea operates on distinct levels. These include the right of possession, the right to use and enjoyment, the right to disposition, and the right of exclusion (DeCuir & Dixson, 2004; Ladson-Billings & Tate, 1995). Counter-storytelling, the fourth tenet is a framework that

legitimizes the racial and subordinate experiences of marginalized groups and people of color (DeCuir & Dixson, 2004; Solorzano &Yosso, 2002). Presented as narratives or counter-narratives, African Americans have been able to tell their stories from their own perspectives, elevating their voices and identifying their word view as legitimate. The fifth tenet of CRT, critique of liberalism, stems from the ideas of colorblindness, the neutrality of the law, and equal opportunity for all (DeCuir & Dixson, 2004). According to this tenet, colorblindness is a mechanism allowing people to ignore racist policies that perpetuate social inequity, which can be found in the lack of inclusivity in the academic curriculum (Ladson-Billings, 1998).

Rooted in critical theory, CRT began in legal studies and evolved into other disciplines including education in the 1990s. Ladson-Billings and Tate (1995) introduced the study of CRT to K-12 education. Arguing that race had been under-theorized, these researchers desired to provide a means that would provide insight into theorizing about race in education. Borrowing tenets from CRT, CRT in education is built around major constructs that allow for the examination of race, racism, power, and privilege in education. With caution, much deliberation, and strong critiques from scholars, Ladson Billings and Tate published their article “Toward a Critical Race Theory” in 1995 in which they proposed three propositions or tenets that undergird CRT in education. The three central propositions were: (1) race continues to be a significant factor in determining inequity in the United States; (2) U.S. society is based on property rights; and (3) the intersection of race and property can be used as an analytical tool through which we can understand inequalities in schools. Presenting strong arguments that race should be placed at the core for understanding inequality, the first proposition recognized that “class and gender-based explanations are not powerful enough to explain all of the difference (or variance) in school experience and performance” (Ladson-Billings & Tate 1995, p. 51). These researchers

emphasized the significance of race, recognizing that class and gender alone could not provide justification for the difference in educational achievement between Whites and students of color. The second proposition, which addresses U.S. property rights, assesses the effects of capitalism on democracy. Acknowledging that many conflate democracy with capitalism, Ladson-Billings and Tate (1995) asserted that "traditional civil rights approaches to solving inequality have depended on the "rightness" of democracy while ignoring the structural inequality of capitalism" (p. 52). They also insisted that there has been friction between human rights and property rights since the development of the U.S. considering the purpose of the government was to protect society. Because African people were brought to the U.S. as slaves and thus seen as "property", the government could not grant human rights for Africans while also upholding the rights of property owners. To address the third proposition, Ladson-Billings and Tate (1995) explained that "[t]he ability to define, possess, and own property has been a central feature of power in America" (p. 53). This statement relates to education as well. There is no surprise that schools in more affluent neighborhoods, which are typically White, receive more funding. Additionally, schools are places where intellectual property is acquired, thus the quantity and quality of curriculum differs with property value. Furthermore, there must be real property (e.g., technology, lab materials and qualified teachers) to sustain such intellectual property (Ladson-Billings and Tate, 1995). Ladson-Billings and Tate (1995) provided the theoretical foundations for why CRT was needed in education.

Applying both theory *and* practice, empirical studies have applied CRT to examine the beliefs and practices of teachers in K-12 schools. Lynn (1999) used CRT as a framework to explore the beliefs of progressive elementary, mainly elementary African American teachers. Using interviews one to two hours in length, he found that teachers' beliefs about the

intersections between race and class, the importance of confronting racism in their schools and in their classrooms, and their commitment to utilizing their classrooms as spaces through which they could help children appreciate their culture, were consistent with themes in CRT which include the endemic nature of racism in the U.S., the intersection of race and class, and the need for pedagogies that transform education. Lynn (2002) also used CRT as a tool to explore (1) how the literature on teachers and teaching has viewed African American teachers, males in particular; and (2) how African American male teachers envision teaching as a social change strategy. He asserted that African American male teachers view teaching as a form of ‘‘racial uplift’’ (Ladson-Billings, 1995b). He also discussed how this view of teaching is consistent with those of earlier Black women activists who viewed teaching as part of the struggle for social and political change on behalf of all African Americans (Johnson, 2000).

Related to science education, Wallace and Brand (2012) used CRT to analyze the extent to which science teachers were aware of their students' racial identities, and if this awareness had any influence on their beliefs and practices geared toward African American students. This study focused on teachers' instructional decisions and pedagogical practices for teaching middle school science to African American students. These teachers (one White, the other African American) were chosen because of their consistent success with students of color, including but not limited to their positive relationships with students, classroom observations, and consistently positive results on standardized tests. Using interviews and classroom observations, Wallace and Band (2012) demonstrated just how impactful the role of race becomes when discussing teachers' beliefs and instructional practices. The significance of the findings indicated that "race still matters, in that the teachers were informed by an awareness of how society's constructions of

race could influence what their students thought about their teachers, themselves, and their academic achievement" (p. 370).

The use of CRT as it relates to my study arises from the limited use of CRT as an analytical tool in science education (Seriki, 2018). Schools are microcosms of society where students (particularly those who belong to the subordinate classes of our society) are taught the values, ideas, objectives, and the cultural and political meanings of the dominant class (Jay, 2003). The thought process behind CRT in this line of research includes the belief that it provides a powerful way to elevate marginalized voices and provide agency to teachers and students of color who are traditionally underrepresented in or marginalized by what Aikenhead (1996) terms "Western science". The cultural features of "Western science" tend to be "materialistic, masculine, reductionistic, exploitive, elitist, ideological, impersonal, decontextualized… and value-free" (p.10). The potential benefits of using CRT in elementary science education include not only providing a platform for voices to be heard, but also presents the use of helping to highlight and possibly eliminate practices within science classrooms that perpetuate the status quo by subjugating the voices, experiences, and knowledge of students of color (Seriki, 2018).

The tenets of CRT are crucial in the examination of African American elementary science teachers as they navigate teaching African American students in an urban environment. Specifically, CRT in education (Ladson-Billings & Tate, 1995) as a framework provides a closer look into the intersectionality of race and class and the absence of this kind of discussion surrounding exemplary African American elementary science teachers. Furthermore, challenging dominant ideologies through a counter-narrative approach, CRT also helps to critically consider

the work and needed narratives of elementary African American teachers of science who are largely absent from the research and literature.

CRT in education recognizes that the first-hand knowledge of people of color is legitimate and critical to understanding, analyzing, practicing, and teaching about racial subordination (Ladson-Billings & Tate, 1995; Solorzano & Yosso, 2002). One of the main purposes for this research involves the use of counter-narratives. They provide alternative lenses of interpretations of the experiences of African American elementary science teachers and represent viewpoints that run opposite to assumed order and control (Stanley, 2007). These narratives are the result of the experiences of individuals or groups that are often critical of the master narrative. Critical race also denounces essentialism. Furthermore, to say that all African American teachers think and teach alike, specifically when it comes to science instruction, contributes to misconceptions and stereotyping. Realizing that there is just as much within variance as there is between variance, CRT takes precaution against essentializing the perspectives and experiences of successful African American science teachers of African American students. However, this study realizes the shared understandings of People of Color.

Using CRT in education within my research design, this study hopes to uncover how teachers' racialized experiences foster into the instructional and pedagogical decisions African American teachers make as they navigate teaching predominately African American students. The body of literature thus far linking science education and CRT does not adequately attend to the experiences of exemplary African American in-service elementary science teachers who teach predominately African American students. The focus has mainly attended to preservice teachers in science methods courses (Gunning & Mensah, 2011; Mensah & Jackson 2018; Mensah, 2019) or on in-service middle grade teachers (Calabrese Barton & Tan, 2010; Goldston

& Nichols, 2009; Wallace & Brand, 2012). Yet, there are limited studies that examine African American teachers' experiences with teaching science successfully within an urban elementary context (Upadhyay, 2009; Xu, Coats, & Davison, 2012).

This study sheds light into the experiences of exemplary African American science teachers by uplifting and elevating their voices. Identifying these teachers as exemplary meant that these teachers exhibit characteristics of cultural solidarity, affiliation or kinship, and connectedness (Foster, 1993). They also demonstrate the dispositions of culturally relevant educators, which include high expectations of all students, cultural competence, and sociopolitical consciousness (Ladson-Billings, 1994a). To some extent, they also have helped students to succeed on standardized achievement tests. Furthermore, they are committed to teaching quality science and creating experiences so that the students they teach may have a fair chance at success with science including participating in science discourse and pursuing science related careers.

Focus on African American and Black Teachers

The terms African American and Black were used interchangeably in this study. This action was purposely done to acknowledge and place value on the way the term has been used historically and as a way for African Americans to "lay claim to the cultural heritage(s) of traditions, practices, languages, histories, and lineages" (Basile & Lopez, 2015, p. 531). Historically, the roles of Black teachers after emancipation and until segregation and the reasons they entered and remained in the field of teaching were directly related to the advancement of the African American community as a whole. Based on Asante's ideas of Afrocentricity, African American teachers were charged with uplifting the Black race through preparing children in segregated schools for freedom, respectability, independence, and self-reliance (Irvine, 1989).

Further, Black teachers taught their students to "use their cultural, philosophical, psychological, and social systems as the hub from which the world can be analyzed" (Savage, 2001 p. 172). The *Brown v. Board of Education* landmark decision produced unforeseen consequences for the Black community and the Black teaching force. In the aftermath of *Brown*, a massive number of Black teachers lost their jobs (Tillman, 2004) because White parents did not want their children to be educated by Black teachers (Kohli, 2009). These events led to the closing of numerous Black operated schools and forced out countless Black educators (Farinde, Allen & Lewis, 2016).

Despite the impact of the 1954 *Brown v. Board of Education* decision that contributed to the demotion and a mass exodus of effective African American schoolteachers, Black teachers remain important to the educational system. Research has shown that Black teachers serve as role models in classrooms to encourage and motivate students to be successful through teaching styles and interpersonal techniques that are more accessible to Black students (Foster, 1993; Howard, 2001; Irvine, 2002, Ladson-Billings, 1994a; Stanford, 1997). Milner (2006) states, "Black teachers can have a meaningful impact on Black students' academic and social success because they often deeply understand Black students' situations and their needs" (p. 93). This is not to say that teachers of other races cannot be successful teaching Black students. However, Agee (2004) acknowledges that Black teachers "bring a desire to construct a unique identity as a teacher...she [or he] negotiates and renegotiates that identity" (p. 749) to meet their objectives and to meet the needs and expectations of their students. Additionally, Milner (2006) informs us through his research with Black teacher educators, "Black students and new Black teachers need to see experienced, successful Black teachers" (p. 97).

While the majority of the research on the importance of African American teachers has focused on teaching in general, more studies that relate specifically to the instructional and pedagogical practices of African American elementary science teachers are needed (King, Shumow, & Lietz, 2001; Xu, Coats, & Davidson, 2012). Moreover, studies that use non-traditional methodologies to examine the impact of race as it relates to Black teachers teaching science to Black students are in need of further exploration (Mensah, 2019). Therefore, this study contributes to the scarce literature on how Black elementary science teachers use their racialized lived experiences to effectively teach science to Black students.

The Focus on Science Instruction

According to the NSTA position statement, *Elementary Science Education*, "High-quality elementary science education is essential for establishing a sound foundation of learning in later grades, instilling a wonder of and enthusiasm for science that lasts a lifetime, and in addressing the critical need for a well-informed citizenry and society" (NSTA 2020). This study further limited its focus to that of science instruction for many reasons. Science is already a subject in need of more examples, in that educators in the elementary context admit low self-efficacy in science instruction, regardless of their students' cultural background (Appleton & Kindt, 2002; Bryan & Atwater, 2002; Gunning & Mensah, 2011). Additionally, there is also a need to understand effective and exemplary African American teachers' science experiences and practices so that the findings from these studies can be used in professional development models. These models can provide preservice and in-service teachers of color and all races the opportunity to be reflective, build confidence, and use effective strategies for teaching science.

Related to outcomes, only 5% of all bachelor's degrees in the sciences are awarded to Black students, and only 6% of the population involved in science related careers are Black

(National Science Foundation, 2017; President's Council of Advisors on Science and Technology, 2012). A substantial percentage of the Black community are, therefore, not contributing to the current cutting-edge atmosphere directed by the sciences, nor confronting hegemonic ideas that dominate the scientific field. As a result, they are also not partaking in the full benefits of being active participants in science-based environments and dialogue (Loney, 2014; National Science Foundation, 2017; President's Council of Advisors on Science and Technology, 2012). As Prime (2019) acknowledges, aside from the economic consequences of not being involved in STEM fields, other consequences related to the emotional and psychological well-being of students occurs from the lack of full participation in the sciences. Research that supports and highlights the early development of scientific literacy and conveniences of scientific knowledge for all students, particularly students of color, from teachers of color warrants further attention.

Purpose

The purpose of this study is to use a critical race lens to examine the racialized lived experiences of African American teachers and how they use these experiences to effectively teach science to their African American students. Issues of quality and priority continue to be challenges in many elementary schools in terms of science education (Trygstad, 2013; Spillane Diamond, Walker, Halverson, & Jita, 2001). Therefore, the literature on exemplary African American teachers, who teach elementary science well, is in need of more research that highlights this unique group. Furthermore, studies that use a critical race lens, including critical race methodologies to discuss the lived experiences of Black teachers who teach science in elementary settings warrants more attention. Current studies focus primarily on preservice teachers (Mensah, 2019) or have focused on the perspectives of middle and high school teachers

(Wallace & Brand, 2012). Moreover, much of the literature centered on teachers' use of attending to asset-based pedagogies and including culturally relevant science instruction is limited to middle and high school levels (Boutte & Kelly-Jackson, 2010; Dimick, 2012; Milner, 2011) and less at the elementary level (Johnson & Fargo, 2014; Patchen & Cox-Petersen, 2008; Upadhyay, Maruyama & Albrecht, 2017). Pedagogies designed to address race in the science classroom such as race-visible pedagogy (Prime, 2019) are starting to circulate in the literature. However, more examples of how this pedagogy can be applied to practical settings are still being developed. Using CRT, this study examined the lived experiences and instructional and pedagogical practices of exemplary African American elementary teachers who teach science. Positioning race to the forefront, the following questions guided this study:

1. What are exemplary African American elementary teachers' lived experiences regarding issues of race and racism?

2. How do these teachers navigate their racialized lived experiences to effectively teach science to African American students in the formal classroom?

Significance of Study

Although the body of research that presents the experiences of African American teachers in science education is growing and contributing a more accurate picture (Kelly Jackson & Jackson, 2011; Mensah, 2009; Mensah, 2019), researchers have acknowledged that many studies involving science education approach research from a colorblind perspective (Moore, 2009; Prime, 2019; Walls, 2016). This research specifically examined African American elementary teachers who make the concerted effort to teach science on a daily or consistent basis, while also being aware of the influence of race guiding their instruction. The significance of this study was to provide voice and insight into African American science teachers working in urban environments serving predominately African American students. Specifically, this research

contributes to the literature on the experiences of African American elementary science teachers and the pedagogical practices that have been shaped by these experiences. In a world where science is often viewed as objective, culture-free, and Eurocentric, (Aikenhead, 1996), including who produces of scientific knowledge (Walls, 2012), this study helps to shed light on the thoughts, experiences, and practices of exemplary African American elementary science teachers. This study focuses on elementary science because of the existing literature that illustrates the challenges of implementing high quality science at this educational level (Weiss et. al, 2003; Roth, 2014). Additionally, the choice to study African American, exemplary teachers who teach science in urban environments stems from the unique challenges and intersections they face in the classroom as compared to their counterparts in suburban and rural contexts.

Definition of terms

The following terms are used frequently in this study. At the very least, terms in the research question should be defined. Aware that in other studies there may be gradations of the meaning of the terms than what is reflected here, I preferred the following meanings for the terms:

African American. The term African American in this study refers to "people of acknowledged African descent" (Tatum 2017, p. 95"). This term will be used interchangeably with the term "Black".

***Black*.** All members of the African diaspora including African Americans and those from the Caribbean. This term will be used interchangeably with African American.

Counter-spaces. Revolutionary settings embedded within larger settings and contexts. That is, they are pockets of resistance that may, to one extent or another, disrupt larger settings and contexts (Case & Hunter, 2012, p. 267)

Exemplary Teacher. A teacher who demonstrates the qualities of culturally relevant and responsive teaching (Gay, 2010; Ladson-Billings, 1994a) including recommendations from principals and research staff at a local research one university.

In-service teacher: Teachers who are currently certified and teaching in a classroom; experienced teachers.

Opportunity Gap. The ways in which race, ethnicity, socioeconomic status, English proficiency, community wealth, familial situations, or other factors contribute to or perpetuate lower educational aspirations, achievement, and attainment for certain groups of students (Ladson-Billings, 2006).

Person/ Student/Teacher of Color. Refers to "individuals of indigenous, African, Latina/o, Asian/Pacific Island descent" (Kohli, 2009, p. 250).

Race. "Notion of a distinct biological type of human being, usually based on skin color or other physical characteristics" (Delgado & Stefancic, 2012, p. 170).

Science. Cross cultural education that is "laden with cultural understandings, interpretations, and a language of its own (Meyer & Crawford, 2011).

Urban. Milner (2012c) uses the term urban intensive to speak to "the size and density of a particular locale; the broader environments, outside of school factors such as housing, poverty, and transportation are directly connected to what happens inside of the school" (p. 559).

CHAPTER 2: LITERATURE REVIEW

The research questions addressed in this study examine the racialized, lived experiences and instructional and pedagogical practices of exemplary African American elementary science teachers. This study also used CRT as a theoretical lens and methodological tool to examine to role of race in these teachers' decisions to teach elementary science. Literature from this review was selected in a careful search of the university's online databases including JSTOR, EBSCO, and Galileo. Additionally, Google Scholar was also used to supplement the literature found on the online databases. Research journals of particular interest were *Cultural Studies in Science Education*, J*ournal of Science Teacher Education, International Journal of Science Education, Journal of Research in Science Teaching,* and *Urban Education.* During the search for relevant literature, a quick read of the abstract determined if the article addressed a necessary component of my research questions. Simultaneously, skimming the reference list was also employed. A basic search for the phrase "Critical Race Theory in science education" began the initial phase of searching for literature. This yielded many articles about CRT and CRT in Education (1,654 since 1995) from the above mentioned journals, but only three empirical studies and two discussion articles addressed both CRT and science education (Parsons, Rhodes, & Brown, 2011; Parsons 2014; Seriki, 2018; Wallace & Brand, 2012; Yerrick & Ridgeway, 2011). *Centering Race in STEM Education for K-12 learners* edited by Glenda E. Prime was recently published and was used as an additional resource to inform this literature review.

Additionally, the literature reported many articles about African American teachers (1,143) but not necessarily related to science. For this reason, literature from other related subject matters was included as well. Because the research focus was on elementary teachers, I also included "elementary science teaching" in my search. The search generated articles that addressed

elementary pre-service teachers developing the confidence to teach science (Gunning & Mensah, 2011), dilemmas and barriers (e.g., policy) that affect the teaching of science in elementary school (Berg & Mensah, 2014; Upadhyay, 2009), whiteness in science teacher education (Mensah & Jackson, 2018), and culturally relevant science instruction (Johnson, 2011; Kelly-Jackson & Jackson, 2011; Moore 2008). After careful review of the retrieved articles, I noted that there was only one publication related to the study's specific focus (Mensah, 2019). While the study contained many aspects of my study employing the same theoretical lens and similar methodological approaches, the participant was a preservice African American elementary science teacher transitioning into an in-service teacher. The search did not generate studies using critical race theory to examine in-service exemplary African American elementary science teachers. In reviewing the literature and other sources, I realized the gap in our knowledge base and thus structured the organization for this literature review into the following sections:

1. Elementary Education
2. Elementary Science Education
3. Who are Our Teachers
4. African American Teachers
5. Critical Race Theory and Critical Race Theory in Education
6. Culturally Relevant Instruction
7. Culturally Relevant Science Instruction and Race-Visible Pedagogies

Elementary education

Most elementary schools define themselves as serving Pre-Kindergarten (Pre-K) through fifth grade students. Further, early childhood education (ECE) covers Pre-K through third grade and overlaps with elementary education first through fifth grade. This distinction is useful for

understanding perceptions and common macro beliefs related to elementary education. These views include the misperception that teaching this age group is fun, fanciful, and requires less knowledge of content expertise (Boutte, 2012). Additionally, the ECE and elementary field is based on a "one size fits all" model when addressing issues of developmental appropriateness with little attention to substantive differences across cultural contexts which include urban elementary environments (Boutte, 2012). Knowing how to balance notions of developmental appropriateness while also acknowledging and accounting for differences in social and cultural contexts requires a certain skillset from elementary teachers. However, discussions of sociopolitical issues that arise in the curriculum are often seen as too advanced and complex for young, "innocent" children to understand (Boutte, Lopez-Roberston, & Powers-Costello, 2011). Many ECE and elementary teachers hold the pervasive belief that young children are colorblind and hence avoid addressing issues related to race, negative societal messages about people of color, and connotations associated with urban (Boutte, 2012). Yet, the literature shows that young students are fully aware (Farago, Sanders, & Gaias, 2015; King & Pringle, 2019; Sanders, 2016).

Boutte and colleagues (2011) found that second graders could articulate the concept of racism as well had experienced racism daily. Through drawings and dialogue, the students demonstrated an awareness and understandings of race and racism that were based on their lived experiences. Boutte and colleagues also offered suggestions for early education teachers (e.g. reflection of own childhood experiences, resources) to address racism with their students. Tenorio (2008) says, "Teachers have a responsibility to recognize the influence of racism on themselves and their students" (p. 21). Likewise, using the African term "Ubuntu", meaning "when one suffers, we all suffer" the research reminds elementary teachers and educators that if

we choose to ignore racism and accept notions of colorblindness, then we too, are indeed a part of the problem.

In addition to the challenges of addressing issues of race within the elementary curriculum, policies such as No Child Left Behind have placed an (over) emphasis on literacy and mathematics instruction, while neglecting additional subjects. Elementary teachers often admit to feeling the pressure to increase the literacy and mathematics achievement of their students, which are tied to accountability which includes negative sanctions for schools who fail to meet accountability measures (Weiss et al., 2003). In many cases, if schools, particularly urban schools, do not do well on accountability measures, they face the real risk of the restructuring of schools which includes firing principals and teachers, recommending curriculum changes, removing authority of control from the local school board, or having the school be taken over by the state (Judson, 2012). Elementary school administrators do not want these types of negative sanctions for their schools; thus, they emphasize the teaching of subjects that count into the accountability equation. Lee and Luykx (2005) found that in the school district in which they were employed, elementary principals instructed teachers not to teach any subject (e.g., science and social studies) that was not included in school accountability measures, specifically in the sixty to ninety-day window prior to statewide testing. Additionally, Goldston (2005) noted that elementary teachers are directed to improve basic reading, writing, and mathematics skills by administrators. He also discussed social and political demands held by school administration "of 'back to basics' mentality that includes accountability, fixed standards, and improved high-stakes test scores" (p.185). The notion in phrasing and policies used to justify this stance rely on deficit ways of thinking of students that imply that elementary students are not capable of learning or grasping content from subjects outside of literacy and numeracy subject areas.

Mensah (2010) makes a similar argument that “elementary schools enforce policies that relegate science (or in some cases, even social studies or the arts) as the least important in the overall school curriculum for students” (p. 979). Mensah explains this phenomenon in a review of thirteen elementary educators, many of whom were teachers of color. The research found that these elementary teachers made a commitment to teach science authentically using reform-based strategies to meet the needs of their students. However, it was after the implementation of NCLB policy that forced these teachers to change their instruction and pedagogy drastically, decreasing the amount of time and quality dedicated to science instruction. These teachers also felt that they were being blamed for limiting or excluding additional subjects, including science, from daily instruction, when in fact policies termed ‘‘opp(regre)ssive” by Rodriguez (2010) were the culprit. Opp(regre)ssive policies simultaneously act as both oppressive and regressive on teaching and learning. These policies marginalize teachers’ voices who desire to become advocates against policies put in place that manifest themselves as hindrances to teachers’ abilities to do what they know are beneficial to students (Rodriguez, 2010). A noteworthy question Mensah (2010) posed in her examination of policy enactment in elementary was: “When can we make science education a top priority at the elementary school level, where science is included as a regularly scheduled course, where high-stakes testing and all-encompassing policies do not interfere with quality science teaching and learning?” (p. 981). Until elementary education rectifies policies that inevitability hurt teachers and students, science and other non-literacy and math subjects will continue to be given minimal priority and will be deemed “less” important at this stage of learning. The science community cannot wait until students enter middle school to engage students with science and not expect there to be gaps in

students' scientific literacies and understandings. For if we do, we create a generation that will ultimately struggle with many facets of science learning (Mensah, 2010).

Elementary Science Education

As a whole, elementary science education continues to face challenges (Roth, 2014). Researchers consistently find that elementary science teachers lack sufficient science content knowledge and have less training to teach in the disciplines they are expected to teach (Appleton, 2003; Fulp 2002; Smith & Neal, 1991). Further, the emphasis on high-stakes testing policies that reduce time for science in U.S. schools (Weiss et al., 2003) prohibit elementary science from receiving its due diligence regarding teaching and learning. The teaching of science in the elementary classroom is an important endeavor that requires serious and sustained attention. Students need experiences that help them to understand the differences between everyday thinking and scientific thinking and why they are important. (Duschl, Schweingruber, & House, 2007).

