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A Phenomenological Case Study Concerning Science Teacher Educators' Beliefs and Teaching Practices About Culturally Relevant Pedagogy and Preparing K-12 Science Teachers to Engage African American Students in K-12 Science

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**A PHENOMENOLOGICAL CASE STUDY CONCERNING SCIENCE
TEACHER EDUCATORS' BELIEFS AND TEACHING PRACTICES ABOUT
CULTURALLY RELEVANT PEDAGOGY AND PREPARING K-12 SCIENCE
TEACHERS TO ENGAGE AFRICAN AMERICAN STUDENTS IN K-12
SCIENCE**

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of


DOCTOR OF PHILOSOPHY

EDUCATION

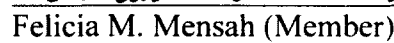
OLD DOMINION UNIVERSITY
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ABSTRACT

A PHENOMENOLOGICAL CASE STUDY CONCERNING SCIENCE TEACHER EDUCATORS' BELIEFS AND TEACHING PRACTICES ABOUT CULTURALLY RELEVANT PEDAGOGY AND PREPARING K-12 SCIENCE TEACHERS TO ENGAGE AFRICAN AMERICAN STUDENTS IN K-12 SCIENCE

Janice Bell Underwood
Old Dominion University, 2015
Director: Dr. Sue C. Kimmel

Due to the rising diversity in today's schools, science teacher educators (STEs) suggest that K-12 teachers must be uniquely prepared to engage these students in science classrooms. Yet, in light of the increasing white-black science achievement gap, it is unclear how STEs prepare preservice teachers to engage diverse students, and African Americans in particular. Therefore, the purpose of this study was to find out how STEs prepare preservice teachers to engage African American students in K-12 science. Thus, using the culturally relevant pedagogy (CRP) framework, this phenomenological case study explored beliefs about culturally relevant science teaching and the influence of reported beliefs and experiences related to race on STEs' teaching practices. In the first phase, STE's in a mid-Atlantic state were invited to participate in an electronic survey. In the second phase, four participants, who were identified as exemplars, were selected from the survey to participate in three semi-structured interviews. The data revealed that STEs were more familiar with culturally responsive pedagogy (CResP) in the context of their post-secondary classrooms as opposed to CRP. Further, most of the participants in

part one and two described modeling conventional ways they prepare their preservice teachers to engage K-12 students, who represent all types of diversity, without singling out any specific race. Lastly, many of the STEs' in this study reported formative experiences related to race and beliefs in various manifestations of racism have impacted their teaching beliefs and practices. The findings of this study suggest STEs do not have a genuine understanding of the differences between CRP and CResP and by in large embrace CResP principles. Secondly, in regards to preparing preservice teachers to engage African American students in science, the participants in this study seemed to articulate the need for ideological change, but were unable to demonstrate pedagogical changes to address the needs of black students in science classrooms (Rodriguez, 1998). Thirdly, the findings suggested the participants' in the study generally reported early experiences related to race helped to shape their beliefs about race and their teaching beliefs and practices. Lastly, implications for science teacher educators, classroom teachers, and educational researchers are provided.

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This dissertation is dedicated to my parents, Michael and Virginia Bell, who sacrificed beyond measure so that my sister and I could attend the best schools and enjoy the benefit of having two parents in our home. Thank you Mom and Dad for all you did to give us the foundation upon which we stand today.

I also dedicate this dissertation to my late grandmother, Doodles (Mary C. Bell), who always told me that I should be “a doctor of something” because I was destined to change the world. Doodles, thank you for praying for me, being my first best friend, and introducing me to our Lord and Savior, Jesus Christ. I will do all that I can to make you proud of me everyday I live on this Earth...

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CHAPTER 1

INTRODUCTION

In President Obama's 2011 State of the Union address, he made reference to the Sputnik crisis of the 1950s, which exposed America's then weaknesses in STEM (Science-Technology-Engineering-Mathematics) fields (Obama, 2011). Moreover, in this address he described a contemporary Sputnik crisis in which yet again, our nation's students are overwhelmingly not excelling in or seeking careers in science. Further, President Obama talked about the urgency and importance of investing in science and math to not only advance our nation as a global leader in innovation, but also to protect our national security, secure our economic stability, and save our world.