Mensah (2010) noted science continues to a subject torn out of the elementary schedule in terms of time, access and quality. Mensah also stated, "Nothing is comparable to [the elementary school] structure in terms of how time is allocated for subject-matter learning, how resources are used and teachers are supported, and how relationships are built" (p. 979). This quote describes the unique role of the elementary teacher who teaches science. Because elementary teachers do not specialize in one content area as middle and high school teachers do, they are expected to teach at least two of the disciplines (e.g. departmentalized settings) if not all core subjects. Moreover, elementary teachers likely do not have science backgrounds (Fulp, 2002; Tilgner, 1990) and, as a result, their confidence in teaching science falls short in comparison to their certainty in teaching the other core subjects (Cochran & Jones, 1998). To be

considered effective, they must develop some type of expertise in these core areas, including science. Preparing for multiple subjects on a regular basis demands elementary teachers to spend a substantial amount of time planning (Levitt, 2002). To reiterate, the time committed to science instruction in elementary schools is more limited, even lacking, due to emphasis placed on literacy and mathematics instruction (Baniflower et.al, 2013).

Research also shows that elementary teachers navigate these dilemmas if they have supports (Berg & Mensah, 2014). Using a case study approach with the researchers as participants, Berg and Mensah found that science was taught more often and adhered to students' engagement when elementary teachers sought the help of science coaches and specialists in their schools. This study shared the experiences of three first grade teachers who had experience ranging from first year to over twenty-five years and were considered new to teaching science with adopted curriculum, Full Option Science System (FOSS) science kits. Teachers used these kits in conjunction with the science coach to help effectively facilitate the lessons and give useful and constructive feedback. Studies such as this one shed light into the complex world of elementary science teachers. They have a plethora of responsibilities because of the nature of their work and having supports such as science coaches may help them to navigate the complexities of their teaching. Additionally, Berg and Mensah (2014) state, "How teachers navigate their uncertainties appears to be related to their career stage, their sense of accountability to teach science, and opportunities to collaborate with reform-minded colleagues and coaches" (p. 17). This study examined teachers' dilemmas with teaching science in the lower elementary grades. Having more studies that address the upper elementary grades can provide new insights.

Addressing upper grade level elementary teachers, Upadhyay (2009) captured how one teacher negotiated her personal and professional identities in a school context that emphasized teaching to the test. Daisy, an African American woman and fifth grade teacher to predominately African American students, was highlighted during the school year as she negotiated the dilemmas faced between teaching science authentically and teaching to high-stakes tests. Employing an ethnographic qualitative case study including data collection methods that involved interviews and video-taped classroom observations, results from the study showed that Daisy "constantly negotiated between her science teaching practices and identities and was willing to modify her teaching so that students could succeed in science" (p. 583). Her goal was to make sure students were provided with relevant science learning experiences, while also meeting the demands of the school district's definition of success. This study highlighted the importance of context: Administrators and teachers of students at low performing schools serving low-income minority students sometimes struggle to see the value in creating authentic science experiences when the pressures of high-stakes testing are involved. Studies like this also show the extreme importance of creating an environment conducive to teaching science that supports teachers' instructional decisions while also resonating with the lived experiences of students. As Upadhyay acknowledges, this study examines one teacher's identity in relation to her science teaching practices. Upadhyay (2009) asks, "How would many other minority teachers negotiate between identity and teaching dilemmas, and what does this negotiation mean to them" (p. 585)? Examining multiple teachers of color may help to generalize findings amongst these teachers and provide new insights into how they navigate their personal beliefs about teaching science and meeting the demands of administration at their schools.

The research also shows that all science experiences are not created equally. Differences with the quality of science instruction may exist when it is taught (King et al., 2001). Not every school is fortunate to have supports and resources to assist elementary teachers who teach science. Also, there may be differences with teachers' reported practices, and the actual practices they engage while teaching science. For schools that do not have the access to science coaches and resources, elementary teachers may mistakenly equate "hands on" activities with inquiry-based, when in fact, the activities are do not align to reform-based science, connect to conceptual understanding of science content, or have relevance to students' lives. Additionally, science instruction may continue to be teacher directed and focus on rote memorization even when teachers believe they are acting as facilitators in the classroom.

King and colleagues (2001) examined four elementary-trained science teachers' beliefs and classroom practices using a case study methodology within an urban school setting. Elementary-trained denotes the fact that two of the teachers could be considered middle school teachers because they taught seventh and eighth grade students but had K-8 certification. Two were African American and the other to where white. All teachers had considerable years of science teaching experience. Science was taught daily in the school beginning with fourth grade. Researchers conducted semi-structured interviews with teachers as well as videotaped observations. King and colleagues (2001) noted that "teacher bashing was not the intended purpose of this study" (p. 104). The results confirmed that teachers' beliefs were not consistent with their classroom practice; a disconnect existed between the language used to describe their teaching practice and observed teaching practice. They found teachers the lessons to be teacher directed and more traditional from the language they used such as "facilitator". While the study highlighted that these teachers were making an effort to teach science and advocated the need for

professional development for teachers, this study presents teachers, some self-identified as African American, in a deficit manner. The study frames teachers as unprepared, lacking both content and pedagogical knowledge, classroom management, and self-reflection skills.

While studies are few and far between, there are examples within the literature to show in service elementary teachers not only making time to teach science, but also adhering to high standards of quality. These teachers were reported to also teach in culturally relevant ways (Ladson-Billings, 1990). Teachers promoted academic success for all students by connecting students' home cultures with the culture of the school and classroom (Ladson-Billings, 1995a). For example, Xu, Coats, and Davidson (2012), examined the science instructional practices of eight exemplary African American upper elementary teachers specifically in addressing the needs of African American students. However, the research pertained to students' interest in science and did not use CRT as the theoretical, methodological, or analytical tool for the study. Because this study examined exemplary African American teachers, selection for participation in the study included criteria including awards won, nominations, and the ability to positively impact the educational experiences of African American students. Interviews and classroom observations were the main source of data collected although other data collection (e.g., lesson plans, student work, digital pictures, etc.) were used to triangulate the data. Findings from this study build on previous research that recognizes that building caring and trusting relationships with students was important (Ladson-Billings, 1995a; Irvine 2002). As this relates to science, this study: (1) created more dialogue centering on ideas of culture in science and (2) provided vivid, illustrative and practical strategies of what quality science looks like in elementary classrooms, particularly for African American students served by African American teachers. This line of research helps to disrupt negative dispositions of elementary school science by

showing what high-quality science can be. Moreover, this research adds to positive depictions of African American teachers in a research world, where they still continually fight to be acknowledged.

More recently, Mensah (2019) employed a longitudinal case study using critical race methodology to provide a narrative account of an African American female named Michele in her journey from a preservice elementary science teacher to an in service first grade elementary science teacher. Recognizing that science elementary remains marginalized at the elementary level (Berg & Mensah, 2014; Mensah 2010), Mensah (2019) chronicles this teacher's childhood educational experiences and the difficulty she faced navigating a racialized and predominately White teacher education as well as her growth and development as she transitioned into an in-service science teacher. Mensah collected many forms of data, but interviews were the main source of data used for analysis. Using a recurring and iterative process of collecting and analyzing data from this one teacher, Mensah (2019) was able to capture the richness of Michele's experiences presented as racialized narrative themes. Michele reported that having a voice in science was especially important as a science teacher of color. Having the confidence to know that she was competent, knowledgeable of inquiry-based science, and a teacher who practiced culturally relevant pedagogy (Ladson-Billlings, 1995a) despite her struggles were ideas Michele expressed in her narratives. Using counter narratives that positioned race to the forefront, Mensah (2019) was able to elevate the voice of Michele and demonstrate how the strong support of mentors in teacher education, particularly teachers of color, is important in helping them grow professionally and understand their importance in elementary science education. Moreover, Mensah (2019) provided insights into how to move further in our research as scholars by not only telling our stories, but by "active transformation of teacher education

policies based on the counter-narrative" (p. 1450). By asserting this work as the next steps, she encourages researchers to not only use the counter narrative, but to consider its use as we theorize about the broader issues in education. While Mensah's research contributes to the literature that uses methodologies not typically used in (elementary) science education, Mensah (2019) does acknowledge that Michele was a former student of hers in a science methods course. Research that focuses on teachers who teach science in upper elementary grades, have more years of science teaching experience, focus on more than one student, and have less of a direct connection to the researcher are needed.

Who Are Our Teachers

The ideology of Whiteness dominates the education field in terms of both in service teachers and preservice teachers. Whiteness is defined as a characteristic that Whites alone possess and is socially constructed, valuable, and property (Harris, 1993; Ladson-Billings & Tate, 1995) The ideal of the elementary teacher as a White, middle-class women still holds constant not only to those in the academy, but also to the general public (Sleeter, 2001). Approximately 82% percent of the teaching force is White in the U.S. (Sleeter, 2017). Additionally, the great majority of teacher preparation programs continue to turn out roughly 80% White cohorts of teachers despite the knowledge that White students are less than half of the K-12 population (U.S. Department of Education, 2016). These percentages present challenges for teachers as children from racially and linguistically diverse backgrounds constitute the fastest growing demographic in public schools. Increasingly, educators, parents, and scholars have expressed concern that without a larger cohort of new teachers of color, students of color in K-12 schools will continue to suffer disadvantage and oppression in a system

that privileges the norms, interests, and perspectives of the dominant culture (Kohli, 2018; Warren, 2018).

The problematic nature of having such a homogenous teaching force often creates a demographic divide between the overall White, middle-class normative culture of schools and their students of color they teach daily. This demographic divide also pertains to an overwhelmingly White teaching force working with a majority non-White student population that is not likely to close anytime soon (Rich, 2015). To address this demographic divide, many teacher education programs have focused on multicultural and diversity issues within education courses. While this may be a great starting point, the sparse number of courses offered ultimately does not fully prepare White teachers to teach in diverse settings to students of color. Research has indicated that such classes tend to focus on *culture* rather than *race* in an attempt to make such discussion less uncomfortable for students (Prime, 2019). Meanwhile, White, middle-class teachers continue to graduate from teacher education programs without having confronted or challenged their Whiteness or privilege (Ladson-Billings, 2001; Picower, 2009).

Teachers graduating from education programs will need additional opportunities to challenge their ideas and improve their practice. Moreover, ongoing support for graduates who enter the teaching profession should become a built-in component of teacher education programs. As Picower (2009) acknowledges, “The first year of teaching is a tremendous struggle for many people, particularly teachers who are working in communities vastly different from their own” (p. 213). One cannot expect for teachers, the majority being White and many who have had one course or semester of a diversity or multi-cultural education curriculum to be “enlightened” about the maintenance of hegemonic practices that maintain White-middle class

norms in education. An additional strategy to address the demographic divide has pointed to the importance of having teachers of color in K-12 educational settings.

There have been calls for increasing the number of teachers of color, including African American teachers, in the teaching force. Villegas and Irvine (2010) examined three major arguments for diversifying the teaching force- "the role modeling effects of teachers of color, the potential of teachers of color to build cultural bridges to learning for students of color, and the workforce rational" (p. 187). Teachers of color serving as role models for all children has been a popular justification for diversifying the teaching. However, this reason has had the least empirical data to support such claims. The other two rationales provide more empirical data using both qualitative and quantitative lines of inquiry.

Quantitatively, studies included the examination of standardized test scores from students who have the same racial identity as their teachers (Clewell, Puma, & McKay 2005; Dee, 2004; Pitts, 2007) have been examined. For example, Dee (2004) used Tennessee Project STAR data to reanalyze test scores from a sample of roughly 11,600 participants including 79 schools from an experiment originally conducted in the late 1980s. Elementary aged students were randomly assigned to teachers in the participating schools from this study. Using least squares regression modeling, Dee found that racial pairing of teachers and students significantly increased the reading and math achievement scores of African American students by three to four percentage points. The race effects were especially strong among poor African American students in racially segregated schools. The results of this study yielded mostly positive findings and indicated "race and ethnicity do matter in the education of students of color" (Dee, 2004 p. 188).

Qualitatively, there are several examples of empirical studies that show how teachers establish cultural links between home and school (Foster, 1993; Gay, 2010; Hollins, 1982;

Irvine, 2003, Ladson-Billings, 1994b). These studies show how teachers of color use their insider knowledge about the language, culture, and life experiences of students of color to improve their academic outcomes and school experiences. For example, Foster (1993) used ethnography methodology to examine the philosophies and pedagogies of 17 diverse and effective African American teachers with a substantial amount of teaching experience. These teachers used their experiences from their childhood to tell narratives of how their teachers, during the time of segregation, influenced their current beliefs and teaching practices. By creating a caring environment and establishing special bonds with students by relating to students as relatives, these teachers were able to bolster students' academic success.

Teachers of color are also beneficial to address teacher shortages in schools, particularly high needs schools. Teachers of color, particularly African Americans see teaching as a "calling" (Irvine, 2002) and a way to "give back to the community" (Lynn, 2006). The results from these studies showed that Black teachers who have this view often went back to their community to make a difference. Moreover, these teachers made the choice to stay at these schools even when presented with other opportunities to teach in areas considered more favorable and less stressful (e.g., suburban). The evidence from these studies also suggested that compared to White teachers, educators of color appeared to be more devoted to teaching students of color, more drawn to teaching in schools considered difficult-to-staff, and these teachers were deemed better able to persist in those settings (Villegas & Irvine, 2010). The research makes a strong case regarding the importance of attracting and retaining teachers of color; teachers of color add value to schools and classrooms.

African American Teachers in the Classroom

Historically African American teachers have played an influential part in the success of their Black students (Foster,1993,1997; Howard, 2001; Irvine, 1989; Ladson- Billings, 1994b, Stanford, 1997). This success can be attributed to their deep understanding and connection that African American teachers have to realities that their students face in and out of the classroom (Milner, 2012). Known as star teachers (Haberman, 1995) and dreamkeepers (Ladson-Billings, 1994a), these successful African American teachers understand constraints imposed by the intersectionality of race a class on their students' educational opportunities, and such an understanding powerfully shapes their pedagogy.

Stanford's (1997) conversation of previous research on four, exemplary African American teachers acknowledged the historical and present familial roles that Black teachers assume as mother and father figures. This study was specifically chosen because one of the participants identified himself as an African American science teacher. This science teacher was known for arriving early to prepare for instruction. He also made sure students attended class sending the message that "no student was considered *unnecessary* for his (science) class" (p.113). Standford (1997) identified four important attributes that surfaced regarding these African American teachers in the classroom. She recognized "community solidarity, community of learners, focus on the whole child, and personal accountability" as attributes, practices, and beliefs of female African American teachers. The belief that successful pedagogy among African American teachers is not peculiar, but rather intentional, was the argument of this research. Stanford's (1997) work demonstrates the deep-rooted belief African American teachers recognize the need to teach in socially just ways to prepare their students for the realities of life outside of the classroom. Likewise, Foster (1993) acknowledged this type of thinking as being "a longstanding practice within Black communities" and echoes Collins (1991) idea of "lifting as

we climb" where "Black teachers have long believed the purpose of their work was to improve the life chances of their students (Stanford, 1997, p. 110).

Howard (2001) also examined the pedagogical practices of four exemplary African American teachers. It should be noted that Howard began with 12 potential research participants but narrowed his search down to four he identified as exemplary based on a rubric of 20 classroom practices he observed. Teachers were interviewed as well as observed. Using a qualitative case study, Howard found that African American teachers were not only committed to the academic needs of their children, but also to their "social, emotional, and moral growth as well" (p. 186). In teaching holistically, these African American teachers understood the tremendous impact they had on their students' educational experience, both academically and socially. Having an understanding of how to help children navigate in school as well as outside of school was important to the instructional strategies used by these four teachers. This research lends itself to the ways in which teachers use culture in the learning process in designing how they design their teaching approaches what is recognized as culturally relevant pedagogy (Ladson Billings, 1995a) in the literature.

Related to science education, Mensah (2009) presented us with a portrait of Black secondary teachers in science classrooms. Using a narrative inquiry approach and qualitative methods of data collection and analysis (e.g., interviews, thematic analysis), she highlighted the teachers as content-specific, meaning they had a degree in a science field (e.g., biology, chemistry, physics). Mensah (2009) also referred to the fact that all children, regardless of their racial or ethnic group, can benefit from academic success when they have high-quality Black teachers who have strong content, pedagogical, and child development knowledge. Through formal conversations with teachers, Mensah demonstrated how the three teachers were able to

tell their stories highlighting their professional growth, development, knowledge, and experience as content specific Black science teachers. Although the study did not use observations as interviews were the main source of data collected, Mensah stated, "the self-connections to science adds another dimension for understanding these teachers" (p. 48). These teachers discussed how they brought their personal lives into their instructional practice by engaging students in critical thinking, personal dialogue connected to science, and taking field trips. This study accomplished the goal of disrupting narratives of Black teachers lacking sufficient science content knowledge, thus serving as a counter-narrative (Solorzano & Yosso, 2002). Additionally, this study created visions of Black teachers in positions of authority and influence (Banks & Banks, 1989). These two goals highlight the importance of Black teachers as competent and necessary to the field of education, two adjectives that have been used scarcely in describing this race of teachers (Mensah, 2009). Having studies conducted like the study described above at the elementary level would continue to combat notions of inferiority of Black teachers and produce more literature that supports teachers.

Critical Race Theory (CRT)

Historically, CRT has been regarded as a movement (Delgado & Stefancic, 2012) that has transformed and questioned society's time and effort to address the needs of people of color. Derrick Bell, Alan Freeman, Richard Delgado and many others recognized and advocated for ways to combat the "subtler forms of racism that were gaining ground" (Delgado & Stefancic, 2012, p. 4) after the civil rights era of the 1960s's. Throughout the literature, variation in the beliefs of CRT scholars is present. Additionally, the tenets that CRT researchers attend to when conducting research vary as well. Presenting a review of how scholars define CRT in the literature centered on race, Milner and Laughter (2015) identified the variation of tenets and

principles of CRT based on scholar. Table 1. presents a recreation of their outline. Milner and Laughter's table was recreated because these scholars' ideas align with this present research regarding race, P-12 education, and science education.

Table 1

Milner and Laughter (2015) Tenets and Principals of Critical Race Theory

Authors	General Theme	Analysis of Theme	Central Principle(s) and Theme(s)	Voice or Discourse
Milner (2007)	Race and Racism are endemic, pervasive, widespread, and ingrained	Challenge mainstream notions of whiteness as norms	Interest convergence	Centrality of narrative and counter-narrative
Delgado and Stefancic (2001)	Racism is normal, not aberrational	Race and racism are products of social thought; differentiated racialization; anti-essentialism	Interest convergence or material determinism and "color-blind" conceptions of equality	Unique voice of color
Solorzano & Yosso (2001)	The centrality and intersectionality of race and racism	Challenge to dominant ideology	Commitment to social justice	Centrality of experiential knowledge
Ladson Billings (1998)	Racism is normal in American society	Critique of neoliberalism	Interest convergence	Employs storytelling to analyze culture
Tate (1997)	Racism is endemic	Portrays dominant legal claims of neutrality as camouflage	Reinterprets civil rights law in light of limitations	Naming one's own reality
Ladson-Billings & Tate (1995)	Racism is endemic and deeply engrained	Challenging claims of neutrality and meritocracy	Reinterpretation of ineffective civil rights law	Theme of naming one's own reality

As evidenced from this chart, writers and theorists of CRT may have their own view or interpretation about CRT's tenets. The number of tenets of CRT addressed in studies may vary as well. Kohli (2009) discussed CRT's tenets according to Solorzano and Delgado Bernal (2001). This discussion noted that the beliefs held by these CRT theorists emphasized five tenets. They are centrality of race and racism, challenging the dominant perspective, commitment to social justice, valuing experiential knowledge, and being interdisciplinary" (p. 238). The use of all five

CRT tenets frame this study. CRT is not only the theoretical lens for this study, but also informs the methods used that include using a focal point for discussion. This research challenges the dominant perspectives and the majority narratives presented in elementary science research by White, middle class teachers by allowing African American in-service elementary teachers the opportunity to "name their reality" (Ladson-Billings, 1998, p.13). This tenet also assisted in questioning how educational research, and society, speak about and believe in the abilities of teachers and students of color. Commitment to social justice, which is a goal of CRT research, draws attention to the need for a more "racially diverse and conscious teaching force" (Kohli, 2009, p. 238). Valuing experiential knowledge shows the power and value in allowing African American in-service teachers to share their narratives and viewpoints. This is also referred to as the counter narrative (Delgado and Stefancic, 2012). They noted that "powerfully written stories and narratives may begin a process of correction in our system of beliefs and categories by calling attention to neglected evidence…" (p. 49). This is especially the case for elementary African American teachers whose views have not been shared in the research.

CRT in Education

Ladson-Billings and Tate (1995) and Ladson-Billings (1998) laid the groundwork for discussions of CRT in education. Specifically, Ladson-Billings (1998) addressed five areas of education including curriculum, instruction, assessment, school funding, and desegregation in an effort to connect CRT and education. With respect to curriculum, Ladson-Billings argued that CRT challenges the lack of meaningful stories and narratives by and about African Americans within the textbook curriculum presented to students. She contends that these stories are "erased" and replaced with "White supremacist master script" if they "challenge dominant culture authority and power" (p. 18). She also indicated that the curriculum can present "race-neutral"

and “colorblind” ideologies about people of color. This notion about the curriculum also mirrors Milner and Laughter’s (2014) point that we dwell in a society where race matters, “but people do not want to acknowledge or talk about why and how it matters [in the context of school and education]” (p. 345).

Regarding instruction, Ladson-Billings (1998) posited that the current strategies used within classrooms operate from a deficit model approach that result in remediation tactics. Considering CRT, race-neutral approaches to instruction and generic support strategies for all students dominate many instructional environments. The problem with such approaches implies that if those strategies do not work, fault lies with the student and not the “one size fits all” approach (Ladson-Billings, 1998). As applied to science education, marginalization of Black teachers and youth can present challenges within and outside of the classroom when it comes to valuing the instructional needs of these students. For example, Ridgeway and Yerrick (2018) found that students of color involved in an afterschool program in citizen science found the curriculum not applicable to the knowledge they possessed, thus making the lessons uninteresting.

Ladson-Billings (1998) argued a point made by several scholars in her work (Gould, 1981; Alienikoff, 1991) with regards to examining assessment through a CRT lens. The argument addresses the perception of intelligence as it is applied to people of color including African Americans. African Americans face a society that sees them as inferior to Whites if they are unable to make the same academic gains through testing. Under the “guise of scientific rationalism” (p. 19), justification for such differences in testing become normalized (Ladson-Billings, 1998). Such justifications do not capture the complete picture of reasons for academic differences. Until the knowledge that students bring to subjects such as science, that can be

captured in ways other than a single score, notions of deficits and "underachievement" will continue to permeate ideas about African American students within educational settings (Ridgeway & Yerrick, 2018). As applied to science education, the opportunity gap continues to be a problem for people of color as indicated by achievement scores in STEM subjects (Boutte & Kelly-Jackson, 2010).

Ladson-Billings (1998) discusses issues of school funding are a result of institutional and structural racism that are influenced by property taxes and per pupil spending. Ladson-Billings stated that "no area of schooling underscores inequity and racism better than school funding" (p. 20). She noted that this disparity in funding is felt when areas of greater wealth have higher property taxes and thus better schools. These better schools receive the educational materials and resources to effectively teach subjects such as science to students thereby helping them achieve academic success. Schools in areas of lower economic wealth, typically communities that serve students of color, may have less of an opportunity to acquire materials for subjects including science thus resulting in missed opportunities for students to engage with science and also have meaningful experiences with science.

Almost 25 years have passed since the introduction of CRT in education proposed by Tate and Ladson-Billings (1995). Additional scholars followed this work and have added considerations for how CRT and the work of critical research apply to the *nice* field of education, as Ladson-Billings (1998) emphasized. CRT in education has been used to address inequalities in education by acting as an evolving methodological, conceptual, and theoretical construct that seeks to disrupt race and racism in educational theory and practice (Solorzano, 1998). For example, using the tenets of CRT, Decuir and Dixon (2004) used the counter stories of two ninth grade students, Barbara and Malcom, to illustrate how these students must navigate being

African American in an elite, mostly White high school. Although the school made claims of celebrating diversity, many of the practices and policies of the school did not align with this vision, including exclusionary dress code policies and unfair disciplinary procedures. The scholars used examples provided by the student's counter-narratives to provide examples of how researchers would use CRT to analyze the narratives. For example, the school hired one African American teacher to teach all multicultural classes, organize activities centered around multiculturalism, and lead diversity workshops to school faculty. The school's choice to do this should be seen as extremely problematic from a CRT lens. As the researchers point out, slow change will occur in terms of creating a more diverse climate for the school because of school's "token commitment to diversity" (p.29). One Black teacher should not be expected and used as the sole instructor of a diversity course for the sake of helping White teachers to feel less uncomfortable talking about issues of race and racism.

Several sources have offered comprehensive reviews and discussions of CRT and CRT in education (Dixon & Rousseau; 2005; Ledsema & Calderon, 2015; Lynn & Parker, 2006). One important finding of these reviews is that as we explore CRT in other disciplines such as education, we must "remain grounded in the legal literature from which CRT originated (Dixon & Rousseau, p. 22). Realizing that some tenets of CRT have yet to be fully implemented, these scholars articulate that we must move from discussion of CRT tenets to action that dismantles ideas, policies, and practices which negatively affect students, particularly students of color, in schools. In 2016, to acknowledge twenty years of CRT in education, Howard and Narravo conducted an analysis of CRT arguing that despite CRT's use in educational research, the disparities of African American and other non-White populations in terms of achievement still continues to lag. Statistically, students of color continue to fall short in terms of graduating rates

comparable with their White peers, face disciplinary action at disproportionate rates in K-12 schools, and struggle with obstacle-filled pathways for postsecondary opportunities (Artiles, Kozleski, Trent, Osher, & Ortiz, 2010; Howard, 2010).

The use of CRT when examining P-20 education entails dissecting the insights, concerns, and questions persons of color, including teachers, have about their educational experiences. Additionally, CRT rests on an extensive and informed set of propositions. Many scholars and practitioners struggle to possess these propositions in their attempts to engage diverse students in the teaching and learning process (Solórzano, 2013). Ladson-Billings (2013) has been clear in her assertion that what CRT is not is a "sexy," or the latest "trend" that excuses scholars and researchers of the responsibility to do "quality work" (p. 44). Moreover, Ladson-Billings provides a CRT "anti-chronicle" (p. 44) that offers a compelling perspective of what not to do as a CRT researcher. The work of a CRT scholar involves doing the often-challenging research that should not be confused with placing blame, but with drawing attention to the critical issues surrounding race. As Ladson-Billings (2013) states, "The work of the critical race scholar must be as rigorous as that of any other scholarship (or perhaps more so)" (p. 45).