"...Half a century ago, when the Soviets beat us into space with the launch of a satellite called Sputnik, we had no idea how we would beat them to the moon. The science wasn't even there yet. NASA didn't exist. But after investing in better research and education, we didn't just surpass the Soviets; we unleashed a wave of innovation that created new industries and millions of new jobs. This is our generation's Sputnik moment... We'll invest in biomedical research, information technology, and especially clean energy technology -- an investment that will strengthen our security, protect our planet, and create countless new jobs for our people... Over the next 10 years, nearly half of all new jobs will require education that goes beyond a high school education. And yet, as many as a quarter of our students aren't even finishing high school. The quality of our math and science education lags behind many other nations. America has fallen to ninth in the proportion of young people with a college degree. And so the question is whether all of us -- as citizens, and as parents -- are willing to do what's necessary to give every child a chance to succeed... Our schools share this responsibility. When a child walks into a classroom, it should be a place of high expectations and high performance. But too many schools don't meet this test... And over the next 10 years, with so many baby boomers retiring from our classrooms, we want to prepare 100,000 new teachers in the fields of science and technology and engineering and math..." (Obama, 2011)

The crisis in science and innovation described by President Obama launched a new national mobilization in education when he urged the nation's students, higher education institutions, and businesses to once again invest in science and innovation (Nixon-Saintil, 2012). However, while President Obama did not address the lack of diversity in STEM fields or the science achievement gap between Caucasian and ethnically diverse students (National Center for Educational Statistics, 2006), Mensah (2010/2013) and others (Mutegi, 2012; Parsons 2008) identify a sort of Sputnik crisis for diverse students and African American students in particular. For example, America's deep-rooted sociopolitical and racial history (Alexander, 2010; Dyson, 2006) has cultivated the field of science and science education into an exemplar of inequity (Furman, Barton, & Muir, 2012; Lee & Buxton, 2010) and forced assimilation, especially for African American students (Mutegi, 2011; Wright, 2011a). Consequently, Mutegi (2011/2013) and Parsons (2008) suggest this crisis is further exasperated because in general science teacher educators and K-12 science teachers are not 1) encouraging diverse students into science careers (Winkleby, Ned, Ahn, Koehler & Kennedy, 2009) 2) working to actively reduce the science achievement gap (Gregory, Skiba, & Noguera, 2010; Parsons, 2008) or 3) creating equitable classrooms where African American (or other diverse students) students see science or the chosen science curriculum as relevant to their everyday lives (Mensah, 2013; Wright, 2011).

Thus, in what follows, the possible reasons why African Americans are marginalized in science and the failure of K-12 teachers to engage African American students in science is discussed. Then, the impact of science teacher education programs to either perpetuate or remediate the problem of African American achievement in

science is explored. Finally, the specific problem, purpose, significance, and theoretical perspectives of the current study are introduced.

It should be noted in this current investigation, dominant culture refers to those in the United States having European or Anglo-Saxon heritage and non-dominant refers to those who hold membership in an ethnic minority, such as African American, Latino, or Native American (Winkleby et al., 2009). And while I acknowledge many types of diversity, for this investigation, I was mainly interested in how science teacher educators equipped preservice science teachers to engage African American students in K-12 science (Mensah, 2013). Of the many reasons of which are later discussed, the main reasons for focusing on African Americans are that African Americans represent the largest minority in the US (US Census Bureau, 2013) and have been historically colonized by the dominant culture (Mutegi, 2011). Further, as a member of this minority group, my personal experiences also played a role in why I focused on African Americans in science. Therefore, a majority of the research cited within this current study represents a specific “black-white” racial dynamic because Mutegi (2011/2013) says the African American student has experienced a unique set of circumstances based on historical antecedents unique to any other ethnic or racial group in America by the hands of white people. However, when necessary, general statements about students of color are made and include all students without membership in the dominant Anglo-Saxon or European American culture. Consequently, to ensure clarity, a detailed description and rationale for terminology and demographic descriptors are outlined in a glossary at the end of chapter one.

Marginalization of African Americans in Science

Wallace and Brand (2012) discuss how scientific measures were used to confirm that African slaves were intellectually inferior to those of European or Anglo-Saxon descent, which caused a black inferiority complex and racial inequity in science. These historical scientific measures were known as “scientific racism” and their goal was to keep black people subordinate (p. 343). For this reason Mutegi (2011, 2013) suggests that traditional scientific inquiry exclusively embraces a Western philosophy of empiricism at the expense of other diverse ways of knowing. Mack et al. (2012) also suggest this Western practice has been privileged throughout history and encapsulates the way people observe the natural world and which scientific discoveries are valued or recognized in history. Consequently, Mutegi (2011) asserts this Western way of knowing is largely marginalizing to African Americans, who historically have had little influence in the world of Western science or its contributions because of pervasive colonization and slavery (Klein, 2010).

In contemporary times, Winkleby et al. (2009) insist the racial antecedents of the past continue to impact science today. Specifically, they suggest, the US is not tapping into the expertise of disenfranchised students, despite the many federally funded science programs aimed at increasing ethnic minority interest in science. For example, Winkleby et al. (2009) report in a 21-year longitudinal study an urgent need to increase diversity in science and health professions due to drastic changes in US demographics, as well as a radical underrepresentation of African Americans, Latinos, and Native Americans. Additionally, legislative and politically motivated actions continue to encroach on the issue of affirmative action, which also negatively impacts African Americans in science

and science related careers (Farley, Gaertner, & Moses, 2013; Washington, 2013). For example, Washington (2013) discusses affirmative action by posing the “race question” about contemporary cases that could potentially undo some of the gains black Americans made with the *Brown v. Board of Education* case. Specifically, Garces (2013) studied the effects of affirmative action bans in California, Florida, Texas, and Washington on students of color within six fields of study, including STEM areas. She concludes,

Affirmative action bans have led to the greatest reductions in science-related fields of engineering, the natural sciences, and the social sciences. These declines pose serious long-term consequences for the United States since these fields provide specialized training critical to the nation’s ability to compete effectively in a global market and for ensuring continued scientific and technological advancement. (Garces, 2013, p. 251)

For example, in 1996, Proposition 209, which now prohibits California public institutions from discriminating on the basis of race, ethnicity, or gender, has eliminated affirmative action efforts in this state. This trend, which is creeping into other states with pending affirmative action litigations, is vastly reducing the numbers of ethnic minority candidates in medical schools and other fields of undergraduate and graduate study (Garces, 2013).

It is important to note, enrollment into medical schools and other science related fields by ethnic minorities increased after the iconic 1964 Civil Rights Act; however, this trend has greatly decreased since 1997 (Winkleby et al., 2009). In fact, African Americans comprise less than 10% of all medical school candidates and Winkleby et al. (2009) suggest many of these ignored and disenfranchised students may potentially have the solutions to our most pressing medical and science related crises.

Marginalizing Trends in Science Education

To address educational inequities in K-16 classrooms, Wright (2011b) discusses how African American students are systematically devalued and dismissed in STEM areas by Caucasian American educational leaders and teachers, who have historically held power in the US (Russell & Atwater, 2005; Walls, 2012). Specifically, he says the science curriculum is marginalizing toward African Americans and the overall educational system is oppressive to all people of color. For example, Wright (2011b) says that contributions made by African Americans are largely absent in the curriculum and what is taught often contradicts values important in African American families. Barton and Yang (2000) and others (Hart, 1997; Maulucci, 2010; Rodriguez, 1998) also say diverse students are grossly marginalized in science classrooms. For example, science achievement disparities (National Center for Educational Statistics, 2006; Parsons, 2008) and the disproportionate numbers of students entering science related careers between students of color and students who hold membership in the dominant culture are alarming (Owens et al., 2012; Rodriguez, 1998; Wright, 2011). Also, the U.S. Department of Education (2014) suggests that schools with high African American and Hispanic populations are less likely to provide access to quality science and math instruction.

As it stands now, greater than 85% of the U. S. teaching force is Caucasian, Anglo, or Euro-American, and the numbers are even higher in teacher education (Banks & McGee Banks, 2010; Cartledge & Kourea, 2008; Richards, 2011). This phenomenon is the reason why the cultural, ethnic, racial, and linguistic disparity between the student population and the teaching force is widely discussed (Atwater, Freeman, Butler, Draper-

Morris, 2010; Galman, Pica-Smith & Rosenberger, 2011; Ladson-Billings, 1995a, 2006; Paris, 2012; Spainerman et al., 2011; Utley, 2011; Villegas, 1991; Young, 2010; 2011).