Although CRT has been recognized as a legitimate analytical tool for examining the role of race within law and education, CRT is not without criticism or critique (Crenshaw, 2011). Over two decades ago (1997), mainstream legal scholars, such as Richard Posner, dismissed Critical Race theorists and CRT as the 'lunatic core' of 'radical legal egalitarianism' (Crenshaw, 2011, p. 1310). Likewise, some have questioned how CRT's work applies to the research and discussion of educational practices and policies. Despite such criticisms, other researchers who conduct research with teachers of color, including African Americans (Milner, 2012) celebrate CRT's "advancement of the narrative and counter-narrative" (p. 28).

The Need for Culturally Relevant Pedagogy

In addition to centering race in the examination of educational disparities, efforts that advocate culturally relevant teacher practices recognize the monumental role of teacher pedagogy in addressing the problematic treatment of students of color in schools. Furthermore, the use of culturally relevant pedagogy (CRP) is one pedagogical practice that teachers can use to meet the cultural needs of their students (Ladson-Billings, 1995a). According to Ladson-Billings (1995a), CRP is "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). Ladson-Billings also stated, "My own interest in these issues of teaching excellence for African American students came as a result of my desire to challenge deficit paradigms that prevailed in the literature on African American learners" (1995b, p. 472).

CRP rests on three tenets: (a) students must experience academic success, (b) students must develop and/or maintain cultural competence, and (c) students must develop a critical consciousness through which they challenge the status quo of the current social order. Academic excellence includes teachers having high expectations of all students and providing the necessary tools to help students who may not be as privileged as others. It is not based on test scores, which is mistakenly what some educators automatically assume when they hear the term academic excellence (Ladson-Billings, 2006). Strategies include providing supports and scaffolding to ensure academic success from all students. Culturally competent teachers incorporate students' culture into their teaching. Moreover, they use the students' culture as a catalyst for learning. Sociopolitical consciousness refers to "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).

In order for students to achieve the three tenets of CRP, Ladson-Billings (1995b) argued that teachers must exhibit three broad characteristics of teacher-enacted CRP: (a) teacher conceptions of self and others, (b) teacher-structured social relations, and (c) teacher conceptions of knowledge. These three broad characteristics emerged from Ladson-Billings' (1990) study of teacher beliefs and behaviors and how they assisted in the success of Black students. In this ethnographic study that later became a highly acclaimed book, *The Dreamkeepers: Successful Teachers of African American Children*, Ladson-Billings (1994a, 2009) used several methods to document the characteristics of the successful teachers of African American students. These included interviews, classroom observations, and focus group meetings. The interviews were transcribed and coded twice—initially using a computer program to search for key words and phrases and then hand-coded, searching for key phrases related to pedagogy and culture. Teacher conceptions of self and others was the theme that represented a culturally relevant teachers' commitment to teacher higher order thinking skills, showcased a love for teaching and an understanding of children, and conveyed a belief that all students can succeed (Ladson-Billings, 1990). Another theme to emerge from Ladson-Billings' (1990) study was of teacher-structured social relations in the classroom. Culturally relevant teachers establish a classroom social dynamic in which student-teacher relationships are less rigid and more fluid, students are supported to learn collectively, and there is a kinship vibe between the students and teachers (Ladson-Billings, 1994/2009). The final theme that emerged from the study was how the teachers thought about knowledge. Culturally relevant teachers view knowledge as communal,

(re)creatable, and shaped by the learner. They also believe that knowledge must be viewed with a critical lens in order to examine and critique social inequalities.

Morrison, Robbins, and Rose (2008) discussed that the enactment of culturally relevant pedagogy ‘‘ultimately clashes with the traditional ways in which education is carried out in society’’ (p.444). They also conducted a synthesis of classroom-based research from 1995 to 2008 addressing CRP practices in all subjects including science and found that a more holistic approach is needed in helping teachers enact such practices in their classrooms. They argued that the approach needs to happen consistently and critically. Being that there is no one way to "do" multicultural education (Ladson-Billings, 2006), helping practitioners to actualize CRP in their classrooms is a complex and multifaceted task. Providing examples to teachers is only one step in a convoluted process that does not guarantee successful implementation of CRP.

Realizing that ideas do not exist in a vacuum, it is important to note that Paris (2012) offered a new term for this type of pedagogy, *culturally sustaining pedagogy* (CSP), which Ladson-Billings (2014) embraced by acknowledging that culture is fluid and that culturally sustaining pedagogy allows for this fluid understanding of culture that embraces the past, present and future, and a teaching practice that explicitly engages questions of equity and justice. Furthermore, because the population is becoming increasingly diverse, the inclusion of Indigenous, Latino/a, Asian, and immigrant populations must also be included in the conversation of what it means to help all students celebrate their heritage and communities in educational settings. Paris (2012) reported that CSP “seeks to perpetuate and foster—to sustain—linguistic, literate, and cultural pluralism as part of the democratic project of schooling” (p. 95). The focus of CRP in this literature review was used as opposed to CSP because it represents a complete picture of teaching including the philosophical stances, beliefs, and actions

of teachers. CSP provides actions that teachers can employ to sustain culture, but the lack of empirical studies to support CSP is a major drawback.

Culturally Relevant Science Instruction and Race-Visible Pedagogy

Because the research questions of this study address the instructional and pedagogical practices of exemplary African American science teachers, the following section presents empirical research of science teachers' uses of CRP and similar practices. In order to meet the social, cultural, and political needs of children, educators first must know and understand their students' needs. The position of science (and other STEM subjects) as often isolated and removed from other subjects has meant that, most students, regardless of cultural or ethnic background, already experience what Aikenhead (1996) called a cultural border crossing. This crossing is where most students must negotiate the differences between the scientific knowledge being taught by their teachers and then apply it to their daily lives. Coupled with other cultural and ethnic mismatches they already face, this border crossing poses an even bigger challenge for African American students and other students who identify with non-European cultural norms (Aikenhead, 1996; Archer, Dewiit, & Osborne, 2015).

Research also shows that preservice teachers are not aware of specific cultural needs, which can then carry over into teaching and learning in the classroom (Sleeter, 2001). Mensah (2011) examined the role of culturally relevant science for elementary pre-service teachers. Three pre-service participated in a university-school partnership in this study. She argues that if the tenets of culturally relevant teaching are to move from theory to practice, then they must be explicitly taught in science methods courses. Additionally, students must be given opportunities to demonstrate that their knowledge of CRP in science using artifacts such as lesson plans and student work. Major findings from the study included the extensive time and effort to teach

science in culturally relevant ways. Additionally, because science is not a priority in many elementary schools, the study highlights the importance of giving science equal priority including the resources and time to ensure that the tenants of CRP are fully utilized in elementary science education.

Kelly-Jackson and Jackson (2011) presented a case study of the beliefs of African Americans teaching in a low- socioeconomic environment. Kelly-Jackson and Jackson noted that this case study was from a larger study that focused on the culturally relevant pedagogy beliefs and practices of middle school science teachers. Although no specific research questions were listed, the researchers implied that the purpose of the case study was to examine how the teacher, Sammie, embraced culturally relevant pedagogy in her science instruction, using culturally relevant pedagogy as the theoretical framework.

The study took place in a rural school in South Carolina that served predominantly low-income African American students (Kelly-Jackson & Jackson, 2011). The school consisted of 411 students in middle and high school. The school was underperforming in science as measured by standardized test scores. Kelly-Jackson and Jackson (2011) collected considerable data during the study. Three classroom observations, hours in length, were conducted during and after school over six weeks. During the observations, immense field notes were taken. Audio files from the observations were transcribed to capture the nature of the interactions between students and the teacher. The researcher collected artifacts such as student test scores, teacher lesson plans, and student assignments to triangulate data sources. Interviews were conducted, however, there no details about the interviews were presented. The data were coded as communication, cultural literacy, teacher-facilitator, inclusive classroom environment, and community of learners. One significant implication of this study was that “one’s pedagogical stance is just as important as

content competency in effectively teaching science to students of color" (p. 412). Kelly-Jackson and Jackson also noted that literature on culturally relevant teaching in science is near absent.

More recently, research has specifically focused on centering race in STEM fields, including science for African American learners and teachers of African American students (Prime, 2019). Known as race visible pedagogy, CRT scholars define this pedagogy as one which "explicitly and implicitly addresses race and racism both in the content of the curriculum and in all curriculum processes" (Prime, 2019, p. 8). Curriculum involves the science material that teachers teach. The curriculum processes include the enactment of the curriculum including teaching strategies and student/teacher relationships. The justification for this type of race-visible pedagogy stems from acknowledging the need to provide additional avenues for thinking about the African American learners in science education. Recognizing that racism is pervasive and a normal part of life including schooling, the argument being made by scholars such as Mutegi (2011) and Mensah (2018) assert that by positioning race to the forefront of science education enables researchers to provide asset-based alternatives to viewing African American learners and disrupting practices that maintain hegemony in science education. These scholars situate the role of race in science education by first helping teachers to feel comfortable discussing race and then learning how to employ instructional and pedagogical practices that are conducive to African American learners, which include transformative learning and teaching for social justice.

With the articulation of new pedagogies for examining race within science education, there will be questions posed about how such pedagogies look like in practice. Mutegi, Morton, and Etienne (2019) posited the need to reconceptualize science education and address systemic racism and used the process of writing Black children's' science literature for elementary students to provide concrete examples for researchers and practitioners of how this

reconceptualization may look in educational settings. Using theoretical frameworks that address social transformation of science (Mutegi, 2011), knowledge of indigenous cultures (Goduka, Madol, Rozani, Notsi, & Talen, 2013), and liberatory education (Codrington, 2014), these scholars linked theory to practice. Through Black Kids Read-Science Writers Project, the first author and writers of this project, three African American females, articulated new ways of approaching science education that address the purpose of science education, science content, and the role of the instructor. The reconceptualization of science education addressed the need to help students combat systemic racism in science and not to solely view access to science a means to "get a good job" (Prime, 2019, p. 88). The reconceptualization of science content acknowledges the needs to not only address the standards-based curriculum in science, but to also focus on science content that is meaningful and worthwhile to students and teachers. Lastly, the reconceptualization of the role of the instructor positions the teacher and student relationship as joint as opposed to unidirectional, where teacher assumes most of the *control*.

Mutegi, Morton, and Etienne (2019) also recognized that the examples provided about the practices in the writing group cannot be implemented on a large scale, but believe providing examples of what science could look like helps to push back against the current view of science that as the authors argue is "detrimental" to Black students and predominately Western. Their work provides alternative ways of thinking about science and uses multiple frameworks to re-envision what science education can look like for Black children. Additionally, by reconceptualizing education, these researchers draw attention to the deeply entrenched structures in place that seek to maintain the current conceptualizations of science.

Because race-visible pedagogy is new, more concrete examples of what such pedagogy looks like in K-12 STEM classrooms, particularly elementary, are needed. The examples given

by scholars such as Seriki (2018) point to the need for intertwining existing frameworks of CRP and inquiry-based science into new frameworks such as culturally relevant inquiry-based instruction (CRISP). Potential frameworks such as CRISP help teachers, particularly teachers of African American students, align the dispositions of CRP and the instructional practices of inquiry-based science to create unique experiences for African Americans that would encourage connections between the content and students' local, global, and national community and identities (Prime, 2019, p. 167).

Mensah (2019) encourages researchers to begin engaging pre-service and in-service teachers in conversations about race and racism within science education. She argues that in order to make this a reality, teacher educators must provide opportunities for teacher candidates and teachers to do so, just as space is used to discuss less difficult topics such as culturally relevant pedagogy and other asset-based pedagogies. Because race affects every aspect of schooling, including curriculum (Banks & Banks, 2010), Mensah also asserts that teachers of science must be explicit and intentional about race in their teaching by being critically reflective in their practice as they engage their African American students. Acknowledging the teaching of antiracist curriculum and pedagogies requires a new way of thinking on everyone's part including teachers and teacher educators. Mensah believes that turning to teacher education contributes immensely to creating spaces where teachers are equipped to make classrooms environments pedagogically engaging and socially supportive for all students, and where race is not are not peripheral to teaching and learning, but a direct and central place in the classroom (Prime, 2019 p. 185).

Summary

Several implications can be drawn from this review of the literature. Policies enacted at the elementary level place literacy and numeracy at the forefront of instruction, thus neglecting time and resources for subjects such as science. At the same time, differences in time and quality devoted to science then become directly related as the research indicates that not all science instruction and experiences are the same. Hence, teachers remain extremely important in creating authentic and relevant science experiences for students in this marginalized subject. As student demographics continue to become increasingly diverse while the teaching force remains relatively homogeneous, research points to the need for more teachers of color because of the cultural referents and diverse perspectives they bring to the classroom and students they teach. Additionally, understanding culturally relevant pedagogy and similar frameworks such as race-visible pedagogy that intentionally bring race to the forefront of instruction and pedagogy in science are addressed.

CHAPTER 3: METHDOLOGY

Qualitative case study design, supported by CRT, was employed to examine the role of race, instructional decisions, and pedagogical practices of exemplary African American teachers as they navigate teaching science to African American students. The following research questions guided this study:

1. What are exemplary African American elementary teachers' lived experiences regarding issues of race and racism?
2. How do these teachers navigate their racialized lived experiences to effectively teach science to African American students in the formal classroom?

Two important methodological tools that assisted me in answering these research questions were case study and critical race methodology. Case studies are typically qualitative in nature as they emphasize the importance of context in determining social realities (Yin, 2009). Merriam (2009) defines case study as an "in-depth analysis of a bounded system" (p. 38). I borrowed from Yin's (2003) suggested case study protocol. The protocol calls for: (1) choosing a case design, (2) preparing for data collection, (3) collecting evidence, (4) analyzing evidence, and (5) reporting cases. He noted that the use of a protocol increases the reliability of the case study research. Critical race methodology uses counter-narratives as an analytical tool to disrupt storylines that: "(1) are under-researched; (2) present people of color from a deficit ideology in teacher education; and (3) provide myopic, one-sided evidence and perspectives" (Milner & Howard, 2013, p. 537). A critical race methodology affirms the experiences of people of color with, and responses to, racism, and other forms of oppression both inside and outside of school as "valid, appropriate, and necessary forms of data" (Solorzano & Yosso, 2002, p. 37). Critical

race methodology comprises five themes to examine the lived experiences of teachers of color and how they navigate teaching in urban educational contexts:

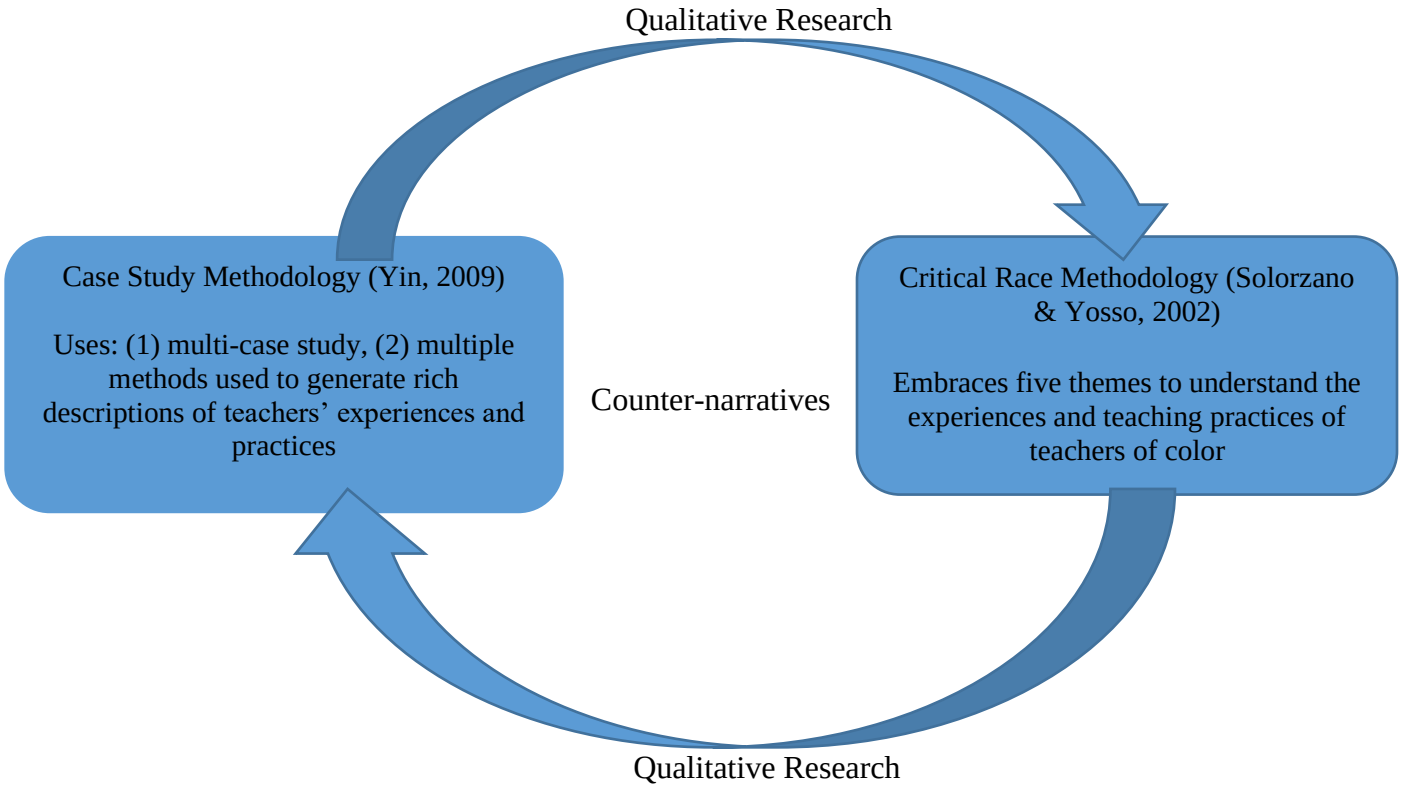
1. The intercentricity of race and racialized oppression
2. The challenge of dominant ideology of white privilege, race neutrality, and meritocracy
3. The commitment to social justice toward empowerment of oppressed minority groups and elimination of racism, sexism, and poverty
4. The centrality of experiential knowledge and its legitimacy and appropriateness in understanding the lived experiences of people of color
5. The transdisciplinary perspective to understand how racism, sexism, and classism impact people of color

Critical race methodology allowed me to focus my analysis on race, racism, and power to guide central understanding of the teachers' narratives and teaching practices. Additionally, I used the narrative factors approach which treats participant narratives as one data source among several from which the counter narrative was constructed (Miller, Lui & Ball, 2020). Miller and colleagues (2020) classify this as a thematic analysis rooted in CRT rather than a full counter-narrative.

Critical race methodology in education contests traditional research paradigms and theories that are deficit-oriented and instead elevates the experiences of people of color. This was accomplished by using counter-storytelling as a prominent tool of critical race methodology (Solorzano & Yosso, 2002). Hence, CRT was methodologically appropriate for this study as storytelling is a significant component of this study. Below shows a visual representation of the research design.

Figure 1

Research Design: Case Study Supported by Critical Race Methodology



Note. This table shows a visual representation of the connection between case study and critical race methodology in qualitative research.

Qualitative Case Study

This study utilized a qualitative case study. A qualitative case study describes, explores, or examines a phenomenon within its context (Yin, 2014). A case study differs from other types of qualitative research because it is defined by the unit of analysis, or ‘‘the case’’ rather than a topic of study. In this study, the case was bounded by a group of five teachers. The case(s) in this study were exemplary African American science teachers who provide insights into the role of race and racism in their lived experiences and connect those experiences to how it impacts their teaching practices in the classroom. Case studies are empirical inquiries that investigate phenomenon using multiple methods of data collection (Thomas, 2016). Multiple methods were

used to generate rich descriptions of teachers' beliefs and practices within case study design (Yin, 2009). For example, observations and interviews were employed to allow the researcher and the participant opportunities to interact and co-construct the meaning of the phenomenon being studied. As conceptualized, case studies allow the researcher to investigate the phenomenon in its real-life context; thus, the case descriptions are holistic in nature. Like other forms of qualitative research, a case study seeks for meaning and understanding of social phenomena. The case study methodology was, thus, suitable for studies in which the researcher aims to emphasize participant viewpoints. Research participants were given the opportunity to share their lived experiences and science teaching practices. The choice to use a case study also stemmed from examining the unique experiences of African American elementary teachers who make a commitment to teach science. A case study allowed for obtaining a rich picture, with boundaries of course, and gaining analytical insights from the data revealed (Thomas, 2016). While there is no formula, the research questions are integral in the choice to use a case study (Yin, 2014). Specifically, questions that begin with "how or "why" and require an extensive description of a social phenomenon provide relevance to use the case study.

Because I examined the beliefs and practices of more than one African American teacher within the context of two school districts, the use of a multiple case study was warranted rather than a single case study. Yin (2009) suggested that evidence from multiple case study designs is more compelling than single case designs because there is the possibility of direct replication resulting in powerful analytical conclusions. In multiple-case study design, the researcher replicates the research process for each case separately. Furthermore, Thomas (2016) stated "each individual subject is less important in itself than the comparison each offers with the others" (p. 172).

Study Context of the School District(s)

The use of research sites within two large school districts in the southeastern region of the United States was appropriate because of my research design. The first school district, Morning Republic, had an active student enrollment of 54,956 students, with approximately 28,000 students identifying as African American. According to the district's website, 78% of students receive free or reduced lunch. The district has a total of 103 school sites: 50 elementary schools (three of which operate on a year-round calendar), 15 middle schools, 21 high schools, four single-gender academies and 13 charter schools. The second district, Discovery County, had an even larger enrollment at 98,957 students and over 140 schools and centers. Students and parents speak over 140 languages and represent over 180 nations. This school district is a leader in STEM curriculum with 10 certified schools and programs in more than 90 schools.

The case study was specifically conducted in two research sites within two school districts: Infinite Academy in Morning Republic and Eagle Academy in Discovery County during the 2019-2020 academic school year. Both schools were in the process of obtaining STEM certification and were of particular interest and chosen because they allowed me to examine the phenomenon of interest. More specifically, science in these schools was valued in the overall school culture and there was more likelihood of observing science teaching on a consistent basis. The STEM focused schools selected had a student population with a large percentage of students who were African American and served students from a mixture of socioeconomic backgrounds.

First Research Site

Infinite Academy is a community school that readily extends beyond its campus borders in strong partnerships with institutions of early and higher learning, industry, and social service

that support a Pre-K through eighth grade curriculum. The school has partnerships with many of the surrounding attractions including post-secondary institutions, aquariums, and museums. Their strategic and core values states: Infinite Academy will lead in educating a socioeconomically diverse population of scholars and be the school of choice for families who share our Core Value of Excellence in academics, applied STEAM integrated learning, and ethical leadership in an urban environment.

Second Research Site

Eagle Elementary is a school that receives Title One funds to support the instructional needs of students. Despite serving students who all qualify for free or reduced lunch, the school has been recognized as a "Beating the Odds" school because of its academic gains in the last few years in science and mathematics. There school motto is: "Soaring Above Expectations" with a vision to foster an environment that is highly regarded for its academic excellence, parental involvement and community engagement, which will prepare and inspire our students to compete and excel in a STEM global workforce. Below is the demographic information for both research sites.

Table 2

Research Sites Demographics

Category	**Infinite Academy**	**Eagle Elementary**
Grades Served	Kindergarten-8th	Pre-Kindergarten- 5th
Student Enrollment	765	562
Student-Teacher Ratio	16:1	15:1
African American Enrollment	86 %	99%
Gender	52% Male: 48% Female	49% Male: 51% Female

Free or Reduced Lunch	79%	100%

Selection of Participants

In this qualitative research study, I elicited the voices and unique experiences of African American elementary science teachers in the formal classroom by using snowball sampling. Snowball or chain sampling is a method that has been widely used in qualitative research. Snowball sampling involves the use of referrals made among people who share or know others who possess some characteristics that are of research interest (Biernacki & Waldorf, 1981). Snowball sampling was logical in this study because the researcher desired information-rich cases to study in depth from a diverse group of teachers. An advantage to using snowball sampling was its cultural competence and the trust it engendered among the research participants (Sadler, Lee, Lim, & Fullerton, 2010). An added benefit of snowball sampling was that it helped me to identify research participants where there are multiple eligibility requirements. The criteria for sampling participants in this multiple case study undergirded by CRT were as follows:

(1) self-identified African American or Black
(2) prioritized race and embedded it as a critical part of their teaching
(3) evidence of effectiveness (recommendations from school administrators and parents, test scores, recognized for excellence in teaching) with all students, particularly African American students
(4) Have more than three years of teaching experience
(5) Taught science in grades kindergarten-third
(6) Taught science in urban intensive contexts

The research criteria were important to my study for the following reasons: First, no assumptions were made about the race of participants. Thus, this study provided a platform for the participants to name their identities. Second, teachers who centralized race as part of their teaching were aware of certain teaching dispositions and practices that address constructs related to my study (King, 2015). Third, teachers were more than just leaders at the school, but recognized for their excellence in teaching at the local and state level. Fourth, on average, teachers with more teaching experience have greater effectiveness on student outcomes (Kini & Podolsky, 2016). Fifth, the literature demonstrates that science is marginalized at the elementary level, particularly in the lower grades (Roth, 2014). Therefore, teachers who taught grades kindergarten through third grade were of interest. Lastly, teachers who taught in urban intensive schools understood the challenges, but also the opportunities.