As members of the teaching force, teacher educators (Ruiz & Cantú, 2013) and science teacher educators in particular (Barton & Yang, 2000; Lee & Buxton, 2010; Rodriguez, 1998) experience challenges in engaging students to wrestle with issues of social justice and power, as well as preparing preservice K-12 teachers to do the same (Giroux, 2000; Mensah, 2011, 2013; Sleeter, 2011a). Therefore, in general many novice K-12 teachers are entering classrooms ill-prepared to address the sociopolitical injustices and unique instructional needs of culturally, linguistically, and racially diverse students (Prater & Devereaux, 2009; Prater, Wilder, & Dyches, 2008; Sobel, Gutierrez, Zion, & Blanchett, 2011).

Collier (2002), Owens, Shelton, Bloom, and Cavil (2012), and Wright (2011a) suggest that in order to solve our nation's STEM crisis we must increase diversity in science education and attract a more diverse teaching workforce at K-12 and post-secondary levels. Additionally, science teacher educators must teach preservice science teachers *how* to instill an enthusiasm for science to an increasingly diverse student population (Maulucci, 2010; Wright, 2011b). And while many say our nation is experiencing a crisis in quality STEM education in general (Nixon-Saintil, 2012; Stohlman, Moore, & Roehrig, 2012), Mensah (2013) and others (Watters & Diezmann, 2013; Winkleby et al., 2009; Wyss, Heulskamp, & Siebert, 2012) say science teacher educators, in particular, play a distinct role in changing the trajectory of this trend, especially for diverse learners because early exposure to high quality and relevant science

instruction is integral to increasing later interest in science and other STEM fields (Maulucci, 2010).

Teacher Preparation in Science

Bryan and Atwater (2002) and others (Hart, 1997; Nixon-Saintil, 2012; Rascoe & Atwater, 2005) say science teacher education programs have the potential to be uniquely positioned to change the current trajectory of teaching and learning. Specifically, Parsons (2008) suggests science teacher educators must prepare future K-12 science teachers to become more culturally relevant to meet the challenges of an increasingly diverse K-12 student population, so that more students of color, African Americans in particular, increase their science aptitudes and propensity to enter science related careers. Similarly, Wallace and Brand (2012) say science teacher educators must embrace the idea that “race matters” and teach in ways that help preservice science teachers reconcile their own race-bias to help African American students overcome societal barriers to science achievement (p. 370). Further, they suggest that all teacher education programs overly rely on individual multicultural education courses to increase cultural awareness of preservice teachers, which does little to impact preservice and in-service teachers’ abilities to understand and address how African American students are oppressed by systemic and institutionalized racism (Wallace & Brand, 2012). Consequently, many well-intentioned preservice teachers enter K-12 classrooms with a positive disposition toward diversity but continue to unknowingly perpetuate inequity and hegemonic practices (Young, 2011) as evidenced by the science achievement gap, overrepresentation of African Americans in special education, and the low numbers of African American students represented in science careers (Wallace & Brand, 2012). Suriel and Atwater (2012) report on average

by high school, African Americans are up to three grades behind white students in terms of basic and scientific literacy. However, Atwater, Lance, Woodard, and Johnson (2013), Bolak (2006), and Prater and Devereaux, (2009) suggest this inequitable phenomenon is not usually for which teacher educators accept blame. Yet ironically, teacher educators are the ones responsible for preparing their students to enter K-12 classrooms and increase achievement in all students. Therefore, all teacher educators and science educators specifically, must engage preservice teachers in conversations about how race and oppression impacts teaching and student outcomes in an effort to create learning opportunities that engage all learners (Atwater et al. 2010) and African American students especially (Wallace & Brand, 2012). For example, Wallace and Brand (2012) agree with Bryan and Atwater (2002) who say science teacher educators ought to critically examine personal beliefs and practices that affect teaching and student learning at the K-12 and postsecondary levels. Moreover, Mensah (2013) advocates for the adoption of culturally relevant pedagogy in all areas of teacher education and science education, particularly to begin to address how teacher educators prepare preservice teachers to engage diverse learners.