Based on the criteria, I contacted the Head of School for the first research site who then referred me to the science coordinator to help recruit participants. The science coordinator for the school had the opportunity to interact and observe these teachers for extended periods of time. The science coach sent an email to teachers introducing me and a brief summary of my research. Additionally, I attended the schools iCurate night to solicit parents' nominations of exemplary teachers. The iCurate nights were afterschool parent/student events that highlighted the school's innovative program, which used project-based learning (PBL), logical thinking and technology to connect ideas across projects in social studies, math, and English language arts classes, and science classes. During these three-hour events held by the school, I had a chance to communicate with parents about teachers who they considered to be strong and effective teachers. I had informal conversations about their child's PBL project and during this time, I chatted with parents about their child's teacher. I noticed that many of the parents talked about

three particular teachers in general. These parents communicated that these strong teachers had strong content knowledge, were professional, provided timely communication and feedback on assignments, and had excellent classroom management. From the science coordinators recommendation and the parents' nominations, three teachers were selected.

For the second research site, I contacted the STEM coordinator of the school district and was given list of possible STEM schools to choose research participants from. From the list, I narrowed schools down that fit the inclusion criteria established for research participants to participate in the study. I contacted the principals and they were able to confirm the list of teachers who matched this study's selection criteria. Through formal and informal talks about my research with the principals, I was able to obtain permission from one principal at one of the selected schools and allowed to conduct research with two teachers.

Consistent with the literature, CRT as a methodological tool in this study insists that research participants are not solely viewed as sources of data (Kohli, 2009). Instead, there is acknowledgment of the value of each person's voice and story. Likewise, Merriam and Tisdell (2015) noted that in conducting critical research, it is imperative that the research is done with participants and not on participants. This idea is a powerful reminder for me in my pursuit of teachers who willingly shared their perceptions about sensitive topics such as race and allow me to observe their science instruction and practice. Once the selection criteria had been met for all participants and agreed to participate, I held an information session in one of the research participants' classroom at the first research site where I discussed the purposes of the research and allowed participants to ask questions and ask for further clarification. For the second research site, I was able to meet with teachers during their lunch to talk to discuss the objectives of the research.

Research participants

Teachers in this study represented a diverse sample. All teachers participating in this study currently taught in elementary settings with at least one teacher teaching in each grade level from kindergarten through third grade. This process ensured representativeness across early childhood and elementary grade levels taught. Two teachers had experience with teaching students in a variety of contexts, (e.g., suburban, rural) although all teachers at the time of this study taught in urban contexts. One teacher had experience teaching at the middle and high school level. Teachers had a combined average of 14 years of teaching experience. Most teachers had obtained master's degrees in early childhood and elementary education. They attended college across the east coast of the United States including predominately white institutions (PWIs) and Historically Black Colleges and Universities (HBCUs). Although all participants were African American woman, their backgrounds and experiences varied, which potentially influenced the type of counter-stories they produced. Table 3 shows the profile for the teachers selected to participate in this study. The names presented in the table are all pseudonyms to protect the identities of the participants.

Table 3

Teacher Profiles

Pseudonym	**Age**	**Highest Degree**	**Number of Years Taught**	**Current Grade**	**Race**
Jasmine Johnson	26	Bachelors	5	Kindergarten	Black

Salem Wolfe	41	Bachelors	20	3rd Grade	Black/Hispanic
Charlotte Bell	25	Masters	4	2nd Grade	Black
Kaye Parker	50	Masters	25	1st Grade	Black
Amanda Jones	42	Masters	18	3rd Grade	Black

Teacher Profiles

Jasmine Johnson: Jasmine is an energetic kindergarten teacher with five years of teaching experience. She is intentional about teaching science at the beginning of day, with most instruction beginning at 8:00 in the morning. She vocalizes that it is her responsibility to provide the support and exposure her students of color need in science. In the elementary years of her schooling, Jasmine attended schools that were predominately White in racial makeup in terms of both students and teachers. She does not remember science instruction until her fourth-grade year, and then fragmented pieces as she matriculated into middle and high school. Jasmine attended schools that were racially mixed in terms of student ethnic make-up, although most of her teachers remained White. Science was taught from a textbook with instruction that consisted mostly of taking notes from an overhead projector. When she entered college, she took one science methods course during her undergraduate career as a pre-service teacher but was fortunate to have a school placement where science and STEM subjects were valued. Her student teaching placement in a kindergarten classroom was a pivotal moment for her in terms of developing a passion for science. Jasmine remembers being exposed to a teacher who

intentionally taught science, while also being cognizant of her students' race. Her mentor teacher, a young African American woman, introduced her to teaching in a way that resonated with Jasmine and most importantly, her mentor teacher's students. It was in this experience that she was introduced to students, many whom were African American, came from low-income communities, and lived in poverty who needed her to expose them to relevant, inquiry-based science and connect the learning to their daily lives. Jasmine was required and challenged to specifically detail how she would meet the needs of all her learners.

Salem Wolfe: Salem Wolfe is a vibrant teacher whose teaching career spans two decades includes a variety of contexts. Her career spans from teaching middle school, then high school, and she is now a third-grade teacher. In elementary school, Salem was bussed from the local neighborhood to another school in hopes of obtaining a better education than the neighborhood school could provide. A home break-in influenced her parents to move from their lower to middle-class Black neighborhood to a more affluent White neighborhood. Attending predominately White populated schools, her earliest experience with science was in elementary school; third grade to be exact. She remembers her teacher having an incubator in class used to demonstrate the process of how chickens hatch with the right environmental conditions. She vaguely remembers that the teacher would talk to them about life cycles and admits there was little connection to the process, but admits it was just exciting to watch the chickens hatch. Salem also recalls a few experiences from high school.

In the early stages of her career as a science teacher, she was told not to teach science by some administrators because the students needed to learn the basics. This made her feel frustrated as she knew the importance of science for life-long skills. In these settings, she knew that students were being harmed because her students of color were not getting the exposure to

science they needed. As a young teacher, she did not have the courage or the words to articulate her disdain for not being able to teach science. For fear of losing her job and livelihood, she complied and did not think twice about disrupting a practice by administrators that she knew was wrong. She says that she would sneak a science lesson into her students when she knew administrators were not in the building but questions the quality and effectiveness of the science instruction since it was done inconsistently.

She began consistently teaching science in her fourth year of teaching as a sixth-grade teacher. When she began teaching sixth grade, Salem remembers having a science coach to help her with the content. Because of her fragmented experiences with identifying what science was and how to teach it in a way that resonated with students, she admitted to needing support. Although she admitted that she struggled initially with making sure her science content knowledge was correct, she knew that she owed it to her students to engage them with science because she did not want to engage in a cycle of lack of science instruction at such a critical grade where students slowly or have already lost interest in science. With the support and coaching needed, she was able to learn the science content needed and then use her knew knowledge to plan science activities and lessons that were student friendly, less teacher directed, and more inquiry based.

Charlotte Bell: Charlotte Bell is a young, calm, and pleasant second grade teacher with the least amount of teaching experience at four years, but recently finished her master's degree in early childhood education and social policy. Charlotte grew up where most of her science experiences were informal, happening at home with her parents doing simple science experiments such as making slime, butter, and creating chemical reactions to make volcanoes. Doing activities at home with her parents made her feel that science was something she was

naturally gifted at. She was considered extremely intelligent, and her culture and heritage as a Black person were celebrated. Her parents instilled values in her that uplifted who she was and gave her confidence to speak up in class and exude confidence in her work, including science. She also had teachers who looked like her and she felt that her teachers attempted to make the curriculum relevant to her life. Because she was considered gifted by her family, teachers, and peers, she originally had plans to attend medical school and become an anesthesiologist. Her rational for wanting to be this type of doctor was because that was what smart kids did; They went to medical school and got paid well. However, it was in her senior year of high school that she decided she wanted to become a teacher.

Kaye Parker: Kaye considers herself a veteran and "old-school" with the most (over 25) years of teaching experience. Kaye attended a HBCU in the South, of which is very proud. She says that the experience was life changing for her in that she learned about the significance of people of color. Kaye admitted that the focus in her teacher preparation program was geared more to reading, and vaguely remembers her science method course as an undergraduate. Her experience with science more so came as she entered the field as an in-service teacher.

She has taught in a variety of contexts, including predominately White suburban contexts, although she began her teaching career in an urban elementary school with a predominately black population. As a Teacher of the Year semi-finalist, she currently teaches first grade and has built a strong relationship with her students and often treat them as her children. Kaye first began her teaching career as a kindergarten teacher. She was at the same school for 17 years. During that time, she had the opportunity to work as the science coordinator for the school during the summer. Students learned about science through poetry, dance, individualized science experiments, and fieldtrips. It was in this leadership experience that she learned that students

should have the same experiences in formal classroom settings that they were having during the summer, especially for her black and brown children. When she relocated to the current school that she teaches, she was asked to take lead of the science lab, where she was able to teach science to kindergarten-fifth grade students. She did so for the first three years at the school, but because of funding, had to return to teaching a specific grade level.

Amanda Jones: Amanda describes herself as a patient and understanding teacher who has high expectations for all her students. She speaks in a soft voice and has been a teacher at the same school in the district for fifteen years at the same school. She currently teaches third grade and has done so for fourteen of the fifteen years. She has been departmentalized for the last 10 years teaching math and science and currently serves a department chair. Although she loves being a teacher, she is ready to be a teacher leader. Her ultimate goal includes being a science or math coach in the district. She still wants to stay in the school system and realizes that she needs to further her education to make herself competitive in such a saturated market.

Amanda vaguely remembers her early childhood school experiences, except for her sixth-grade teacher, an Asian male, who made science interesting by having the class participate in hands-on experiences. The heavy lecture style of the courses made it nearly impossible to ask questions unless you took advantage of personalized learning. Her science method course was not much better. She just wanted to pass the class and move on to the other requirements of the teacher education program.

As a science teacher, Amanda incorporates hands-on and inquiry-based science activities in her classroom. She often teaches using science stations, choice boards, technology, and journals to help students communicate their science ideas. Although Amanda enjoys teaching science, she understands that she can always grow as a science educator. To stay abreast, she

attends professional development workshops that the district offers. She likes that the district offers resources in science that help teachers to be responsive to the needs of her students. She uses stations in which students rotate to facilitate collaborative learning. She stresses differentiation in her classroom. She understands the varying levels of her African American students even though they share the same race. She sets the bar high for all her students, regardless of their abilities.

Data Sources

Data were triangulated using four data sources: 1) individual interviews, 2) participant observations, 3) field-notes, and 4) researcher memos. Interviews and classroom observations served as the primary sources of data and the field-notes and research memos were used as secondary sources. Data collection began in the fall semester of 2019 and ended in the spring semester of 2020. Each instrument served a specific purpose to help answer the research questions posed in this study. Table 4 shows connections between the data collection procedures and connections to the research questions adopted from Bloomberg and Volpe (2008).

Table 4

Data Collection and Connection to RQs adopted from Bloomberg and Volpe (2008)

Research Question	Data Sources	Connection to Research Questions	Connection to Theoretical Perspectives
1) What are exemplary African American elementary teachers' lived experiences regarding issues of race and racism?	Interview #1 Researcher memos	Interviews will help me to center race around AA teachers' beliefs of science learning through open dialogue and discourse. I seek to record the lived and shared experiences, which are often personal, of exemplary AA teachers	Gives voice and agency to exemplary AA teachers while challenging dominant ideology and making a commitment to social justice
2) How do these teachers navigate their racialized lived experiences to effectively teach science to African American students in the formal classroom?	Interview #2 Participant Observations (multiple, 45 to 60-minute observations per participant) with	Participant observations explores how exemplary AA teachers meet the needs of all their students, including African American students thus making "Black	Sheds light unto effective practices that help to "eradicate practices within science classroom that perpetuate the status quo" (Seriki, 2018, p. 98) and recognize

observation protocol and field notes	students normative (Ladson-Billings, 1994)	the lived experiences of exemplary AA teachers as valid.

In-Depth Semi-Structured Interviews

To address the first question, in-depth audio-recorded semi-structured individual interviews were used (Merriam, 2009). For this research study, two interviews were conducted (See Table 5). The semi structured format "allow[s] the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic" (Merriam, 2009, p. 90). Likewise, the structure of the semi-structured interviews, following CRT methodology, allowed the teachers to build on their beliefs through focused questioning related to the tenets of CRT. Roulston (2010) provided strategies for conducting a "good interview." She suggested that an interviewer create at least 3-5 open-ended, relevant questions before the interview to serve as a guideline. A protocol (See Appendix B) containing five questions situating race and science teaching strategies was used to assist in conducting the interviews. The first interview focused on learning more about their early life experiences with no particular period in mind and then gradually progressed into the current work they do now as teachers. The researcher sought to record the lived and shared experiences, which are often personal, of exemplary African American teachers who teach science to predominately African American students (Merriam & Tisdell, 2015). Roulston (2010) also advises to select a location with limited distractions and interruptions that is comfortable for both parties. Thus, interviews were conducted at the school or a convenient meeting spot for the teacher with the time and date set by the teacher. For one teacher informant, this was a local coffee shop close to the research site. The interview series began by establishing the context of the teachers' lives and current professional

experiences, then shifted to narrow on the details of their day-to-day experiences regarding race (utilizing race as the primary reflective lens).

During the first interview, the researcher also encouraged and probed for teachers to describe the science curriculum, typical classroom activities, their role as a science teacher, including what they liked most about their current teaching practices and what they would like to change. The goal was to seek clarity and understanding while engaging in dialogue with participants. In a qualitative interview, the researcher should listen for the meaning of what the participant is trying to communicate (Rubin & Rubin, 2005). Additionally, developing rapport with the teacher informants was crucial to the research process as it allowed the researcher to gather the rich, thick description of information during the interview (deMarrais, 2004). Creswell (2003) noted the limitations of interviews are 1) information is filtered through the participants, 2) researcher bias may be present, and 3) people are not equally articulate and perceptive. To address these limitations, the researcher used additional forms of data such as observations to support themes found within interviews.

The second interview occurred after all observations had been completed. The purpose of this interview was to clarify any information from the first interview and series of observations. I used my field notes taken from the observations and additional questions written as memos to ask teachers to further explain or clarify when needed. For example, if teachers seemed to contradict themselves in either a lesson or observations, I asked teachers their reason for their response or action. I also used this interview to allow participants to provide any new information they felt was relevant to the research questions being addressed. This interview allowed participants to provide final thoughts about their science teaching and teaching in general. From this final interview, participants' counter-stories were produced.

Table 5

Interview Goals, Roles, and Products

Interview #1	Interview #2 (after observations)
Goal: Get to know the participant **Structure:** Review participant's demographic survey, conduct semi-structured interview **Researcher:** Write and review researcher memos and reflections, transcribe interview, identify themes and label passages of interest, code passages of interest into Dedoose software refer to original transcripts and audio recording as needed **Participants:** Write down any questions from interview, ask questions related to the interview **Product:** Teacher Profiles	**Goal:** Member-check with participants regarding interviews and observations **Structure:** Conduct semi-structured interview, present profile, make revisions member check **Researcher:** Write and review researcher memos and reflections, transcribe interview, identify themes and label passages of interests into Dedoose software refer to original transcripts and review audio recordings as needed **Participants:** Ask questions related to interview **Product:** Fuse all data sources to create Counter-narratives

Note. This table provides a complete overview of the interview process with specific outcomes for the research and participants.

Participant Observations

As stated in the review of the literature, differences may exist between what teachers report they do in terms of science instruction and what is observed (King et al., 2001). After conducting the first interview about the participants' lived experiences including their and science teaching experiences with regards to race through their interviews, the research led me to triangulate this information in the form of participant observations (See Table 6). Consistent with case studies, the second question addressed using data from field notes collected from classroom observations and the researchers' role as participant observer. My knowledge as an elementary science teacher, a current science teacher educator, and experience with Classroom Assessment Scoring System (CLASS) observations provided me with the level of expertise needed to conduct observations (Pianta, LaParo, & Hamre, 2007). Although there are many ways

to conduct participant observations, Merriam (1998) outlines a protocol of what to capture in the field notes during a participant observation including the physical setting, which provides context. Then, attention should focus on the participants and the activities and interactions that occur in the setting, including the frequency and duration of those activities/interactions and other subtle factors, such as informal, unplanned activities, symbolic meanings, nonverbal communication and physical clues (Dewalt & Dewalt, 2011; Merriam, 1998). The goal was to triangulate the data and to corroborate what research participants communicate in their interviews. Additionally, triangulation of data increased validity in that support for a researcher's conclusions was provided by more than one source of evidence (Yin, 2009). When using participant observations, dosage and duration become two important factors to consider. Prior to leaving for the holiday break, I had a chance to visit the classrooms of the three teachers from the first research site for fifteen minutes to thirty minutes and get a general sense of the layout and flow. During this time, each teacher introduced me to the classroom and told students that I would be a regular visitor over the next few months. Students had a chance to ask me questions about my role in the classroom. I happily engaged in conversation with students to let them know who I was and my purpose by providing student friendly explanations. I wanted to relate to students by telling them, I, too, was a student in school just as they were. This was important because although I was considered an insider because of my race, being a doctoral student at a research-intensive institution also positioned me as an outsider (Merriam & Johnson-Bailey, 2001).

For this study, I took part in the science lessons with the African American teachers by participating in the activities and attending field trips. I observed between three and eight 45 to 60-minute science blocks of instruction from each teacher within a ten-week timeline. Because

of the sampling process, a two and half month delay occurred with the second research site. I was able to conduct eight participant observations from the first research site. Eight observations were chosen because that allowed me to reach a point of saturation. Once I obtained clearance to conduct classroom observations at my second research site, my intentions were to conduct eight observations. Instead I was only able to conduct three observations for each teacher at the second research site due to the global pandemic, COVID-19, which led to school closures and thus prevented me from conducting the additional classroom observations. Although attempts were made to conduct virtual classroom observations, I was not able to observe any additional science lessons. During the bulk of the observations, a narrative description of each teachers' science teaching practices was recorded. In addition to the narrative description, the Culturally Responsive Instruction Observation Protocol or CRIOP (observation protocol was used to provide more structure during the observations and focus specifically on teachers' instructional practices, assessment, and discourse (Powell, Cantrell, Carter, Cox, Powers, Rightmyer, Seitz, & Wheeler, 2011). The tool was adapted to answer the second research question.

The Culturally Relevant Instrument Observation Protocol (CRIOP) kept me organized and focused on specific practices of each teacher. Although students were not the focus of this research, student behaviors and engagement with the lesson were also documented. After most observations, I had the opportunity to talk to the teacher about the observation. This usually happened at the end of the instructional day as I did not want to disrupt the planning time and other duties the teachers had to perform throughout the day. If teachers could not meet after school because of faculty meetings or other plans, a 5-10-minute discussion over the telephone took place about the interview.

Table 6

Length of Field Experience Observations per Participant

Participant	Number of Observations	Length of each Observation (minutes)	Total instructional time (minutes)
Jasmine	8	60	480
Charlotte	8	45	360
Salem	8	60	480
Kaye	3*	60	180
Amanda	3*	60	180

Note. This table outlines the total number of observations and time I observed in each teachers' classroom.

*Had to cancel remaining observations due to COVID-19 pandemic. Contacted teachers to do virtual science lessons to no avail.

Summary of Observations

I began my first observation on the third day back from the winter holiday on a mild weathered January morning. I contacted Charlotte the day before to make sure that she still wanted me to come and that she would still be teaching a lesson matter. When I arrived at Charlotte's classroom, students were sitting on the carpet reviewing the calendar and morning message. Upon my arrival, I nodded at Charlotte and sat at a side table in the room. As I proceeded to take out my notebook, posted on the promethean board was a scenario presented to the students to engage them in the day's lesson. The lesson referenced a student and how he had spilled his drink on the kitchen floor. Students chimed in that he had spilled a liquid. Students were then asked what solutions they could brainstorm to clean up the mess. Students replied that

they could use a paper towel. Others mentioned they could use a sponge. One student even said they could use a towel. Charlotte then transitioned into students creating hypotheses for which material would absorb the most juice. They worked in small groups with materials and filled out their lab sheet. During the lesson, Charlotte walked around the classroom acting as a facilitator to her students by asking questions and having students articulate their responses. Once the exploring phase ended, students had a chance to come back to the group to explain their reasoning and provide rationales for their hypothesis based on evidence. This lesson did not have a formal assessment, but Charlotte was able to check for understanding as students explained their reasoning.

This was just one lesson I saw. Having the opportunity to complete classroom observations helped me to visualize a complete picture and profile of these teachers' practices. Many times, I had to return to my notes and create research memos for questions I had about the lesson. Many informal conversations transpired between me and the teachers as they grew accustomed to me coming to see visit their classrooms regularly. I even had the chance to participate in school functions such as pep-rallies and had many chances to read to students on Fridays. I consider this my "giving back" portion because these teachers were so generous in letting me observe in their classrooms. In a way, I had become a part of the classroom. Students looked forward to me coming on Fridays to help and volunteer.

During many of the observed lessons, many of the teachers incorporated the 5E lesson plan model in their lessons (Bybee & Landes, 1990). The five phases, all beginning with an "e" are as follows: Engage, Explore, Explain, Elaborate, and Evaluate. Bybee (1997) declared that "using this approach, students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment. Learners interpret

objects and phenomena and internalize those interpretations in terms of their current conceptual understanding" (p. 176) During the *engage* phase, there was some type of hook teachers used to involve students and get them engaged. This was often done through dance or presenting a problem to students for them to think about how they would solve it. Next, they would have materials for students to *explore* and discuss not only with the teacher, but the students as well. This helped them to gain a better understanding of the phenomena being explored. The *explain* phase was where students themselves would explain phenomena and this is where the teacher would clarify any misconceptions. The elaborate phase was one in which the students were given new opportunities to use or apply their newly acquired skills or concepts in everyday situations. In the *evaluation* phase, a summative evaluation was created to match the stated objectives in the inquiry lesson and included a rubric with appropriate criteria as needed. Students would then be evaluated on the lesson for the day and during the week. I noticed that teachers did this throughout their planning. Many of the lessons occurred over a series of days and much of the assessment was informal.

Teachers in each grade also used the Next Generation Science Standards (NGSS, 2013) as well as the State Standards to plan instruction. During observations, the teachers covered the standards related to their grade level. Lesson plans were posted on the outside of the classroom. If the plan was not there, I communicated with the teacher after the lesson to view the lesson plan. Below (See Table 7) details the focus of the lesson, the state standards, and the NGSS standards that teachers used in their science and STEM lessons

Table 7

Lesson Focus with state standards and NGGS Addressed

Teacher	**Lesson Focus**	**State Standards Addressed**	**NGSS Standards Addressed**

Salem	Growing Plants in Different Types of Soil Aquaponics	S3E1. Obtain, evaluate, and communicate information about the physical attributes of rocks and soils.	Did not use an applicable NGSS standard
Jasmine	Properties of Matter	SKP1. Obtain, evaluate, and communicate information to describe objects in terms of the materials they are made of and their physical attributes. Elements: a, b, and c.	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
Amanda	Caring for the Environment	S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.	Did not use an applicable NGSS standard
Charlotte	States of Matter/Engineering Designs/Opportunity Costs	S2P1. Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects. MGSE2.MD.8	Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
Kaye	How do plants help us function?	S1L1. Obtain, evaluate, and communicate information about the basic needs of plants and animals.	K-LS1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive

It is important to note that not every lesson I observed was always student focused. Sometimes science lessons would contain a combination of teacher directed science instruction and then move to more a student-centered focus. Teachers would sometimes spend one-third of the lesson or activity in large group. When teachers spent such a prolonged time in large group, I

did notice that students' behavior would sometimes wane, and they would have to be redirected. When this happened, teachers were aware that they were losing engagement with students and would quickly transition to small groups.

Data Analysis

According to Merriam (2009), "Data analysis is the process of making sense of the data" (p. 175). The analysis of qualitative data is also ongoing and requires techniques that require sophisticated approaches (Creswell, 2003). This study utilized Braun and Clarke's (2006) description of thematic analysis to unearth the stories of these African American teachers' thoughts and experiences regarding race and how both factor into their science teaching. Additionally, I incorporated Solorzano and Yosso's (2002) critical race methodology that uses standard qualitative methods for data collection with the resultant data coded to produce thematic analysis (Miller et al., 2020). In using Braun and Clarke's (2006) six-step process approach to thematic analysis, I incorporated five of the suggested six phases of to ensure that this process was recurrent rather than linear, alternating "back and forth between phases rather than strictly progressing from one to the next" (p. 90). The phases were:

1. Data Familiarization
2. Producing Initial Codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes

Data Familiarization. The interviews were the first form of data to be transcribed. The interviews were transcribed four days after being received to provide for an accurate account of what was stated by the teachers. The transcriptions were cleaned and during the first phase,

teachers were asked to member check and review the transcripts for any errors or to offer clarity on portions of the transcripts that were unclear to me. Once I received the reviewed and/or corrected transcripts from the first interview, I was ready to begin the initial phase of familiarizing myself with the data. During this phase, I immersed myself in the data by repeatedly and actively reading the hard copy transcriptions before coding. I recorded any initial thoughts and ideas in the margins of the hard copy transcripts, and in some instances, recorded analytic memos about the transcriptions on sticky notes.

Producing Initial Codes. Merriam (2009) discussed analysis as an important stage in the research process and how it should occur concurrently with data collection. In essence, as each data source was collected at different times, my execution of phases one and two occurred simultaneously of each other. For example, as I transcribed and reviewed the observation protocol I, shortly after coded the field notes. As, I transcribed and reviewed the initial interview, shortly after I coded all the interviews together. I followed the same pattern for each field note, memo, and the final interview. I initially began the process of manually coding, line by line on each document. Though that process of physically manipulating and writing on the hard copies was beneficial it became cluttered with my codes and notes, and I decided to use Dedoose, an online coding source that helped organize my memos, codes, and notes about the data (See Appendix D). The benefits of using Dedoose according to Saldana (2015) included permitting "the researcher to shift quickly back and forth between multiple analytic tasks such as coding, analytic memo writing, and exploring patterns in progress" (p. 36). According to Saldana (2009), coding provides a systematic arrangement of data in order to categorize. Beginning with open coding, the researcher moves into more complex types of coding referred to as "analytical coding". Additional codes were added based on CRT scholarship using the tenets of CRT linking

teachers' narratives to the CRT codes. Specifically, the data were coded and categorized through a critical race analytical lens, and tenets of CRT were used to analyze participants' experiences, instructional, and pedagogical practices as African American elementary science teachers. For example, participant's statements such as "We all learned the same. There was no intention by teachers to connect our backgrounds to the content being learned", was coded under colorblindness. Another example includes, "I was considered the "lazy" Black kid in my predominately White school" was coded under the permanence of race and racism.

Searching for themes. During this phase of searching for themes Braun and Clarke (2006) noted that it is a time to make sense of the codes that were created. Searching for themes was an iterative process where I moved codes back and forth to produce different themes. I also created candidate themes. According to Lyons and Coyle (2016), creating candidate themes involve grouping the codes "into a coherent story that makes sense of the data" (p. 110). These "candidate" themes have the ability to change and can be temporary. I often referred back to my research questions during this time to confirm my initial assumptions. To do that I typed each research question into a separate document and began cutting and pasting the focused codes with excerpts under the question I thought it addressed. Next, I was able to review my focused codes and generate candidate themes. Those initial themes were recorded in the same Excel document as the focused codes under different tab. Table 8 shows each candidate theme and a list of focused codes.

Table 8

Initial Candidate Themes with Focused Codes

Candidate Theme 1. Positive and Negative Early experiences	Candidate Theme 2. Aware of labels, but recognizing the good	Candidate Theme 3. Relationships in the classroom	Candidate Theme 4- Representation

Focused Codes:	**Focused Codes:**	**Focused Codes:**	**Focused Codes:**
-Family support -Family influences -Scientists -Can achieve -nature-girl -Being African American -Fragmented	- Labels - "These" students -Students on this side of the county -Inner-city -Scholars -Agency -Narrative	- Teacher connecting outside the classroom Open door policy Like a mother -Still doing research -I can always grow	-Ability - Capacity - Capability -Science trade books -Non-traditional -Guest speakers -Fieldtrips

Reviewing Themes. In this next phase, I reviewed my candidate themes by matching codes and excerpts from the data (Braun and Clarke, 2006). I referenced back to my Excel document and reviewed the color coded the excerpts and codes under the possible themes. I referred back to my Excel document and reviewed the color-coded excerpts and codes under the possible themes. I went through a process of looking for similarities in the segments of data that were extracted and determined whether the data were represented across all sources such as the interviews, observation protocol, field notes, and memos.

Lyons and Coyle (2016) note that "phase four begins when you have devised a set of candidate themes, and it involves the refinement of those themes" (p. 20). During this phase, I reviewed the initial candidate themes in order to refine them into more targeted and encompassing themes. I reviewed the research questions and asked the following questions as I reviewed the initial themes. Is this initial theme a big idea, a subtheme, or supporting evidence? Is this initial theme supported by evidence from across the data set? Does this initial theme address the research questions? Which initial candidate themes can be combined? Based on my analysis at this phase, I determined that many of the candidate themes identified in phase three were not actual themes but were subthemes or supporting evidence.

Defining and Naming Themes. A requirement of thematic analysis states that themes are not generated based on only a few vivid examples, but that coding has been "thorough, inclusive, and comprehensive" (Lyons and Coyle, 2016, p. 36). During this phase, I selected pieces of the data that best connected to each theme and defined the selected themes. I was careful not to pull what I anticipated but to choose excerpts that were representative of participants' comments in each gathering or context. I considered how each theme fit into the overall story about the entire data set in relation to the research questions (Braun & Clarke, 2006). Deeply immersing myself into the data, I repeatedly scrutinized the coding of all the data before I considered the themes final (Nowell, Norris, White, & Moules, 2017).

Within-case and Cross Case Analysis

Merriam's (1998) multiple case study model involves two stages of data analysis: within-case analysis and cross-case analysis. For the within-case analysis, I analyzed and coded each participant's case separately. Using a reflective journal, I wrote descriptions of each case, searching for similar and dissimilar patterns in the data, and developed a plan for articulating explanations for different phenomena (Bogdan & Biklen, 2007). After completing the within-case analysis stage, I member checked my interpretations with the participants before I began the second stage. The second stage, cross-case analysis, entailed building and strengthening common arguments, themes, and findings across the five singular cases. Through cross-case analysis, I was able to provide a synthesis of selected teachers' experiences as African American elementary science teachers. While this synthesis may not be generalizable to all African American elementary science teachers, this multiple-case study established an in-depth description of both the unique experiences of selected teachers' and similarities between their experiences. Using cross-case analysis, I developed more understanding, descriptions, and

explanations across the cases. Each teacher was considered as an individual case to illustrate various lived experiences (Creswell, 2013); however, data were analyzed within and across cases to enhance transferability of the findings (Miles, Huberman, & Saldaña, 2014). This qualitative data analysis process allowed for a different interpretation of data, sharing findings with those under study, and an opportunity to address questions regarding data analysis. I used this process to bring into focus the main themes used to answer the research questions.

Researcher Role and Positionality

Discussion of transparency is a critical next step because as the "primary instrument for data collection and analysis", I bring with me personal biases or subjectivities that have the potential to influence the research (Merriam & Tisdell, 2015, p.16). I position myself as a resilient, Black middle-class man, scholar, and emerging science teacher educator. As a 35-year-old Black man who grew up in a crime-ridden neighborhood and attended schools that were considered "underperforming", I learned the ways in which race and class intersect and have shaped my educational experiences. Although considered poor as a child, my basic needs were met, and I did exceptionally well in school. During high school, my family was able to move from just above the poverty level to the middle class when my mother was able to find a well-paying job working for the railroad. As the only child of a single parent, values such as education and learning to overcome challenges were instilled in me.

Having attended schools in the southeastern region of the United States, I vaguely remember many authentic experiences with science despite earning high grades. My science experiences of science as an elementary student were few and far between which included attending the planetarium at local science museums and earning the science award in 5th grade. To be honest, I do not know what I did to deserve the award, other than perhaps having the

highest average in the class generated from worksheets and open book paper and pencil quizzes. Despite my lack of inquiry-based and meaningful science experiences, throughout elementary and middle school, I went on to take advanced science courses including AP physics in high school and become a member of the junior league of National Society of Black Engineers (NSBE). Again, I did well in these classes and clubs, mainly because I had mastered the art of being a "good" student, but there was no real connection to science or engineering from my standpoint.

In college (at a PWI), I remember taking introductory science courses such as Biology 1103 and 1104 in large auditoriums filled with hundreds of freshmen from many different majors for lecture. I was only known by student ID number. I learned facts and formulas during lab time, which was on a separate day of the week from lecture. They were the biology courses for non-science majors and were prerequisites that had to be fulfilled before I could get into my major. In these classes, I made decent grades to pass, but there was definitely a learning curve as I tried to make sense of the material. After I graduated, and did some soul searching because I could not find a job in the concentration I had majored, I enrolled in an alternative certification program for teachers and earned a master's degree in elementary education. This program was beneficial, because it helped to spark an interest in learning about and teaching science to students of color and from diverse backgrounds that were absent during my childhood and the beginning of my adult life. The fact that I had an African American professor helped to shape my identity as a science teacher. I saw a professor who looked like me who challenged me to think about and critique the ways in which science was being taught to children of color.

I started my teaching career as an early childhood educator in 2009 in a school with a predominately African American population that had earned the rank of "low performing", based

on the school's report card. I attended professional development workshops to strengthen my content knowledge and pedagogical knowledge in elementary science. I also participated in mentoring experiences with pre-service teachers. These efforts eventually led me to become a teacher who went from teaching all subjects to specifically teaching math and science in third grade settings. I was able to focus more of my efforts on creating authentic science learning experiences for my students, helping them to realize the importance of science. I advocated for resources and opportunities both inside and outside of the school for my African American students. My students would even compliment and thank me for helping them to develop an interest in science, something they said was missing from their previous years in school.

Although I believed I was growing as a science teacher, I did not feel as though my colleagues were. In my urban contextualized teaching settings, I rarely saw teachers and students engaged in authentic science. Through no fault of their own, I would see many teachers use outdated textbooks and (dis)engage students through worksheets. What I observed frustrated and challenged me at the same time. To ease my frustrations, I would often find myself having to order supplies online or go to stores or events outside of the school district I worked to obtain the materials and resources I needed to effectively teach my students of color. I would share resources with teachers in hopes that they would teach science. Sometimes they used the resources; often, to my dismay and disappointment, the materials would be left untouched.

As I moved into my career, I was again able to increase both my science content and pedagogical knowledge by earning a science endorsement. I was also able to increase the test scores of my students who found the way I taught science to be enjoyable and relatable to their lives. About four years ago, I decided to pursue my doctoral degree as a full-time student in early childhood and elementary education with a focus on science education. I currently teach science

methods courses to pre-service elementary teachers. Many of my preservice teachers represent the current teaching force in terms of racial makeup. As an African American male, I do draw their attention to race, racism, and learners who may look and behave different from them as we also learn the science content. At times, uncomfortable feelings arise, but having designed the class as a safe space helps the class to continue during difficult discussions. My goal is to help teachers improve their science instruction by addressing their misconceptions about science content and assisting them to recognize and attend to the diversity of impressionable learners in their classrooms. As an emerging science teacher educator, my goal is to provide teachers tools and resources to deliver effective science instruction to elementary students who may not "see" themselves in the science curriculum.

I shared this account of my experiences to explain my truth, my story, and most importantly my reason for this research. My experience as an African American male and emerging teacher educator has shaped me to adequately prepare others, including in-service and pre-service teachers of all races, to be successful with regards to teaching authentic, reform-based, high quality science. Teaching science and teaching science well are not the same. Quality teaching of science in elementary schools to children of color is rare (Roth, 2014; Tate, 1997). As I conduct research centering on African American teachers in science education, I constantly wonder what type of experiences these teachers have had and what influence do these experiences have on their students.

Data Management and Ethical Considerations

As both Merriam (2009) and Yin (2009) suggest, a data management plan is necessary to keep data organized so that it can be easily accessed during both the analysis and writing process. During this study, I employed several steps to guard against the identification of data

sources in order to protect the confidentiality of the participants and the school district. As the primary data collector, it was important that I take every necessary step to protect the identity of the teacher participants. Prior to the beginning of data collection, each teacher informant received a consent form and was provided a thorough explanation of the contents. Teacher informants were encouraged to ask questions about their participation in the study and many did prior and during the process. Whenever teachers were quoted, pseudonyms selected by the teachers were used. The researcher also took precautions to make sure participants did not experience any type of harm or ridicule by keeping information confidential, including keeping them informed during the entire process and storing data in locked offices and safe-guarding data using password protected files.

Trustworthiness

Trustworthiness is one-way researchers can demonstrate that their study is credible and meets standards of quality (Lincoln & Guba, 1985). Trustworthiness also encompasses the researcher's integrity, ensuring that a qualitative research study provides rigor and consistency within and among all parts of the research process, from the conceptualization of the study to the reporting of findings (Creswell, 2014; Lincoln & Guba, 1985; Merriam and Tisdell, 2015). As a qualitative researcher, I am aware that my research is not neutral or objective. Addressing my own biases and remaining transparent about the complications of COVID-19 was of upmost importance to guarantee that the study was trustworthy and legitimate. For this study, I served as a former third grade teacher at one of the research sites. Over the years, I have maintained relationships with the school leaders, teachers, students, and parents. For this research study, I interrogated the data and welcomed data findings that ran opposite to the cases studied (Corbin & Strauss, 2014). Because I did not want to dictate my own experiences during the data

collection and analysis phases, I challenged my own assumptions and biases and recognized when these beliefs and feelings would manifest.

The traditional ideas of validity, generalizability, reliability, and objectivity that are essential to quantitative research are not appropriate in qualitative research (Guba, 1981). Instead, Guba (1981) offered the following terms and criteria for establishing trustworthiness appropriate for qualitative research: dependability, transferability, and credibility. I describe all three below.

Dependability

Dependability refers to the study's ability to be replicated and corresponds to reliability in quantitative research (Guba, 1981; Meriam & Tisdell, 2015). However, in qualitative research, exact replication is unlikely simply because people, experiences and environments are complex. Yin (2014) suggests that the researcher keep an organized trail of research procedures and be explicit with data collection and data analysis procedures. This suggestion was employed in this research. Additionally, elaboration on how I collected, organized, and analyzed data were thoroughly discussed in previous sections on data collection, data organization, and data analysis.

Transferability

Transferability refers to whether the findings of this study can be generalized to operate effectively in another setting or situation. Transferability in qualitative research does not measure the specific transfer of findings into another setting; rather, it points to the theoretical pieces that may suggest some predictability for other situations that share the same characteristics as the study (Yin, 2014). The use of rich, thick descriptions was used to achieve transferability, helping the results become more realistic and aid in the validity of the findings (Creswell, 2014).

Triangulation of the methods provided greater rigor and access to the richness of the research. Multiple methods were employed to gain an in-depth understanding of African American teachers using their lived racialized experiences to teach science to their students in elementary formal settings. I cross-checked the field notes with interview data.

Credibility

The purpose of a study's credibility was to ensure "the findings are accurate and consistent with the various sources from which the data is drawn" (Guba, 1981, p. 80). Credibility ensured that the correct tools, methods, and measures have been used in bringing about, as closely as possible, the real representation of what is being studied. To ensure the credibility of this research, I used member checking with participants with moments to correct, modify, explain, and embed information throughout the analysis process. I also used peer checking and peer debriefing as a way to ensure that I was interpreting the findings appropriately. I selected advisors who were experienced about this study's methodology to provide feedback about the precision and competence of the narratives and counter-stories during scheduled weekly meeting times. Additionally, the data collection spanned over two semesters that the resulting data be thorough, reflective of the teachers' pedagogical practices, and reflective of their perspectives on all matters being recorded (Merriam & Tisdell, 2015). It is important to note that data collection specifically took place over four months, and then was interrupted by a global pandemic. This was a major disruption to my research, specifically conducted at my second research site. Classroom participant observations ended abruptly. The goal was to provide an accurate account of the experiences witnessed from a population of teachers who have traditionally been marginalized in the research.

Summary

A case study undergirded by CRT was used to continuously code and analyze the data. I embraced critical race methodology as an unconventional tool to communicate the lived experiences and teaching practices of African American elementary science teachers, drawing on those realities to construct counter-stories as a way of telling their stories (Solórzano & Yosso, 2002). My data collection methods included individual interviews, observations, field notes, and researcher memos. I interviewed each participant two times, observed each teacher a minimum of three times, and worked collaboratively with teachers to co-construct their counter-narratives. The observational field notes and researcher memos were used to inform and triangulate the interview responses. Appropriate measures were taken to ensure trustworthiness during all phases of the data collection and analysis process. The findings of this study emerged from the teachers' counter-narratives and are not meant to generalize the experiences of all African American elementary science teachers, but rather share the stories of unique individuals with diverse knowledge and perspectives.

CHAPTER 4: FINDINGS

This chapter presents findings based on the words, beliefs, and teaching practices of five African American women in-service teachers: Jasmine Johnson, Salem Wolfe, Charlotte Bell, Kaye Parker, and Amanda Jones. This study sought to understand the role of race, instructional decisions, and pedagogical practices of exemplary elementary African American teachers as they navigated teaching science to their African American students. My study also employed counter-narrative within a CRT approach as it was a significant way that "knowledge can and should be generated through narratives and counter-narratives that emerge from and with People of Color" (Milner, 2012; p. 28). This understanding was pursued by addressing two questions:

1.What are exemplary African American elementary teachers' lived experiences regarding issues of race and racism?

2. How do these teachers navigate their racialized lived experiences to effectively teach science to African American students in the formal classroom?

This chapter highlights the overarching themes that emerged from the multiple sources of data and their connection to the two focal research questions. Before I discuss the themes that emerged from the data, I would like to revisit the use of CRT and critical race methodology of this study. In discussing the "findings" and "research participants" of this study, it was imperative that I recognize the significance of each teacher's voice and contribution. In valuing their voices, the teachers were not considered just sole "participants," but individuals whose stories contained complex lives, and struggles (Kohli, 2009). In essence, Jasmine, Salem, Charlotte, Kaye and Amanda engaged in aspects of CRT and critical race methodology that demonstrated their fight to speak against dominant perspectives about their African American students and shed light unto how they used a combination of techniques to effectively teach

science. These teachers also offered examples and reflections of their experiential knowledge as Teachers of Colors inside and outside of the classroom. They demonstrated their commitment to social justice for their African American students by being intentional with delivery of their science instruction, both content wise and pedagogically. They also expressed moments of struggle, but also a deeper awareness in their understanding of the centrality of race and racism and the intersectionality of race and class relating to teaching science. Their voices, lived experiences, and teaching practices contributed significantly to an area in the educational research that rarely gives voice to African American elementary teachers of science.

In Their Words and Through Their Actions

In this section, I brought together the words and actions of the teachers by addressing each research question and embedding the themes that connect to each question. More specifically, I created counter-narratives, taking the words of the research participants, and applied a critical race lens to their responses and pedagogical practices (DeCuir & Dixon, 2004). According to Miller and colleagues (2020), counter-narratives are "a means to document and share how race influences the educational experiences of people of color, whose stories counter the stories of the privileged that are considered normal and neutral" (p. 273). The data from the interviews, fieldnotes, observation protocol, and analytic memos were reviewed to find salient themes across all the data in what is known as a narrative factors approach to counter-narrative (Miller et al., 2020, p. 279). Four themes with embedded subthemes emerged from the data. The four themes were:

Theme 1: Teachers leveraged positive and negative early childhood experiences to inform their classroom practices and philosophical approaches to teaching science to elementary school students.

Theme 2: Teachers defied odds/expectations and refused to perpetuate stereotypes and generalizations by becoming agentic in creating new narratives for themselves and their students.
Theme 3: Teachers positioned themselves as extensions of students' immediate families and built intentional and meaningful relationships for authentic science classroom instruction.
Theme 4: Teachers prioritized representation in the curriculum and early exposure to science and STEM careers by embracing the unique contributions of AA scientists and nurturing students' capabilities to do science.

The participants' stories were organized with the following general structure: (a) Broad themes and subthemes addressed (b) introduction of the theme (c) quotes to support the themes that emerged (d) examples of specific instructional and pedagogical practices that support the themes, and (e) a summary at the end of each theme. I follow this format for all four themes that emerged.

Theme 1: Teachers leveraged positive and negative early childhood experiences to inform their classroom practices and philosophical approaches to teaching science to elementary school students.

This theme addressed the research questions as the teachers focused on their own upbringings. Through the first interview and analytic memos, I share the positional stories of teachers as they describe their childhood experiences, both positive and negative, related to their formal and informal science experiences. Through these stories, teachers use these narratives to envision and manifest the types of experiences in their current science classrooms that they experienced growing up or would have liked to have experienced in childhood.

Nature Experiences with Grandpa on the Farm

Kaye communicated that her grandfather was an influential figure in the development of her love for science. Kaye, excitedly and vividly, described her grandfather:

> I learned that my grandfather, he loved the land. My grandfather only had a second-grade education, but he grew fruits and vegetables. We had a garden. He fixed on cars, built his own house, and was always doing something hands on. I can remember him planting a fruit that tasted like orange and pineapple. It was something I had never seen, so it amazed me. It also tasted really good. Like I said, I was a nature girl, so I helped by grandfather in the garden and played outside a lot. He always said that if he had the education I had, he would really be somebody. (Interview # 1, March 2, 2020).

Raised by her grandparents, Kaye loved being outdoors, often climbing trees, planting fruits and vegetables, and making concoctions (leaves, water, mushrooms, dirt mixed with grass) in the back yard. Many of Kaye's science experiences were also informal and involved trial and error when tinkering and exploring. Her grandfather, a scientist with only an elementary education, was a positive role model for Kaye, and helped her to learn about science by exploration. Being an inquisitive child, Kaye learned a valuable lesson about plant safety. While playing in the forest one afternoon, her feet began to swell and turn red. Kaye ran to her grandfather for help, and he informed her that she had gotten into some "poison ivy". Her grandfather explained to her that some plants are poisonous and showed her how to look for characteristics on plants to help her distinguish the poisonous plants from the non-poisonous plants. For Kaye, her grandfather, a Black man with expert knowledge in STEM, showed her the importance of building strong competencies around science through positive, supportive, and informative relationships. Unlike her home experiences, at school she remembers completing paper assignments and watching the teacher lecture in class. Because she did not have many hands-on experiences in formal school,

her goal as a science teacher in formal school settings was to create and nurture those experiences with students she taught. Kaye wanted to create experiences in science that her students would remember.

As a "nature girl", many of Kaye's lessons were centered on life science. Kaye wanted her students to have an appreciation for nature just like grandfather instilled in her. Planting and gardening were activities Kaye planned for. During one lesson on plants, students were observing the plant seeds they had grown. Some students made observations that some of their plant roots were growing down, while other students' roots were growing to the side. Kaye allowed the students to formulate their own hypotheses about why this was occurring, and students got a chance to explain their hypotheses in large group. After the lesson, Kaye stated:

> My kids and I have formed a bond where they do not depend on me to constantly tell them things. They have learned to question why things happen. They used to always ask me, but now they're starting to ask each other. I'm thankful I get chance to build a great foundation with them. (Lesson debrief, March 4, 2020)

Affirmations from Family about Science Ability

Charlotte, too, had a family that encouraged her to explore her curiosity through science. Charlotte stated that as a child, her community and the teachers were mostly Black. She said that these images made her feel visible inside the classroom and made her feel confident in her abilities to participate in all subjects, including science. She considered herself fortunate to have such experiences including her parents (her first teachers) instilling in her that she could do whatever she put her mind to. Whenever Charlotte had a question, her parents would suggest that she try it out. For example, Charlotte wanted to know what the inside of a pumpkin felt like. Charlotte's mother bought her a pumpkin, cut the top off, and let her have a field day with

exploring the inside. Her parents also helped her conduct simple science experiments at home, such as making butter and ice cream. They would talk about changes in matter as they enjoyed their tasty science. Charlotte stated:

> Whatever I wanted to do, my parents were right there to support me. For a science fair project, I remember having to borrow my neighbor's camera and take pictures of plants that contained lots of chlorophyll and plants that did not, and then compare the two. I remember my parents helping me by buying the materials needed for the project and helping me put it together and practice what I wanted to say. I won third place. My parents and I were happy- because I loved school. (Lesson debrief, January 6, 2020)

Charlotte's experiences as a child have helped her to bring this same mindset of supporting her students in science class. Because the school had many resources to help students to engage in science, students knew that they could ask for supplies to complete science projects or engage in STEM challenges. Students in Charlotte's class knew they were supported in making science discoveries and undertaking projects they wanted to complete.

Seeing Past a Label

Prior to fourth grade, Jasmine had been labeled as "lazy" at her predominately White school. As she reflected on her early childhood and elementary experiences, she realized that many of her teachers, mainly White women, taught the curriculum without much thought to their students' culture or race. This was Jasmines reason for not wanting to complete assignments. She was uninterested. Feeling invisible and misunderstood as a little Black girl, Jasmine was considered an "average" student, making B's and C's with little incentive to want to do better in her classes, particularly science, until she met a teacher who saw differently. This teacher was a White woman, who took the time to help her become a better student, focusing on Jasmine's

strengths and nurturing her weaknesses. Jasmine appreciated her teacher's efforts and there was an immediate change Jasmine's work ethic in subjects including science, sense of self, and outlook toward school. Jasmine went from a student who made average grades to a student making mostly A's. Jasmine's label for being "lazy" was altered because one teacher saw potential in her abilities and nurtured them.

The life altering experience that Jasmine received from one teacher who saw past a surface understanding of her was how she approached the teaching and learning of science to her students in her classroom. Because her learners were so young, she provided them with many opportunities for students to be active and move around the classroom before, during, and after lessons. She encouraged her students to talk and engaged in feedback loops with students as they articulated their ideas. If she found students not wanting to participate or seemed uninterested, she would ask her assistant teacher to lead an activity and spend-one-on-one time with students until they wanted to rejoin the lesson. The reason for the lack of participation stemmed from the student not feeling confident to participate in the lesson.

An Awakening in High School

Although raced in a mixed-raced neighborhood, Salem attended predominately White schools in elementary and middle school. Salem remembered very little about her science experiences growing up as a child. For her, lectures and book work dominated the types of instruction she received. In those textbooks, Salem recalled a curriculum that was colorblind to her life experiences, even pictures of enslaved African American people smiling. For the experiences she does remember, they increased her curiosity for learning science, but were filled with gaps and wonderings about the actual science piece of the lessons. Salem recounted that she

found school to be boring to her and that she really did not understand the purpose until she was able to engage in discussions about the relevance of science as applied to her life.

Salem recalled two science teachers in high school, one Haitian and the other Jamaican, who made a difference and have in many ways shaped her career as an elementary science teacher. Remembering those teachers who just taught "different" from the rest is what Salem articulated as being most influential in helping her to appreciate science. Teachers took the time for her to think during scientific investigations, allowed her to question why certain things happened, and allowed her to wrestle with ideas that did not make sense to her. Salem stated:

> These teachers allowed us to struggle with science. They did not tell me what was going to happen. You had to provide reasoning for your answers. You had to discuss with your classmates why particular things did or didn't make sense. Science was challenging, but fun at the same time. (Interview #1, December 19, 2019)

Salem was insistent that her third graders would have science experiences that were worthwhile but challenge them. Salem used flexible grouping in her classroom and incorporated activities that students found both exciting (e.g., physical manipulation with different soil types) and challenging (identifying soil types based on key characteristics presented as clues). A strength of students in Salem's classroom was their excellent use of technology Therefore, she allowed students to design digital assessments and WebQuests to use as tools of assessment in learning about soils. She also relied on them to design answer keys and rationales to support their science reasoning when creating such assessments.

Scattered Memories: Just Getting By

Amanda identified as a lover of science. Being outside for her was an oasis for learning about the natural world. However, her early experiences as a child were less than memorable.

Amanda, like Salem, remembers rote instructional techniques in elementary school. She took notes from a board and had a test every other Friday. Middle school brought back pleasant memories for Amanda where she began to really enjoy science. Amanda's teacher, an Asian America male, engaged the class in topics such as composting and created opportunities for them to dissect a sheep's eyeball. Amanda remembers the learning being hands on inquiry-based and remembers her excitement for science. Unfortunately experiences like this for Amanda quickly faded as she entered high school and does not remember much about the biology or chemistry classes she took. In college, she even admits to just getting by in her science methods courses. Amanda stated, "I went to office hours, and was happy to receive a passing grade at the end of the course. You do what you have to do."

Despite the feelings of just needing to get by in her science methods course, the impression that Amada's sixth grade teacher left on her was the same feeling she wanted to leave with her students. "When are we doing in science today?" was a common question students would ask that brought joy to Amanda because they had connected an action with learning science. They knew that there was type of experiment or investigation linked to real-life application.

Summary

This theme used teachers' narratives to showcase teachers' reflection of their own lives and struggles regarding issues of race and racism as it related to their own upbringing. These narratives tell how both positive and negative experiences in childhood influenced their classroom practices today. From the interviews, both Kaye and Charlotte indicated that their first science teachers were their family. They developed a knack for science through positive experiences with relatives who provided opportunities for them to see science as more than just

learning facts absent of real-life application. Jasmine and Salem both learned that not all teachers will be supportive and can actually be detrimental to one's attitudes towards school and the ways in which they identify with science. Amanda's childhood experiences fell somewhere in between positive and negative. Through these experiences, teachers learned how to situate science learning experiences that were beneficial to students, and prioritized students taking an active role in their learning rather than teacher directed instruction.

Theme 2: Teachers defied odds/expectations and refused to perpetuate stereotypes and generalizations by becoming agentic in creating new narratives for themselves and their students.

This theme addressed the research questions as teachers discussed and demonstrated agency in breaking cycles that of reproduce deficit ways of thinking about students and their abilities, including word choice with students, knowledge generated by students, and reflection demonstrated by teachers. Teachers knew they were responsible for eliminating hegemonic thinking that classrooms, schools, and communities often perpetuate.

Intentional Use of the Word "Scholar

Charlotte referred to her students as scholars when talking with them or about them. *"*All of my scholars are capable," was a quote she articulated many times throughout the day when interacting with students including during the learning of science content. She used it so much that even her scholars begin to call themselves scholars when interacting and collaborating in science activities. Her intent with using language such as "scholars" was to help her students, particularly her Black girls and boys, see themselves as such. During our debrief of her first science lesson, she stated:

> I don't just say it to them. But we also have discussions about what it means to be a scholar. Someone who is constantly learning, but someone who is also a teacher as well. Someone who is an expert. Teaching is so much more than me just pouring into them. My scholars understand that they are teachers themselves. (Observation debrief, January 6, 2020).

Charlotte talked and operated her classroom from a place of empowerment. When elaborating on her practices, Charlotte frequently began with the phrase "I want my scholars to be able to", followed by her desire for her students to think a certain way, see science from a certain perspective, and experience science in a certain manner in her classroom. She wanted them to ask questions of the content presented to them and provide them with science assignments in which they could excel. For example, student choice was important while implementing science lessons. Students had multiple ways of demonstrating the science they learned. Charlotte used choice boards, a tic-tac-toe model for differentiating instruction. They could act out their learning, use the Chromebooks and iPads, create a song, poem, or rap, or opt to take a paper and pencil assessment. Many students created songs or dances to the latest tunes to describe the properties of matter. They also worked collaboratively to build structures that had to meet certain guidelines. In Charlotte's class, students of all ability levels and interest levels were able to contribute to the scientific knowledge base in the classroom. Empowerment for her came from the desire to witness her students succeed. During an informal conversation, Charlotte stated, "They have important things to do in the future, but they also have important things to do now in second grade."

Charlotte's statement about her science scholars having a purpose stemmed from her belief that her students needed agency and a sense of direction in the elementary years. She felt it

was her responsibility to provide them with ways to demonstrate their knowledge. Charlotte's statements about her scholars being teachers was reflected in classroom practice. Scholars had classroom jobs that they took very seriously. Charlotte had fish as classroom pets. She helped her students learn how to take care of living things. Scholars were also observed caring for the fish during classrooms observations. Scholars were assigned as group captains to help facilitate the learning of their groups. Because I could not be there every day for science lessons, when I did return, students were assigned to report what had occurred since I had last been in the class. Charlotte exhibited a strong science identity. Realizing that some of her students may not have had these experiences, she did her best to instill in her students a strong science identity. During the first interview, she made it known that teachers who share the same race with their students can also hold negative views of their same raced students, which can affect the way the students think about themselves. When asked to elaborate, she said:

> I think that even as Black people, you can still come in with biases to your classroom. And society sets us up to think that certain people are lazy or certain people can't do things or certain people are not going to want to work hard, or they're going to want stuff handed to them. Or you're going to think that certain people are smarter, certain people are just more adept to do whatever in the world. My scholars need to know that they can be successful at subjects such as science." (Interview #1, December 18, 2019)

Charlotte had a class that could be considered diverse in terms of academics and behavior. There were students who needed additional supports, but because of funding issues, Charlotte received minimal support. Her class also consisted mostly of African American boys. Charlotte recognized the assets of the Black boys in her classroom and was very aware of the societal messages sent to her Black boys through the media. Teaching strategies she used to

engage her Black boy students during science instruction included calling on them and allowing them to speak or answer questions even if they did not raise their hand or asking them to help assist with leading science experiments. She also used music, including instrumentals and drumming, to help engage students in lesson vocabulary and many of the science lessons.

With her acknowledgement of being a culturally relevant teacher, she explained that she wants fellow teachers and those aspiring to be teachers to understand that we, meaning the teaching force, do a disservice to children of color as teachers when we do adopt colorblind practices in the classroom. Teachers are not bringing attention to the unique ways in which people of color have shaped and contributed to the world we live in. Charlotte said:

> We are teaching in different times. I need to know my history, and so do other teachers, 'cause I think if you do not know your history, you don't know what to bring to the classroom. You, in good faith, will teach students all the same, not realizing the power you possess to get students excited and make the science relatable and fun. (Interview # 1, December 22, 2019)

My students "Can" and "Will"

Jasmine's refusal to perpetuate stereotypes about her students was two-fold. This refusal stemmed from her own experiences growing up and her desire to create better experiences for her students. Although Jasmine communicated that she liked to teach science**,** she admitted that she struggled with identifying as a science teacher. During our initial interview, Jasmine proclaimed, "I am just a teacher who teaches science. I'm not a science, science teacher**,** you know like a biology teacher. You should have a science degree. Like you should be an expert in science." Because of Jasmine's experiences with science that ignored both her race and gender,

Jasmine's inability to identify with science was rooted in the experiences she had as a child seeing mostly White, male science teachers. Although Jasmine wrestled with her science identity, she felt a sense of responsibility to move past her struggles and made the commitment to teach science to her African American students at Infinite Academy. Through a social justice approach, she used dance, play and sensory experiences, and fieldtrips as a means to provide opportunities for her students to demonstrate their science knowledge and foster their critical thinking skills. With this approach, Jasmine was also providing her students with experiences to create interest and set the stage for her students to form positive science identities.

Science for her was not something that had to be complex to teach, and it definitely did not stop Jasmine from having a sense of obligation to teach her students of color to build interest and identify with science. Thinking about the labels that most of her primary teachers placed on her, Jasmine was adamant about not continuing the cycle of deficit language. She stated:

> I don't want to put labels on them, because they already come in with labels on them, being African American, being from low-income families, being from families that are single-parent homes, or just have a lot going on. A lot of heavy things going on. So, I want to give them experiences that help reach where they are. If you need to dance to learn some science, let's dance and learn about science. (Interview #1, December 17, 2019)

In addition to not placing labels on students, Jasmine knew it was important to provide students with experiences to help them realize their full potential as learners and doers of science. Jasmine understood that, unfortunately, her students have been negatively lumped into categories by society inside and outside of the classroom. These categories not only apply to her students, but

to the communities her students come from. Her goal was to produce students who rose above low expectations established for them and provide positive narratives of their abilities.

> I try to give them as many experiences as I can in the classroom that way they are exposed to it or we'll go on a fieldtrip. People underestimate this age group because they're young Black kids. It's like, "Hmmm, you can't really do much." And it's like, "No, actually you can do a lot.

Jasmine's comments speak to deficit thinking about students of color, particular African-American children. Having been a child that had not been taught to value the importance of her worth and value in school until fourth grade, Jasmine's focus was on the experiences she wished to engage in with her African American students as she focused on the teaching and learning of science with her kindergarten students. These experiences were going to be positive and promote cultural competence and academic success. Understanding that society had already deemed her students as "at-risk", which is problematic, she understood the importance of making sure that when students entered her classroom, she operated from an asset-based perspective about their abilities. Jasmine spoke positively about her students. She saw them as sponges who take in everything around them, including messages that not only relate to the enacted curriculum, but the hidden curriculum as well. Through her interactions with students to help them engage fully with the content, Jasmine helped her students to build confidence and self-worth in their abilities

Using fieldnotes as a tool to observe Jasmine's science teaching, Jasmine made movement essential in her lessons. Many students prided themselves on knowing how to do the latest dances, and Jasmine provided students opportunities to learn science vocabulary (e.g., matter, property) in a way that resonated with her students: dancing. Jasmine was familiar with many of the dances that students knew, but there were a few that students had to show her.

Students enjoyed positioning her students as experts with the dance moves so that she could then help them better learn the science content.

When you know better, you do better

Kaye has worked in a variety of educational settings, which have given her experience her a myriad of experiences with students from different races to socioeconomic statuses. Kaye admitted to using deficit language in her beginning days of teaching to describe some of her students, particularly from her students that live in the inner-city. While being reflective, she also expressed that her language to describe students has changed over the years. During a debrief of one of her lessons, Kaye reflected by saying,

> You know what. I remember how I would say that I was dumbing down the lesson for some of my students if I had to modify the lesson to meet their needs. To help them "get it." I now realize that although I did not mean anything by the term, it is hurtful to a child. They know what the word dumb means. (Lesson debrief, March 11, 2020).

Kaye's acknowledgment of her own problematic language to her students by saying "dumbing" down the curriculum reflects her growth as a science teacher. Although Kaye shared the same race as her students, Kaye's phrase was in fact a way of labeling her students as *less than* or *lacking.* Kaye stopped using the phrase when she had a course assignment in her master's program that challenged her deeply to think about the ways she was reproducing inequalities in the classroom. Her acknowledgment of toxic phrases also spoke to the need for all teachers to understand the diverse perspectives of their students while clarifying misconceptions, helping them to engage in the science and engineering practices, and considering alternative explanations to science phenomena.

In her classroom, Kaye positioned her students as adding value to the lessons. In one lesson, Kaye and the students were discussing what living things need in order to survive. The basics like air, water, food, and shelter were discussed. Then one student raised his hand and said, “sleep”. Kaye asked him to explain, and he continued by stating as a human, he needs sleep so that he can function in school. He also lamented about how dangerous it can be to operate objects such as cars and heavy machinery when tired. Kaye looked up for a second and said, “You know what, I never looked at it that way. Then she went over to the science textbook and said, “Maybe you will be able to add to what’s in our textbooks.” This one small action in the class was one of Kaye’s ways of acknowledging this student’s diverse perspective and recognizing him as having something valuable to contribute to the science discussion.

Building Students Up

As a self-proclaimed “nature girl”, Kaye identified strongly with science as a teacher. Her experiences with her grandfather shaped a lot of why she has love of science, and her long-standing career as a teacher has shaped the way she taught her students, which she described as mostly coming from poverty and low-income households. Kaye says that she has had to “build up” the learners in her classroom.

> They come to me afraid to speak up. Afraid to share their science ideas for fear they may be wrong. At first it used to bother me because I didn’t realize why they were so quiet. It’s a skill that I have to teach them and eventually most students come around. I have to realize that their home structure may be set up in a different way. I have to meet my students where they are.

Kaye’s comments about her students and her approach in science lessons reflected a commitment for her students to have confidence and a voice. By approaching science as a collaborative

investigation, she offered her students spaces in which they could freely express their ideas even if they struggled with some of the tasks assigned to them. The structure of her classroom encouraged dialogue allowing her students opportunities to exercise agency amongst themselves and their peers. She also encouraged students to express their ideas with drawings and diagrams in their science journal, provided praise and positive feedback to students, and allowed students to act think, talk, and negotiate their ideas together. These practices by Kaye proved beneficial to all of her students, even those students who took longer to complete assignments.

Being Cautious with Wording and Language to Describe Students

During our initial interview, Salem and I met at a coffee shop. I could tell at times she felt uneasy about our conversation about race and her students. She would look around and often pause before she made a statement, especially when she used words such as "socioeconomic status" or "poverty." Because we were in a public place close to the school, she exhibited signs of being uncomfortable for fear that someone might hear her speaking about these issues related to her students and misconstrue her words. I reassured her that would not be the case. Salem communicated that in a perfect world, it would be easy for us not to think about race as we teach, but ultimately it does a disservice to children because, by doing so, we are failing to account for differences in learning styles. She understood that her students of color, particularly those living in poverty, deal with things and face circumstances that she could not possibly fathom. While being frustrated, she understood the important role she plays in their well-being and learning despite the challenges they face.

Salem wrestled with the language to describe the students she has taught. She felt that if she used terms such as low socioeconomic status or poverty when referring to her students of color, she would be contributing to the deficit views that she desperately did not want to

reinforce. Instead, she wanted to address her role in helping students to become better prepared for a world that is requiring more skills in science, technology, engineering, and mathematic fields. Because Salem had two decades worth of teaching experience, she had opportunities within her career to teach siblings as well as additional family members (i.e., cousins). She communicated that many of the families she saw had basically lost hope and could not see a better life for themselves. It frustrated her because she saw the potential in those students. “I think science and technology, things like that can push kids outside of their circumstances to really change and hope for better.” Instead of coming from deficit views, she reiterated the importance of access to quality science experiences at early ages to have the preparedness to pursue STEM related fields. She was also mindful that in just two short years, in fifth grade, students will be tested in science. Having been a fifth-grade teacher, she knows all too well that eight short months are not enough to get students prepared for the science standardized test that students will be expected to score proficient on. By choosing to teach third grade, she wanted to make sure that she does an adequate job of preparing them for science related content earlier, with the intention of making it worthwhile and interesting to students.

More than Points

Amanda said, “As an African American teacher we are dealing basically with race, and how students see themselves *(*Researcher Memo, March 9, 2020*).* She indicated that her school’s administration preferred to use terms such as differentiation, but race is really the root of the issue, because the root of the matter is not so much about ability level as it is about the experiences kids have had. Amanda recalled becoming upset that some members of the administrative team at her school discussed students according to testing language (e.g., beginning learners, developing learners). Amanda indicated that because she teaches third grade,

a testing grade for some subjects, language to describe students are based upon the language of the test. She said, “We get told that we need to get students to proficient and distinguished learners if we are going to raise the status of the school.” Amanda was adamant that labeling kids in this manner puts tremendous pressure on not only her, but on the students and the labels attached to their score on a standardized test. Asked to elaborate further, Amanda proudly stated:

> We cannot continue to label students according to their “proficiency level”. Kids are not points. What we can do is present them with opportunities inside and outside of the school that can help them. I am an example of excellence for my students and can show them that learning science can be fun and worthwhile. The south side of the county often gets a negative rap, but we are doing great things over here. (Interview # 1, March 11, 2020)

Amanda’s statements about not labeling students as “points” echoes Basile and Lopez’s (2015) notion of racial commodification, which views attributes value to students of color if they pass state tests in mathematics and science thus contributing to intellectual property. These students represent an economic benefit to the field of STEM. If they fail such tests, they are commodified “with near-zero market value” (p. 525). Amanda understood that such messages detract from teachers’ creating experiences that directly benefit her African American students in science.

Reflecting Back

Salem has not always been the teacher she is now. Salem, too, struggled with identifying with what it meant to be an elementary science teacher. While Salem now enjoyed planning for and teaching science, she did not consider herself a super strong science teacher. Many of her struggles came from her own lived experiences. Salem stated:

> I have a little bit of guilt for all the years that I said, "Open to page 7. Chapter this. And then gave them a test on the chapter unit. Really thought that I had them learning something because they got a 92. They probably did not know it was connected to anything. You know?

She realized that her actions did not serve the needs of her students, and that she was unconsciously subscribing to a deficit mode of thinking about her students and their abilities by engaging in rote science assignments. Because she was taught science in a way that was invisible with regards to race and power structures as a child and during her teacher preparation, she did the same things as an in-service teacher. Although expressing feelings of guilt, she also expressed feelings of contentment.

> But it also makes me thankful that I could change. And maybe they'll get another good teacher down the line who's also going to really teach science in a way that excites them. But I like what my science class looks like and feels like now and kind of the last few years of me teaching than I did before. (Interview #2, March 24, 2020)

Salem recognized the importance of being reflective as a teacher and making the necessary changes to positively influence her students' science learning. She understood the impact that her previous inattention to race, and the way her students learned. She is now very conscious about the learners in her third-grade classroom at this moment and the types of science experiences she wants to create for them. The important thing to note in this statement is that her thoughts have changed about the learners in her classroom as the social and political climate has changed during her twenty years of teaching.

Summary

Teachers positioned themselves as experts in their classrooms even if they sometimes struggled to identify as such. From Charlotte's intentional use of the word "scholar" to Jasmine's unwavering believe that her students could exceed the highest of expectations, teachers spoke confidently about the learners of their classrooms and demonstrated sound pedagogical practices to help their students reach their fullest potential. Their strategic actions about their choice of words, phrases, and types of experiences they created in the classroom helped to defy notions of Black inferiority toward a subject such as science. Teachers were also reflective and demonstrated vulnerability by acknowledging that they, too, have stereotyped and generalized in the past. Each teachers' goal and commitment to social justice was to move past the deficit thinking of students and nurture the assets that students brought to the science classroom.

Theme 3: Teachers positioned themselves as extensions of students' immediate families and built intentional and meaningful relationships for authentic science classroom instruction.

This theme demonstrated teachers' commitment to form lasting relationships with their students and their families, thus assisting in answering the second research question. Through the interviews and witnessing the pleasant nature of teacher-student and student-student interactions, this theme was developed as teachers worked collaboratively with students and their parents both inside and outside of the classroom.

Bridging Formal and Informal Experiences

Relationships with students inside and outside of the classroom were important to Amanda. Through the interviews and informal conversations, Amanda communicated that building relationships with students meant attending events out of school so that she could earn

their trust as well as their family's trust and respect inside the classroom. Regarding the relationships that she builds with her students, Amanda proudly stated:

> I go to some of my kids' (football) games. Meet their parents. Meet their family members. Just setting that relationship with them. I sit down with them and have what we call Lunch Bunch. Just sit down, talk to kids. See what's on their mind. (Interview #2, April 3, 2020).

For her, establishing a positive relationship with students was the first step before getting to the science. From these "Lunch Bunch" sessions, Amanda was able to gauge student interests and used them as springboard for discussion topics to engage students in inquiry-based science. Amanda conveyed that this approach was much more personal and resonated more with students than students completing a worksheet about their interests or simply being asked randomly. From her conversations with students, she was able to plan and provide successful execution of science learning stations for students to explore and investigate.

Amanda also explained that having a bond with parents helps to bridge her students' formal and informal science experiences. Having a close bond with the parents, Amanda felt it was important that parents knew what was occurring inside the classroom and what her expectations for science were. Having been at the same school for 15 years allowed her to witness and have the honor of teaching generations of relatives at the school. She did not want the familiarity of teaching relatives to interfere with the high expectations she set for students each year. In order to maintain expectations, she sent home monthly letters to parents about science activities and ways parents could support. Amanda's open-door policy also encouraged parents to participate in the school culture and ask questions about the science curriculum students were learning. Amanda realized that she must meet parents where they are. Some

parents did choose opportunities to come read a science text to children. Others brought supplies needed to develop models and plan and carry out investigations.

Amanda was adamant that relationships matter, especially when talking about her African American students. She considered herself a mother figure to her students. In a serious tone, she stated:

> I know that all my children are Black, and that means I must teach them in a special way. I'm their mother when they are here at school. Not all teachers see it that way. I've been here fifteen years and I can tell you some things I've seen. I know what my babies need. That means making changes to the curriculum. That means being selective in the materials I choose. I have to make the learning relevant for them and include experiences that they are familiar with to get them to want to engage in experiences that challenge them. We do our best over here at Eagle Elementary to help students to make sure that they know they can be successful at subjects such as math and science. (Second Interview, March 11, 2020).

Right where I am supposed to be

Kaye also demonstrated a commitment to the students and families where she taught. She has been at her current school for eight years. She commutes over two hours roundtrip daily to teach students who can benefit the most from her teaching. Although she realizes that she could find a teaching job closer to her dwelling, she boldly articulated that the experience just would not be the same.

> My students need me, and I need them. With my wealth of experience and the opportunities I have been presented here to help my students learn, especially science, I

> can't give that up. Waking up at 4:30 every morning is wheeew, tough. But it's worth it." (Observation debrief, March 9, 2020)

Kaye would not have it any other way. She indicated that she would enjoy a shorter commute, but her desire to meet the needs of her students was a driving force that overcame the inconveniences of where she lived. Kaye knew that schools closest were not where she could be most beneficial to students or experience the greatest satisfaction in teaching. At her current school, Kaye felt a moral obligation to "show up" for her students daily and tap into their worlds so she could be the best science teacher for them.

This statement reflected Kaye's understanding that the society we live in is not as nurturing and supportive as she is, and, in some cases, may have already written them off as people because of their skin color. She worries about the challenges they will face. Students of color, particularly Black students from urban environments, must learn to navigate a world that sees them as deficit and deficient. She wanted to give them the confidence to face a world where they will always have to prove their worth. If only for a year, she wanted them to have science experiences they will not forget; ones that will be permanent fixtures in their lives and engrained in a manner similar to her science experiences with her grandfather and middle and second-grade teachers.

Kaye also felt a responsibility to challenge students as part of their relationship. This was displayed in how she expected students to respond to questions asked in science lessons. Phrases like "I don't know" were not acceptable. Even if students did not feel like they had anything to say, Kaye communicated that students did have something to contribute in helping to build knowledge in the classroom. Teachers would allow wait time for responses or come back to

students to ask for input. Through these actions, teachers showed a commitment to students that recognized their knowledge as important and valuable. Kaye commented:

> My intention is to go the extra mile and do everything that I can to let my students know that getting an education is important and that they have to take what they are learning seriously. I want to get them excited about what they are learning, because they will face some challenges in their lives just because of the way they walk and talk. Even if they go off into left field during science, I want them to stand tall and confident while also being prepared for all these things. (Interview #2, March 30, 2020)

Amanda, like Kaye, showed an unwavering desire to her students and their interest, development, and growth in science. Amanda had opportunities to leave her current school, but she indicated that her passion and commitment for teaching science for her Black students outweighed any possible benefits she could receive from teaching somewhere else. Her long tenure at the school has afforded her many opportunities to serve in many leadership roles, including being the organizer responsible for professional learning communities on science.

It is an Organic Community

Charlotte described her classroom feel as one that feels organic but acknowledges that it took time to establish this vibe. When complemented on the positive climate of her classroom, Charlotte stated,

> Oh, no. It did not start that way. It is intentional. It is something that has to be taught and you have to build it. So from day one, we're starting with morning meeting and making sure that they understand the importance of valuing one another. So, when it is time to collaborate during science, we can do so, and actually exchange ideas.

Charlotte liked that fact that students in her students did not change classes as they had in previous years. Although Charlotte understood its benefits, this type of flexible grouping according to ability level hindered and negatively impacted the community building of the class. Charlotte used "we" to describe herself and her students. Because students remained in the same classroom for all subjects, students had more opportunities to build a relationship with Charlotte and the other students in the class. Charlotte discussed that was not possible when students switched for every subject. Additionally, Charlotte could rearrange the schedule to teach allot more time for science or decide to teach science later in the day rather than first thing in the morning if needed.

Summary

With greater visibility of race because of social media, teachers were well aware of the messages being sent to their African American students. Teachers understood how easy it is for society to make one feel invisible, as some teachers expressed how they felt as children. The teachers in this study wanted to ensure that students felt noticed and understood. They believed that noticing and attending to students' need was important to students to help them gain greater student-teacher relationships with their students. From Lunch Bunch to advocating to students to remain with one teacher through the day, teachers built relationships with parents formally and informally and established positive classroom communities that help to increase learning.

Theme 4: Teachers prioritized representation in the curriculum and early exposure to science and STEM careers by embracing the unique contributions of African American scientists and nurturing students' capabilities to do science.

This theme addressed the second research question concerning teachers' instructional strategies related to science instruction. This theme was formed from the analysis of most of the observation and field note data with quotes from the interview to triangulate the findings. Teachers share their experiences with adapting the curriculum and using real life examples to present a diverse outlook on science to their students.

Exposure critical for Representation

Salem was clear about her intentions for teaching science, particularly to her students of color. She understood that science must begin in the early grades for students to have a fighting chance at being interested and prepared to go into STEM fields. For her, exposure was the key to helping students see themselves as scientists. But she also spoke to the larger structural implications of what she has seen in schools, especially in schools that serve students living in poverty. Salem said,

> There's a huge lack of representation, especially from African Americans in the science field. And I believe it has nothing to do with capability or capacity but if you think about traditionally, like how we are talking, how kids are either given or not given science instruction. If you don't get science until you get to middle school or high school, then going into those fields isn't probably really something that you're going to do. (Interview #1, December 13, 2019)

Exposure to science was a key component for Salem. She realized she had to make the effort to teach science in order for students to engage in scientific ways of thinking which are different from everyday thinking. Salem did this by teaching science consistently and collaborating with colleagues on the same grade level and across grade levels to plan instruction that reached all students. Salem knew she had to "hook" students with interesting or puzzling phenomena or her

students would become disengaged. Then she could then tie those experiences into her students' lives and engage them in the science and engineering practices to develop conceptual understandings.

Guest Speakers as Additional Forms of Knowledge

The teachers in this study realized that students could benefit not only from their expertise but also through the involvement of other science professionals to show that people of color could be successful in the areas of science and STEM. Because of the partnerships with the community at Infinite Academy, speakers, such as engineers and scientist of color, were invited to visit the school to talk about their experiences. For example, the science coach invited an app developer engineer from Georgia Tech to come to the school's Career Week to talk to the students about her experiences with learning to code and design apps. Prior to the visit to Salem's classroom, she had students design questions they could ask the presenter. The questions were reviewed by the class for appropriateness and redundancy.

Wearing a hoodie and designer tennis shoes, the engineer was able to dispel "stereotypical" myths about how a scientist should look. A student commented that she was not dressed like an engineer, which sparked a lively conversation in the classroom. The engineer invited an explicit conversation with students about the way she was dressed. She also showed pictures of what she does at work, how she collaborates with data scientists, and how she looks when she has to present in front of people who want to test the apps she designs. Students indicated that it did not matter how she was dressed if she knew how to do her job well. Students got to test a few science educational apps and, most importantly, were able to see a Black person positioned as an expert in a STEM field in a manner that was relatable.

In our second interview, I asked Salem about her thoughts on the engineer that came to speak, and Salem replied:

> I enjoy when guest speakers come to present. My students are sweet, but I know they get tired of me (laughing). I am not ashamed to say that I am still growing and learning myself. I learn just as much as my students. It's good to see our people showing our kids that they can have cool jobs in subjects such as STEM.

In previous conversations, Salem discussed representation in the STEM workforce as it related to race and capability and her intentional approach to providing students with opportunities to engage and interact with STEM professionals of color. For Salem, experiences such as these helped students to see beyond the classroom walls and know that they, too, can position themselves to thrive and succeed in STEM careers. Salem knew she did not have all the answers as a science teacher, and therefore wanted to increase the intellectual property within her classroom and curriculum by having someone who could do more than just tell about the importance of STEM, but also show in a real-life application.

Increasing Knowledge through Fieldtrips

The teachers in this study also understood the importance of making connections to science inside and outside of the classroom through experiences such as fieldtrips. Charlotte was intentional about the types of learning experiences she wanted to engage her students in before, during, and after the fieldtrips she and her students attended. She planned a fieldtrip to Legoland that I had the pleasure of chaperoning and observing during my third observation of her class. Legoland is a discovery center designed for preschool through fifth grade students. It is located in the heart of the city. Students were engaged in several activities related to STEM learning including an area to build objects made from Legos, many that had wheels. Additionally, a

workshop that addressed engineering standards from the Next Generation Science Standards and focused on the four C's of 21st learning: Critical thinking, Creativity, Collaboration and Communication was a part of the learning activities during the fieldtrip.

Prior to attending the fieldtrip, Charlotte assigned her students a writing activity about how the fieldtrip related to what they were learning in the classroom. Many students communicated that it related to a physical science standard from the state's adopted curriculum standards. The standard involved constructing an explanation for how structures made from small pieces (linking cubes, building blocks) can be disassembled and then rearranged to make new and different structures. Students jotted down the connections using their science notebooks and drew pictures of what they anticipated they would design, redesign and construct while at Legoland.

During the fieldtrip, students got a chance to build structures, articulate their strategies for constructing structures, and provide reasoning for the choices they made related to building materials. During the workshop, students were designated as Master Model Builders and asked to construct structures that were representative of their city. Some students chose to construct the local football stadium, being that the night before had just been the Superbowl and students remembered it was held in their city the previous year. Other students chose to design their apartment complex and neighborhood. During this time, Charlotte went around to the groups and asked questions such as: "Tell me about your design". During this time, students got a chance to work in groups during the fieldtrip adding to their value as co-constructors of scientific knowledge.

When students returned from the fieldtrip, students were asked to reflect on their experiences during the fieldtrip. Students did this through partner sharing, and eventually large

group. Many of the students communicated that they enjoyed the fieldtrip and wanted to stay longer. Charlotte informed them that she was planning a fieldtrip to the Tellus Museum, a 120,000 square foot natural history and science museum that they would also find interesting. The museum has labs for students to partake in related to the state standards. Charlotte wanted the students to participate in the lab activities, learning more about the states of matter, learning about liquid nitrogen, and exploring the galley to learn more about solids, liquids, and gases.

Although I was not present for the fieldtrip that Jasmine took with her students to the zoo during their lessons on animal features and habitats, Jasmine communicated that as grade-level chair, she was responsible for coordinating and planning fieldtrips. Jasmine articulated that she has learned to properly execute the process of preparing for fieldtrips because, unfortunately, she did not learn how to do so from her days as a pre-service teacher. Jasmine articulated her role as being very active during fieldtrips, including asking questions and making connections to the curriculum. Having her students think critically about the animal adaptations as they discussed different animals was important for Jasmine because she stated that it is a lifelong skill her students will need, particularly as students of color. Jasmine showed me the lesson plans she used during this time and talked about how she connected the standards to the fieldtrip. Jasmine even provided pictures of students engaging during the fieldtrip.

Children's literature and science trade books in the classroom

The use of science literature was important to Charlotte. Charlotte had a classroom library full of science trade books that reflected the race of her students, including both female and male scientists. As a teacher of predominately African American students, Charlotte felt it was important to have books that reflected the race of her students. During one observation, Charlotte was observed reading *Ron's Big Mission* by Rose Blue and Corrine J. Naden. She used

the book to talk about the challenges Ronald McNair faced as a little boy wanting to obtain a library card in the segregated South and how he persevered to become an astronaut. When asked why she included a diverse mixture of children's books in the classroom, Jasmine indicated that her Black students needed to physically see themselves in children's books. "It's like mirrors and windows", said Jasmine during an informal conversation about her classroom library. This one intentional action by Jasmine was crucial in the important message of recognition, value, affirmation, and the validation of all her students.

She indicated that teachers must acknowledge race as they choose science materials and implement instructional strategies in the classroom or they risk teaching the curriculum "blindly" to students, without regard for the experiences and knowledge students bring into the classroom. The institution she attended for her master's degree was predominately white. While in her master's degree program, she said that she sometimes felt awkward when professors would teach "best practices" without drawing attention to race. She indicated that she would cringe because they perceived they were doing what was in the best interest of all students, but by not teaching to see race within the curriculum, by providing concrete examples of how to make science relevant to all students, these, in fact, were *not* best practices.

During a debrief of the third lesson I observed with Charlotte where the hook involved showing students African American Museum of Civil Rights, she stated: **"**Anytime someone says race doesn't matter or we're in a colorblind society, all of that, I think it just negates a whole experience of people." As a young African American teacher whose life experiences have taught her about what it means to a Black woman in a society that does not always value her, Charlotte was well read on the experiences of people of color in this country. Charlotte used the notion of colorblindness to discuss the way science is presented to students of color. She said that students

cannot see the value of science and become disinterested in science when they do not see themselves presented in the curriculum. In informal talks, she communicated that one of her biggest reasons for teaching science was to expose her children of color to their history. “Our story does not begin with slavery. We were doctors, architects, and engineers in Africa”. In her lessons, she made it a daily habit to read about or show a video clip of important African American scientists, including women and men. These included scientists such as Dr. Mae Jemison and Lonnie Johnson, African Americans still living, and those that she knew students from all walks of life, could relate to. She instilled in them and understanding, that they too could be scientists, if they were interested in pursuing science as a career choice.

Exploring Science Stations

Amanda said her love of science grew as she began to teach it, and she hopes to instill the love of science in her students. She described science as exploring the natural world while exploring phenomena, making predictions, and engaging in inquiry. She believed that as an African American elementary science teacher, she wanted to represent excellence in teaching and learning for her students. She wanted to create experiences that would spark interest in students far beyond her classroom and lead to students to think as themselves as scientists. When asked about why science experiences matter, Amanda said:

> I want my girl students know they can be like the women in Hidden Figures. I want them to know that they are smart, capable, and powerful. I want my students to know that African American women and men have made great strides in science and American society and they can too. (Interview #1, March 11, 2020)

In her science lessons, Amanda used stations where students got a chance to rotate to every station throughout the week. She used stations so that students could demonstrate their

competency in science in multiple ways. Students read about influential scientists of color in her "Read It" section and afterwards wrote about connections about themselves they drew from the text in the "Write It" station. In the "Explore It" station, students engaged in experiments of four students where they used science materials to clean up an "oil spill". The goal of the group was to capture as much oil as they could from the body of water. Throughout the stations, Amanda acted as a facilitator by responding to students' questions when they read and used science time to listen to student ideas as well as provide scaffolding. She encouraged her students to talk to each other while negotiating their science ideas, especially in the "Explore It" center. Throughout all the stations, she was focused not only on her students' content learning, but also on the multiple ways they demonstrated that learning.

More than Just a Farmer

Jasmine made it point to go beyond what was presented in the curriculum. In a BrainPOP interactive lesson, George Washington Carver, a scientist who found over three hundred uses of the peanut, was depicted as a farmer. While the work of farmer is beneficial, society's conceptions of the important work farmers do was trivialized. This was the time when Jasmine was able to pause the lesson and talk about the importance of recognizing the brilliance in his work. Recognizing him as a scientist, inventor, and farmer, this instance became a teachable moment where Jasmine was able to have conversations about the practices scientists engage in and how it is often one filled with many challenges until the scientist gets it *right*. She did this in a way to highlight the important work farmers do, but at the same time, dig deeper into the importance of recognizing people of color as influential and knowledgeable at a time in society at a time when it was not so easy, even dangerous at times to be a thriving person of color.

Summary

Teachers in this study understood the importance of representation in the science curriculum and provided many experiences for students to see themselves reflected. Salem was adamant about teaching science daily because she knew it was important for students to have access and exposure to science and STEM if they were going to have a fighting chance of being interested and prepared to take science courses later in their educational trajectories. By inviting STEM professionals of color to the classroom, she helped her students to see that they too, belonged in the field of science and could pursue science and STEM careers. Charlotte's intentional use of children's literature and science trade books that reflected people of color and minorities in STEM provided students to engage in conversations and dialogue about science topics that were of interest to students. Jasmine's discussions with her students that delved deeper into the contributions and extraordinary accomplishments of African American scientist represented Jasmine's ability to help students make sense of what they could possibly achieve.

Cross Case Analysis

A cross-case analysis looks for similarities and differences between multiple cases (Merriam 1998). Cross-case analysis requires rigorous comparison and interpretation, which strengthens the preciseness and stability of the research (Merriam, 1998). For this study, two research sites across two large school districts were used to examine the racialized lived experiences of five exemplary African American teachers and how these experiences informed their instructional and pedagogical practices as science teachers. The cross-case analysis suggested that four themes were consistent across the five teachers that participated in the study. Yin (2009), suggests a cross-case analysis among cases can be developed utilizing tables to

display data from individual cases rendering a uniform framework. Table 9. Shows the similarities and the differences across the cases.

Table 9

Cross-Case Analysis among Teachers

Participant	**Lived experiences of race and racism**	**Instructional and pedagogical strategies**	**Implementation**
Jasmine	-Being labeled as defiant -Having mostly White Teachers -Caring White teacher who changed trajectory -Strong Mentor teacher of color	-Explicit vocabulary -Fieldtrips -Nontraditional projects -Application of youth culture -Critical Thinking skills -Use of real-world examples -Adaptation of STEM curriculum	-Doing dances and social media to teach students science vocabulary -Fieldtrip to the zoo -Substituting lesser known materials for common household items -Having students dress as their favorite scientist and act out their contributions to society for audience
Salem	-House broken to in Black community -Attended mostly diverse schools -Colorblind teachers -Not remembering any teachers of color who taught science	-Explicit vocabulary instruction -Fieldtrips -Hands on, inquiry-based projects -Student talk -Student leaders	-Taking a walk to the Georgia Aquarium as a fieldtrip - Inviting a female engineer from a local college to come speak to the classroom - Providing “wait” time for students to articulate explanations - Planting plants in various types of soil -Having students report findings
Charlotte	Black community that “protected” and	Explicit vocabulary	-Fieldtrip to Legoland

	believed in her -PWI undergraduate and graduate studies -Feelings of isolation and loneliness in science classes	-Use of inquiry activities Real Life examples (e.g., African American Museum of Natural History) -Real life scenarios involving the use -Fieldtrips Promoted higher order thinking skills -guest speakers	-Responsiveness to students' needs, particularly those with special accommodations - STEM challenges (building the tallest structure, building a strong enough structure to withstand strong winds using Legos)
Kaye	-Strong connection to science and sense of Back pride -Made to feel "less" than competent to teach when relocating from another state -Cannot see herself other than Eagle Elementary serving "her" kids.	-Explicit Vocabulary -Able to bring science lessons back to topic -Allocates time to talk about non-related science issues -Smooth transition from in-person to online teaching (Zoom lessons)	-Recognition of diverse learning perspectives (e.g., What do living things need to survive?) -Real life examples that included experiences from her childhood (Planting fruits with her grandfather) - Asking children to find materials in their house that they can push, pull, or both. Having them report to their classmates
Amanda	-Does not remember the curriculum including her -Struggled to pass science methods -Understands property as whiteness (e.g., refurbished science materials for students on the South side of the district	-Explicit vocabulary -Stations to promote integration -Use of anchor charts -Promotes higher order thinking skills -Uses probing questions to scaffold children's scientific thinking	-High expectations for all students through constant communication -Read About It, Explore it, Write About it, Draw About It Stations -Has children use Claims-Evidence-Reasoning in the Write About it Center

Summary

The themes that emerged serve as counter-narratives and revealed that African American teachers were aware of their critical role in helping students shape positive messages and images of science and themselves as learners of science. Their attention to the societal messages sent to students of color about their aptitudes and abilities around science and STEM subjects were highlighted in the ways in which they discussed issues of race to include whiteness, colorblindness, and bias within science education. In addition, they were reflective of the types of learners and teachers they once were and now are, as well as what they hoped for their students as they matriculate through elementary, middle, and high school. Answers to the research questions materialized from the themes that emerged from the teachers' counter-stories.

CHAPTER 5: DISCUSSION

This research investigated the racialized lived experiences of exemplary African American elementary science teachers and how they navigate those lived experiences to effectively teach science to African American students in the formal science classroom. The primary goal was to understand the teacher's realities through their rich stories, descriptions, and teaching practices. This chapter contains discussion and future research possibilities to help answer the research questions:

1.What are exemplary African American elementary teachers' lived experiences regarding issues of race and racism?

2. How do these teachers navigate their racialized lived experiences to effectively teach science to African American students in the formal classroom?

I began this research with deep concerns about my own experiences as a former elementary science teacher of African American students and an emerging science educator of pre-service teachers who will work in schools serving children of color, particularly students of African American descent. I knew that my research work would enable me to help tell a different narrative of both teachers and students of color, particularly in urban intensive contexts. Through my research, I have gained a passion for uncovering stories of successful African American early childhood and elementary in-service teachers who desire to create equitable science learning experiences for their predominately African American students. A major goal of this study was to share their narratives as it pertains to a subject such as science, which is often viewed as Eurocentric, Western, male, and objective from the reality of Black women teachers.

Another major goal of this research was that teachers will be able use its findings as helpful in executing their own strategies that recognize the role of race for the students they

teach. The findings suggest honoring a mode of learning based on verve by incorporating hands-on, inquiry-based experiences and reducing activities that focused on traditional teaching practices that included note taking and seat work (Boykin, 1994). While this finding was not unusual, the pedagogy of these five teachers went further in revealing that science instruction for students of color, particularly African American students continuously involves movement, talking, partnerships, discourse, music—consistently (i.e., before, during, and after the learning of scientific concepts and ideas). The findings also examine the skills students of color, particularly African American students, need in order to be successful in school. Along with the research questions, this chapter includes a discussion of major findings as related to the four themes that emerged from the data. The chapter concludes with a discussion of the recommendations for future research, limitations of the study, and final thoughts.

Interpretation of findings by Theme

Theme 1. Teachers leveraged positive and negative early childhood experiences to inform their classroom practices and philosophical approach to teaching science to elementary school students. Findings from this theme suggest that early informal experiences are potentially more influential than teachers' formal classroom experiences in shaping teachers' approaches and classroom practices regarding teaching and learning science (Smith, 2005). Consistent with literature on the structure of elementary school settings (Baniflower et. al, 2013), all of the teachers in this study experienced traditional, textbook-driven science instruction throughout their K-12 life-in-schools, more so in middle and high school, because teachers took more time in these settings to teach science. However, it was those early out-of-school experiences that strongly shaped teachers' approaches and classroom practices. For teachers who did not have positive early experiences with science, it fueled them to want to create meaningful

early experiences with science inside their classrooms. They were determined not to let barriers nor policies that oppress teachers within the elementary science context stop them from teaching science (Berg & Mensah; Rodriquez, 2010).

Research indicates that students do not naturally develop the understandings of science (Kuhn & Franklin, 2006; Roth, 2002). Therefore, instructional experiences are critical to building what students bring to the science classroom and supporting them in their scientific growth (Roth, 2014) Through both positive and negative early experiences with science, these teachers were able to take to reflect on these past experiences to create opportunities within their classrooms by implementing high-leverage teaching practices. Ball (2009) describes high leverage teaching practice as "…those that, when done well, give teachers a lot of capability in their work" (p. 461). Most often, teachers engaged in reformed-based science practices, setting up their classrooms to produce student voice and autonomy and creating experiences inside the classroom that mimic their communication styles outside of school (Emdin, 2008). Student talk was expected, encouraged, and facilitated.

Addressing race-visible pedagogies, the findings of this study revealed teachers were aware of the racialized experiences of themselves as Black teachers and their students. They made every effort to address such experiences in the decision of content to teach, best ways to provide instruction, and their desire to form supportive, nurturing teacher /student relationships all designed with thoughtful and careful attention to the experience of Blackness (Prime, 2019).

Teachers did not have much need for textbooks in their classrooms for lessons, which did not accurately reflect the types of experiences their students had. Their classrooms were filled with anchor charts, living things, pictures of scientists (both women and men from diverse backgrounds), and pictures from science activities and fieldtrips. Teachers sought out and used

science materials that required hands-on and inquiry-based learning for students. Many of the science lessons were "messy" in nature and involved students knowing how to handle materials, which can go against notions and traditional ideas of how science should be conducted. Research shows that teachers have a hard time with reform-based practices that are less teacher directed (Harris & Rooks, 2010). Teachers in this study were not afraid to give up "control" as students engaged in the engineering and scientific practices during science lessons. For the most part, they balanced instruction with classroom management techniques that worked with their diverse group of students. Lessons were not focused on behavior management, as these teachers had excellent classroom management. This was accomplished by exhibiting what Delpit (1995) calls personal power, which includes giving students direct and explicit instructions and communicating with students in ways that resembled their students' own cultural patterns such as speech patterns, communication styles, and participation structures (Nieto & Bode, 2007). High expectations were communicated to students and helped to empower students, emancipate themselves, and to move beyond their current situations.

Theme 2. Teachers defied odds/expectations and refused to perpetuate stereotypes and generalizations by becoming agentic in creating new narratives for themselves and their students. The findings of this study help to position elementary in-service science teachers as professionals who were aware of various social markers that influence their science identities including the ways in which they advocated for themselves and their students. This work reflects and extends the work Mensah (2008) has done on positional identity with pre-service elementary science teachers and secondary science teachers who use this knowledge to influence "what we teach, how we teach, and how we continue to prepare ourselves as teachers and educators" (p. 686). By concentrating on developing students' self-worth and identity, teachers were able to

leverage these constructs to promote their fulfillment of curriculum objectives (Wallace & Brand, 2012).

Educational research often perpetuates problematic narratives, such as African American students do not care about school or have substantial gaps in their knowledge, which influences teachers to focus on "basic skills" in lieu of offering content-rich instruction, such as science (Spillane, et.al, 2010). Teachers in this study articulated they were well aware of the societal messages of inferiority that had been assigned to them as children and young adults. They even communicated their understandings of how their students are criminalized based on race by society at such young ages (Wright & Counsell, 2018). They also understood that the permanence of race and racism still exist today as they try to shield their students from these messages. Teachers engaged the teaching of science in a way that strengthened their understandings of the experiences of their students (Kane, 2015). These teachers also understood the purpose of science was not only to teach scientific concepts and practices, but to offer students outlets to see themselves as thinkers and doers of science. Moreover, these teachers understood their significant role in supporting not only their students' content knowledge, but also their students' constructions of science identity. For some of the teachers, they were trying to find their own science identities as well. As Carlone and Johnson (2007) state, "A strong science identity entails competence, having knowledge and understand of science content, and recognition, perceiving oneself, and being perceived by others, as a 'science person'" (p.1196). Having teachers be vulnerable enough to admit that they have had struggles with their science identity, but managed to teach science that best resonated with their students was a major finding of this study because it shows that no matter how effective a teacher is perceived to be, teaching is a journey and not a destination (Maulucci, 2010). Teachers had to confront the experiences

that have shaped them into the teachers they are today. Ultimately, teachers of this study all believed that there is promise in their students and their abilities. As such, the narrative concerning these students can and must be altered to represent this hope. The myth of Black inferiority includes all African Americans despite their life circumstances (Wallace & Brand, 2012). As illustrated by the discussions, conversational side chats, and pedagogies used that acknowledged the strengths in their students, findings suggest that many students depended on these teachers moving them beyond the limits imposed by these hegemonies.

Theme 3. Teachers positioned themselves as extensions of students' immediate families and built intentional and meaningful relationships for authentic science classroom instruction.

Unlike studies demonstrating that discipline is the main focus of classroom instruction in classrooms, particularly science classrooms (Jeanpierre, 2004; King et al.,2001), the findings of this study indicate that when teachers build meaningful relationships with students and connect to the science learning to the experiences of their students, teachers have less issues with discipline. The teachers in this study described relationships as integral to their students' success, which included their own relationships with their family and teachers as children and young adults. Nieto (2003) asserts that, "Teaching involves trust and respect as well as close special relationships between students and teachers" (p. 37). The narratives shared by these teachers and the science teaching practices in this study also demonstrate the importance of building strong relationships with students, particularly students in urban intensive school settings (Milner, 2012). Teachers in this study recognized their roles as advocates for their students, setting high expectations for their students as well as demonstrating a commitment to social justice. These teachers also reaffirmed what many scholars have shared about being African American teachers (Foster, 1993; Howard, 2003; Milner, 2012.) Because these teachers lived and experienced being

Black, they were able to talk about building strong relationships with their students. Moreover, because many of the teachers had positive experiences with science, although informal, they were better situated to fuse those experiences into the formal classroom. They also have students who want to take a more active role in learning the science content.

Their relationships grew to incorporate the understanding and needs of both students and parents. Although Charlotte was the only teacher to mention culturally relevant teaching, all teachers exhibited the characteristics of culturally relevant teachers. They demonstrated "connectedness" (Foster, 1991) with students and extended relationships inside and outside the classroom. Recognizing that parents are children's first teachers, the teachers in this study collaborated with parents to foster greater science learning (Trotman, 2001). This included going to sporting events outside of school, which could then be brought back into the school (e.g., forces and motion). They also demonstrated an ethic of care (Foster, 1993; Noddings, 2006) for their students as they demonstrated concern for their present and future wellbeing.

All five teachers felt personal responsibility for their students. Having been nominated by parents and school administrators spoke volumes. Teachers in this study found ways to make the classroom inviting by establishing relationships with parents and acting as "other mothers" (Case, 1997; Collins, 1991; Milner, 2012) to their students. In the role of "other mother", teachers offered a level of care and compassion that often require them to provide levels of support, empathy, and expectation that was sourced from the racial realities of their students. This is often a reality for most African American teachers. Milner (2012) noted that the history of the Black teacher and their role and responsibility in the classroom was:

> far reaching beyond the hallways of their schools and the teachers had a mission to teach their students because they realized the possible consequences in store for their students if they did not teach them and if the students did not learn. (p. 30)

The findings of this study are significant in that the teachers articulated the needs of their students as having teachers who understood their realities, created memorable and responsive science learning experiences, believed in them, and demonstrated trustworthiness (Wallace & Brand, 2012). Moreover, theses teachers demonstrated care and mutual respect for their students, which is crucial in any environment, but especially in urban classrooms (Milner, 2006).

Theme 4. Teachers prioritized representation in the curriculum and early exposure to science and STEM careers by embracing the unique contributions of African American scientists and nurturing students' capabilities to do science. Teachers in this study understood the importance of identities-in-practice (Calabrese-Barton, Tan & O'Niel, 2014), which are fundamental tools for supporting students' engagement in science education. Students need to see themselves in science before being persuaded to engage in science (Brickhouse, Lowery, & Schultz, 2000). This was shown in how teachers incorporated science classroom literature for students to see themselves represented in what Bishop (1990) calls "mirror books". Additionally, experiences such as African American scientist who were guest speakers for the classrooms helped students to make the connection that African Americans can be successful at subjects such as science and help them form important connections between doing science and recognizing who they are and what they wish to become. Research shows that students, particularly girls, are told they can be scientists, but the examples in real life may not always be present (Hammrich, 1997). Further, this finding supports the claim that before students can be motivated with science, they have to develop identities that are congruent with science.

The findings of this study also support that early exposure to STEM initiatives and activities positively impacts elementary students' perceptions and dispositions (Bagiati, Yoon, Evangelou, & Ngambeki, 2010; Bybee, & Fuchs, 2006). Teachers in this study believed in children's cognitive abilities to engage in science and STEM through interacting with STEM professionals and attending school fieldtrips. This finding supports that the notion that not only do STEM lessons and activities excite young learners, but they also build their confidence and self-efficacy in relation to their own abilities to be successful in more advanced math and science subjects in later school years (DeJarnette, 2012).

Lastly, Maltese and Tai (2010) found that national science reform initiatives often center on improving student achievement or increasing enrollment in advanced science courses in high school rather than on engaging young children in science. Consequently, a study such as this is significant and timely because it justifies the need to reframe the larger conversation about cultural dispositions, positionality, and identity, and planning early for careers in science. This study also provides practical strategies along with descriptive and illustrative examples of how teachers used their own racialized lived experiences to break down racial stereotypes to form meaningful relationships with students and help them to fully engage with science.

Discussion of Research Findings in Relation to CRT and Critical Race Methodology

Critical race theory served as the theoretical framework and critical race methodology served as the analytic tool to honor the voices and experiences of African American teachers through their counter narratives. This study challenged deficit models that are often present in the dominant discourse and research on science experiences and trajectories for African American students. Moreover, this study used teachers' positionality to situate science learning that best met the needs of their students. I employ the five tenets of CRT to discuss findings.

Tenet One: Permanence of Race. CRT views racism as an inherent and permanent fixture in society (Ladson-Billings & Tate, 1995). Although teachers did not specifically mention racism, they did allude to differential treatment based on stereotypes that were imposed on them as children and adolescents. They also saw these same labels and deficit approaches to thinking applied to the students they taught.

Tenet Two: Centrality to Experiential Knowledge. The counter narratives teachers provided challenged deficit models that are often present in the dominant discourse and research on science experiences and trajectories for African American students (Solorzano & Yosso, 2001). This study contributed as a means for educators looking to broaden their own consciousness regarding teaching science in authentic and culturally relevant ways to students learning in urban intensive contexts. It also confirmed the theory in this study that race matters. Through their stories and as equally important their actions within the classroom, they understood the enduring nature of racism in America and used their positionality and identity to situate science learning that best matched the needs of their students. As Miller and colleagues (2000) acknowledge, when collecting research on counter-narratives, "we should employ a comprehensive framework to focus on whether or not counter-narratives move beyond the sharing stage and into transformative action" (p. 284).

Tenet Three: Commitment to social justice. A goal of critical race scholarship is to understand racism in all forms so that what is learned is used for social justice, empowerment, and positive social change. The findings provided a strong way to give voice and agency to teachers to help students who are traditionally underrepresented in, or marginalized by, Western science (Aikenhead 1996). This was done by documenting the CRP practices that recognized students' distinctive assets. This study also illuminated successful practices of teachers thus providing

practical means to help eradicate some of the practices in science classrooms that perpetuate the status quo within science education (Parsons, Rhodes & Brown, 2011). Teachers in this study advocated for their students and taught in ways that recognized the historical past of injustice based on race and deficit approaches to teaching and learning.

Tenet Four: Challenge to Dominant Ideology. The information gained from teachers in the findings of this study contributed to a knowledge base of those often pushed to the margins in education (Milner, 2012). Each teachers' discussion of race as it related to their early life experiences and pedagogical decisions made in their science classrooms functioned to "create research and teaching strategies that acknowledge racial minority teachers as insiders... and as valuable assets in the fight for educational justice" (Kohli, 2009, p. 250). African American teachers' counter narratives empowered and gave agency to their often-marginalized communities. By choosing their *own* words and telling their *own* stories, each African American teacher provided alternative points of view, helping to create complex narratives that represented their realities (Ladson-Billings & Tate, 1995).

Tenet Five: Use of inter-disciplinary perspective. This study addressed the call by Parsons and colleagues (2011) to address the limited use of CRT as an analytical tool in science education. This study CRT sought to advance educational equity and promote empowerment by using CRT in an elementary context. As demonstrated by the findings of this study, the science education community needs continued research on teachers uses of pedagogies such as CRP, systematically viewed through the lens of CRT. Only if this type of research is in place will we challenge the status quo of the social order.

Counter-spaces

According to Solórzano, Ceja, and Yosso's (2000) counter-spaces are defined as “sites where deficit notions of people of color can be challenged and where a positive climate can be established and maintained” (p. 70). For this study, these teacher’s classrooms became counter-spaces not only physically, but also conceptually and ideologically. This study highlighted the importance of creating counter-spaces where teachers could freely discuss race and demonstrated how their counter-narratives were manifested in daily science lessons and classrooms with their predominately African American students. At times, these teachers spoke with conviction—at other times with apprehension. Despite sharing the same gender and race, their diverse lived experiences speak to their desire to advocate for their students and create new possibilities for themselves and their students. Recognized as exemplary teachers by the parents, science coaches, and school administration, these African American teachers were charged with upholding high expectations for their students, while understanding the reality of those expectations within the context of a country and education system that is ripe with systematic racism and discrimination.

Implications for Practice

Several implications can be drawn from the results of this study. The following section contains a discussion of those implications for two stakeholder groups. These groups are colleges of education/teacher preparation programs and in-service elementary science teacher professional development.

Colleges of Education/Teacher Preparation Programs

As new teachers enter the profession, it is hard to ignore the impact that race has on how they instruct their students in the areas of science and STEM. It is important based on this study, that the knowledge possessed by African American teachers be viewed as an asset that allows

other minority teachers the opportunity to speak about their experiences. This work can begin a needed a conversation that Ladson-Billings (2000) argued does not always occur with preservice teachers, who go on to become in-service teachers. She maintained that these teachers need support in [recognizing] the ways that race and racism structure the everyday experiences of all Americans. More specifically, "teachers must understand how race and racism negatively impact African American students and their ability to successfully negotiate schools and classrooms (Ladson-Billings, p. 211).

Related to teacher preparation, Mensah (2019) notes, "Preservice teachers need opportunities to talk specifically about race" (p.1443). Teacher educators may feel comfortable talking about less sensitive topics such as culturally relevant and responsive pedagogies, but for the needs of African Americans to be met, teacher educators cannot continue to operate in what is termed "strategic colorblindness" (Apfelbaum & Sommers, 2008, p.18). Teacher educators must also move teachers past feelings of uncomfortableness to raise consciousness regarding the assumptions and biases that they bring to the classroom and be able to interrogate these feelings in order to change. This includes a reexamination of course materials for issues of racism and oppression and that seek to maintain the status quo of teaching practices.

Conversations that address pre-service teachers' positional identities (Mensah 2012) are also needed in teacher preparation programs as there is a tendency to overlook emotional concerns of teaching in favor of more technical aspects of teaching (e.g., lesson planning). Teacher educators can allow pre-service teachers to re-tell their unique personal histories and narratives to help teachers identify their goals and aspirations for teaching science and provide experiences that support the growth of teachers (Rivera Maulucci, 2012). If students do not have such stories to tell, they should be provided with readings that allow them to unpack and critique

their schooling experiences (Mensah, 2019). Engaging in this type of positional identity work, pre-service teachers can learn to define purpose for teaching while also being critical of how their relative positioning offers both advantages and disadvantages as social justice teachers.

In-service teacher professional development

In sharing their lived experiences of race and how that informs their science instructional practices, the teachers spoke from a place of racial experience and connection to their African American students. With the demands of teaching, particularly in urban contexts, teachers rarely have the chance to share their experiences in spaces that honor and elevate their voices. It is important based on this study, that the knowledge possessed by Black teachers be viewed as an asset that allows other minority teachers the opportunity to speak about their experiences. When stories are shared about teachers' willingness to cultivate spaces that uplift students, beliefs about entering a classroom with young science learners of color is better informed and provides a space for teachers to utilize equitable practices for these students.

Additionally, science teachers must formally and explicitly be taught what science looks like in a variety of contexts. This can be done through professional development that aims to not only increase teachers' content knowledge, but to acknowledge and extend previous frameworks and models that are transformative, liberatory, and culturally relevant, and raced based (Barton, 1997; Boutte, Kelly-Jackson, & Johnson, 2010; Johnson & Fargo, 2010; Prime, 2019). Science teachers must also be given multiple opportunities to explore and confront their biases well into their teaching careers. The question to be asked is, what supports do in-service elementary science teachers have to further challenge their assumptions and beliefs about students who are more culturally and diverse than ever? Further, they must be open to adjusting their instructional

"tool- box" to incorporate a plethora of instructional strategies that have proven effective in reaching underrepresented and underserved students in science ((Parsons & Carlone, 2013).

Limitations

This study has limitations, which is true of all research, but measures were put in place to minimize them. Case studies have an inherent limitation, in that they cannot be generalized to a broader context, so the findings apply to only the women in this study and cannot be generalized to other Black elementary science teachers. However, by including multiple cases within two research sites and spanning multiple grade levels, teachers' experiences bridged early childhood and elementary science education.

The sampling technique could be a potential limitation of this study. Although the research participants were relatively new to the first research site where I conducted my research and I did not know them prior to conducting the research, it is important to note that I was affiliated with the school. A larger study including more teachers from a school where I did not have an affiliation might help provide additional information about the impact of race as it relates to how teachers use their racialized life experiences to effectively teach science to African American students. Additionally, the nature of my sample presents some limitations. For this study, teachers represented a wide range of years of teaching from four years to twenty-five years. Although teachers in this study were identified exemplary from teaching awards won and parent nominations, some teachers were undoubtedly new to teaching. In terms of representation, teachers spanned across the early childhood and elementary spectrum (K-3) but did not include a full picture of the elementary spectrum in that it did not explore upper elementary grade teachers, which include includes standardized testing.

The impact of COVID-19 was also another limitation. My study was interrupted by this global pandemic which prevented the total number of equal observations for my data collection. Access to the school site and face-to-face interaction with teachers was cancelled for the remaining of the school year and consequently for the remaining data collection period, which was to extend an additional month. Virtual learning occurred in classrooms, however conducting the rest of the observations through Zoom would have required changes to the Institutional Review Board (IRB).

Lastly, my subjectivity may be seen as a limitation but also a strength. Being an African American elementary science teacher of both early childhood and elementary education affected the way in which I communicated and related to my participants. I realize that research is not neutral. However, by employing "theoretical sensitivity" (Corbin & Strauss, 1990), I was able to separate relevant information from the irrelevant parts. I was also able to balance my role as both an observer, researcher, and over the course of this study. The research participants were able to trust me and give me their honest thoughts, feelings, and stories during interviews as well as allow me into their counter-spaces to observe and participate.

Recommendations for future research

Several areas for future research emerged as part of this research that offer productive direction for research. They include: (a) engaging in new and complementary methodologies and approaches for conducting research that include a greater sampling of teachers of color, (b) research that moves beyond testing outcomes to include a more expansive set of learning outcomes and (c) science teaching and learning by virtual learning.

Greater sampling of teachers using critical race methodology

As a tenet of CRT, experiential knowledge urges for a placement and consideration of the experiences and understandings that People of Color, specifically African Americans, encounter in their everyday lives. I believe that further examination of racialized and positional identities using critical race methodology from a larger number of African American teachers across several school districts and in different context (e.g., rural, suburban) would be beneficial. Greater sampling would help unearth the stories of teachers who understand the impact of race as it relates to their students and consciously use this knowledge to make sound pedagogical and instructional practices within science education. When we fail to recognize and examine the part that race plays in the issue of elementary science education in urban contexts, we run the risk of reinforcing the miseducation of teachers, schools, and policymakers.

More expansive set of learning outcomes

Students display higher levels of science content understanding and application, positive science identity development, and increased levels of engagement when teachers are able to assist students in leveraging their understanding of place, meaning where they believe they fit in within the science community (Calabrese -Barton, Tan & O'Niel, 2014). Future research related to assessment in formal learning environments that focuses on more expansive learning outcomes that paint a more complete picture of what is being accomplished in science classrooms is warranted. Standardized testing will continue to permeate the educational system. Teachers must be willing to look beyond teaching, learning, and assessment that focuses strictly on science content. If teachers are to increase the number of students participating in science and STEM careers, they must not only help them build a strong science content knowledge base but must support students in developing a sense of self in science and STEM.

Virtual Leaning

The effects of COVID-19 will affect the scope of this research and the teaching of elementary science moving forward and well into the future. Although the majority of teachers in this study worked at schools that already incorporated virtual learning days, the perception of this type of learning is seen as inferior in favor of the face-to-face model of teaching and learning. However, increased virtual learning days may become the new normal. Bonk and Graham (2006) noted that "Online learning is different from traditional in-classroom learning. The teaching quality does not depend upon the teaching tools and models, but on the intention to achieve the study objectives of students" (p. 25). This study used live classroom observations as means of to collect pertinent data to answer the research questions. Future studies may examine the challenges elementary science teachers face as they prepare to implement high-quality, asset, and race-based science to their students within urban contexts. Additionally, investigating issues that relate to the allocation of physical resources for students such as computers and high-speed internet access may be examined as teachers are faced with taking on the challenge of implementing inquiry-based lessons for students or planning activities such as virtual fieldtrips (Cassady, Kozlowski, & Kornmann, 2008).

Final Thoughts

We need more research on Black Teachers and Teachers of Color and the amazing work they do. Let's share more of their narratives and the impact on their practices in PK-12 and high education classrooms- (Felicia Moore Mensah, 1/19/2020, twitter post)

Mensah's post speaks to the reason research studies similar to this one are needed. Before taking part in this study, I do not believe that Jasmine, Salem, Charlotte, Kaye and Amanda were challenged or granted an opportunity to consider their beliefs about race or think about how race

influences their science teaching practices with their predominately African American students. This was evident in Salem's comments regarding her role in previous research where she indicated she sat passively and was not encouraged to ask questions or give feedback in the way in which the research was collected nor presented. The purpose of this research was to elevate the voices of teachers who are not only passionate about the students they teach, but also knowledgeable about the content they teach. This research was designed to tell a different narrative: One grounded in appreciating honest, caring, cultural competence, racially conscious, and reflective teachers. Although Salem was the only teacher who explicitly told me that she was excited to participate in research that recognized and valued her perspectives, all teachers expressed an appreciation for the research giving them a platform to highlight the important and often challenging work they engage in daily. Each participant in this study shared their stories by opening up about their frustrations and victories. During the final interview, I asked each teacher to reflect on the journey of sharing her experiences with me. I thanked them for inviting me to their classrooms and engaging their thoughts and actions so that their voices could be elevated and awakened. I also thanked them for believing in my research enough to continue the research amid a global pandemic. As such, I would like to share some closing thoughts that the teachers shared with me. These thoughts were situated on a foundation of hope for their students.

Charlotte: I am very much aware of my own biases that I bring to the classroom even though I teach children who are majority Black. It's easy to give up on kids who may have a unique set of circumstances. All the things I learned in my master's degree program were really interesting to learn. But I would like to see those same professors who teach about culturally relevant pedagogy actually come back into the classroom. Things are much more different than they used to be 15-20 years ago. We are in a different political climate. Three first grade teachers

quit last year. They ask me all the time if I'm leaving. I assure them that I am not leaving. I want to stay; I want to be here.

Salem: We always talk about the growth of our students, but in many ways, I have grown as a teacher over the last two decades. I thought that teaching the content was the most important thing I could do to help my students learn science. I quickly realized that was not the case. Students want a teacher that they can relate to and values them. They want a teacher who genuinely cares about their well-being. Without those things, the science that I teach is irrelevant to them. Being here for the past four years has really shifted my beliefs about what an inner-city school is. My kids are smart, loving, funny, and most of all just want to know that they are supported.

Jasmine: Students have to know that you care. Once they know that, they will do anything for you. This is the only school I have taught at. At this age, they are so impressionable and the listen to and take in everything. I am setting the foundation for their experiences with science. I do not take that lightly. I also feel that I cannot create all the experiences, including science, all by myself. Seeking out additional ways to incorporate science learning into the curriculum is important to me. I am glad to have landed at school that encourages us to incorporate science and STEM subjects into our curriculum. It makes it easier to do science, and for kids to see how it relates to their life.

Amanda: Teaching in an urban school is not easy. Every year is a different year. When I say every year is a different year, your approach one year may not be the same approach the next year; depending on your students and the level they are. So, I always find myself, as a teacher still doing research, still trying to find other ways. I have been here over 15 years, and it shifted my way of thinking as a teacher. I want to give my students the best of me, including helping

them to see that science is all around them. I cannot lie. I do get tired sometimes. It feels like starting over every year my students. With all the demands that are placed upon teachers, especially for us where it feels like we are constantly testing our kids gets overwhelming. What keeps me going is knowing that I am making a difference in my kids' lives. Some kids have come back to tell me that they are graduating from high school and majoring in Biology or attending an HBCU on a full scholarship. They want to come back and tell me, "Thank you". I feel proud to know that I was just one of many parts in their success. It's good to see them thriving.

Kaye: Although I have taught many years, I still have a deep passion for educating young children, particularly my black and brown babies. I'm a mother before anything. I am firm but loving. I was trained as an educator on the philosophy of Dr. Mary McCleod Bethune, "Enter to Learn: Depart to Serve" and I truly believe that Greatness is not what you have, but what you give. Teaching is a passion that run deep in my family history and over ten of my immediate family members are educators at various levels. I favor early education and science because young minds are so impressionable, and it is so rewarding to plant "Seeds of Greatness" and watch their "Beautiful Blossoms". I have touched over 1,000 little lives and it is so rewarding to see my former students climbing the ladder of success, which include careers in science and engineering. To know that I played an integral art by giving them a strong foundation assures me that I am fulfilling my purpose on Earth and fills my heart with joy.

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APPENDICES

Appendix A

INSTITUTIONAL REVIEW BOARD

Mail: P.O. Box 3999
Atlanta, Georgia 30302-3999
Phone: 404/413-3500

In Person: 3rd Floor
58 Edgewood
FWA: 00000129

November 26, 2019

Principal Investigator: Gary Bingham

Key Personnel: Bingham, Gary; King, Natalie S; Pickens, Mario

Study Department: Georgia State University, College of Education and Human Development

Study Title: Elementary Science: A Critical Race Perspective of the Beliefs' and Practices of Exemplary African American Teachers.

Submission Type: Exempt Protocol Category 1, 2

IRB Number: H20295

Reference Number: 357485

Approval Date: 11/22/2019

Status Check Due By: 11/21/2022

The above referenced study has been determined by the Institutional Review Board (IRB) to be exempt from federal regulations as defined in 45 CFR 46 and has evaluated for the following:

1. Determination that it falls within one or more of the eight exempt categories allowed by the institution; and
2. Determination that the research meets the organization's ethical standards

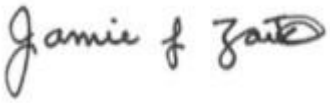
If there is a change to your study, you should notify the IRB through an Amendment Application before the change is implemented. The IRB will determine whether you research protocol

continues to qualify for exemption or if a new submission of an expedited or full board application is required.

A Status Check must be submitted three years from the approval date indicated above. When the study is complete, a Study Closure Form must be submitted to the IRB.

Any unanticipated/adverse events or problems resulting from this investigation must be reported immediately to the University Institutional Review Board. For more information, please visit our website at www.gsu.edu/irb.

Sincerely,



Jamie Zaikov, IRB Member

Appendix B

Demographic Information

1. Name: _____
2. Phone number: _____
3. E-mail address: _____

   (Phone number and/or e-mail address will only be used to contact you for a follow-up interview, should it be necessary.)
4. Gender (check one): Female____ Male_____
5. Please indicate the race you identify with (Check one)? __ Black, ___ White, ___Hispanic, ___ Latina/o, ___ Asian, ___ Islander/Pacific Other _____
6. Age: _____
7. Total years of teaching experience (including this year): _____
8. Total years of science teaching experience: _____
9. Grade level currently teaching: _____
10. Have you always taught in schools with a student population predominately African American? American? Yes____ No_____ (If No, please describe the teaching contexts below and the years of experience you have in each context).

    1._____

    2._____

    3._____
11. Undergraduate and graduate degree and major(s) (please list):

    1._____

    2._____

    3._____

    4._____

Appendix C

Date:
Start Time:
End Time:

One on One Semi Structured Interviews Protocol (Creswell, 2013)

Life History (RQ1/Tenet 1):

1) Tell me about your earliest experiences with science.
2) Regarding being African American, what do you remember most about those experiences.
3) Was there a major life event or experience that sparked your science curiosity? Explain.
4) How would you describe your overall experiences as an African American elementary science teacher?

Elementary Science Teaching Experiences:

- Being African American, what strengths do you feel you bring to the field of science education? (RQ2/RQ3/ Tenet 2/Tenet 4)
- When the statement is made that "race does not matter in today's society" how would you respond considering the current science teaching force? (Tenet 1)
- When you hear the phrase "teachers of color", what words, images, or thoughts come to mind as it relates to science?
- Tell me what strategies have been most helpful and useful regarding teaching science to predominately African American elementary students. (RQ2)
- How do you plan for science instruction for African American students? (RQ2)
- Describe a lesson that you taught that had a profound connection to your African American.
  a) What was the lesson topic?
  b) What specific strategies did you use as the teacher? (RQ2)
  c) What was the response of the students? (RQ3)

Closing:

- What questions do you want to ask me?
- What is the best way to contact you if I have questions?
- What is the best way to give you the case narrative I write so you can review it for accuracy?

RQ1- Research Question 1
RQ2- Research Question 2
RQ3-Research Question 3
Tenet 1- Centrality of Race
Tenet 2- Challenging the Dominant Discourse
Tenet 3- Intersectionality with other forms of subordination
Tenet 4- Commitment to Social Justice

Appendix D

Classroom Observation Protocol-An adaptation from the "Culturally Responsive Instruction Observation Protocol" instrument (CRIOP)

Teacher:_____
Date:_____
Start Time:_____
End Time:_____
Lesson Objective

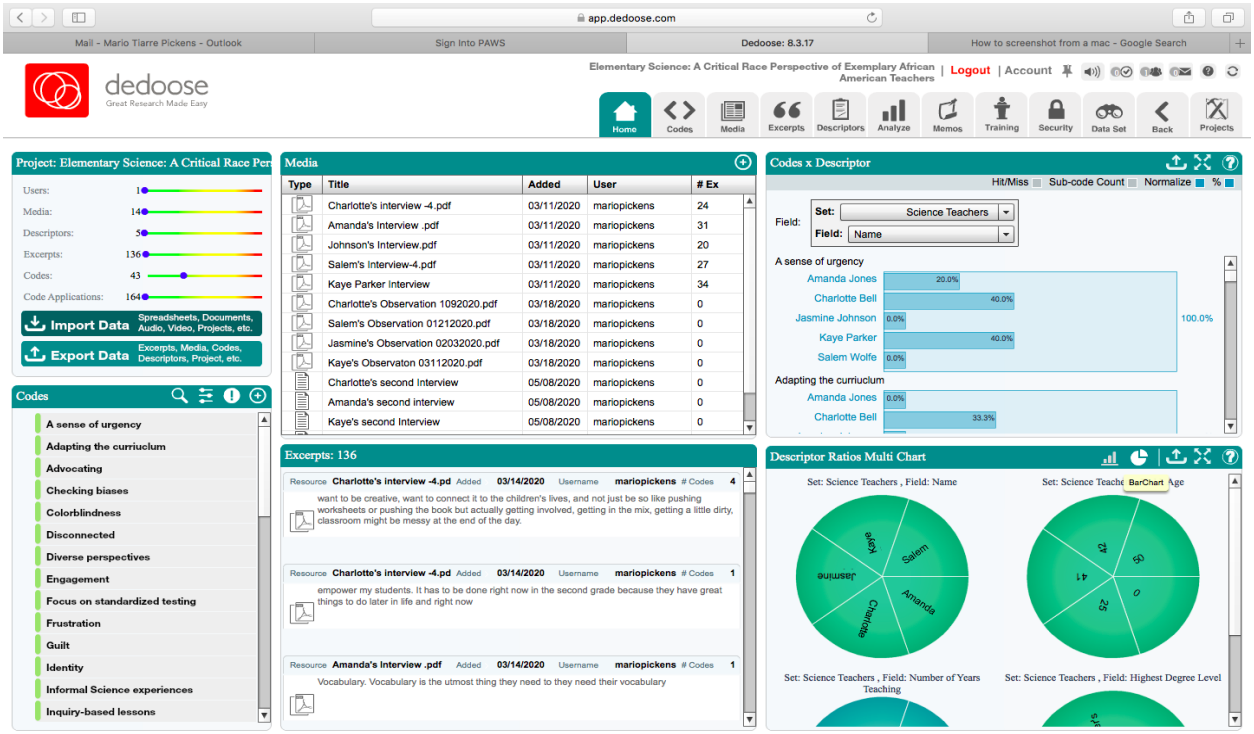
Instructional Practices	Instruction is contextualized in students' lives, experiences, and individual abilities	Students engage in active, hands-on, meaningful learning tasks, including inquiry-based learning	The teacher uses instructional techniques that scaffold student learning	Students have choices based upon their experiences, interests and strengths
Memos	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes

Discourse	The teacher promotes active student engagement through discourse practices	The teacher promotes equitable and culturally sustaining discourse practices	The teacher provides structures that promote academic conversation	The teacher provides opportunities for students to develop linguistic competence
Memos	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes
Assessment	Students are able to demonstrate their learning in a variety of ways	Authentic assessments are used frequently to determine students' competence in both language and content.	Students have opportunities for self-assessment	
Memos	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	

Curriculum	The curriculum and planned learning experiences incorporate opportunities to confront negative stereotypes and biases	The curriculum and planned learning experiences integrate and provide opportunities for the expression of diverse perspectives	The curriculum and planned learning experiences provide opportunities for the inclusion of issues important to the classroom, school and community
Memos	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes	Present/Absent (circle one) Fieldnotes

Appendix E

Development of Codes and Themes Using Dedoose



Appendix F

Observation Schedule

January

6th	7th	8th Charlotte	9th	10th
13th	14th	15th	16th Salem	17th
20th	21st Salem	22nd Charlotte	23rd Charlotte	24th
27th	28th Salem	29th Charlotte	30th	31st Jasmine

February

3rd Jasmine	4th	5th	6th Charlotte	7th
10th Jasmine	11th	12th	13th Charlotte	14th Salem
17th Jasmine	18th Salem	19th	20th	21st Jasmine
24th	25th Salem	26th Charlotte	27th Kaye	28th Jasmine

March

2nd Salem	3rd Kaye	4th Jasmine	5th Charlotte	6th Kaye
9th Amanda	10th Jasmine	11th Kaye	12th Amanda	13th Amanda

Appendix G

Flowchart and timeline of the process for participant selection and data collection and analysis