Problem Statement

The problem addressed in this study is that the science education community reports teaching to and for diversity is an important part in addressing the achievement gap between African American students and their Caucasian/European American counterparts (American Association for the Advancement of Science, 1989; Lee & Buxton, 2010, 2013; National Science Teachers Association, 2013; Rodriguez, 1998;).

However, it remains unknown *how* science educators, many of whom reflect the dominant culture, achieve this (Milner, 2010).

Many agree that having racially charged discussions are tough for Americans because of apprehension, fear of otherness, and/or the denial of its importance (Atwater et al., 2010; Buehler, Gere, Dallavis, & Haviland, 2009; Gay, 2000). More importantly, these discussions about race are not being authentically addressed with science teacher educators (Mensah, 2013; Mutegi, 2011; Rodriguez, 1998) regarding African Americans (Boutte & Hill, 2006; Douglas, Lewis, Douglas, Scott, & Garrison-Wade, 2008) perhaps because of the tensions caused by the historical struggle between white and black people in the US (Alexander, 2010; Dutro, Kazemi, Balf, & Lin, 2008), which is arguably causing a severe inequity in science education (Wright, 2011a, 2011b). Critical race theorists would suggest these tough conversations are not being had because manifestations of racism in American schooling are sometimes unintentionally viewed as routine, typical, and equitable by members of the dominant group or status quo (Delgado & Stefancic, 2012; Ladson-Billings, 1998).

Purpose of the Study

In light of the large science achievement gap among white and black students, the purpose of this study was to find out how science teacher educators prepare preservice teachers to engage African American students in K-12 science. Thus, using Ladson-Billings' (1995a) definition of culturally relevant pedagogy, I attempted to identify how science teacher educators reported their understanding of culturally relevant teaching in the context of science education. Also, I explored these science teacher educators' espoused teaching beliefs, practices, and past experiences related to race.

To investigate science teacher educators' beliefs and teaching practices, the following research questions guided the study:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their beliefs and personal experiences related to race that have impacted their teaching beliefs and practices?

Significance of the Study

Bryan and Atwater (2002) call for science educators to investigate their “beliefs and practices” (p. 821). Further, Atwater et al. (2010) suggest cultural research is primarily focused on preservice teachers and K-12 settings as opposed to teacher educators in university settings. For that reason, this study is important because investigating *how* science teacher educators perceive culturally relevant pedagogy, as a tangible strategy in preparing future K-12 science teachers to engage African American students in science, is largely unknown. Secondly, studies related to race and culture have been explored in many other disciplines, such areas as poetry (Bacon, 2011), literacy (Conrad, Gong, Sipp, & Wright, 2004; Kesler, 2011), physical education (Choi & Chepyator-Thomas, 2011), English (Adkins-Coleman, 2010), family and consumer sciences (Rehm & Allison, 2006), math (Nasir & Hand, 2008), special education (Utley, Obiakor, Bakken, 2011), and social studies (Miller-Lane, Howard, Halagao, 2007). However, its impact on science is just beginning to be discussed (Mensah, 2013). Therefore, focusing on how science teacher educators perceive race and the instructional

needs of African American students contributes to a gap of knowledge in science education (Bryan & Atwater, 2002; Mutegi, 2011). Finally, examining this gap from a teacher education perspective is worthy to explore because traditionally, in-service K-12 teachers have shouldered the onus for the results of the cultural mismatch between K-12 teachers and K-12 students as opposed to the teacher educators that prepared them (Wallace & Brand, 2012).

Theoretical Perspective and Methodological Framework

Creswell (2012) and Merriam (2009) say a theoretical perspective corroborates a relationship between what is currently being studied and the established literature of a particular topic. The theoretical framework that guided this study was critical theory because this philosophical lens allowed for an examination of science teaching beliefs and practices that may impact African American students in science. Kincheloe and McLaren (1994) suggest critical investigations are characterized by researcher partisanship and the willful acceptance of hegemonic oppression by dominant groups, which defined the scope of the current study.

Personal reflection among participants is a recognized outcome for qualitative research that employs a critical paradigm (Atwater et al., 2010) because critical research espouses a connection between confronting and reforming societal injustice and empowering individuals, in which the researcher admits to partisanship as opposed to a traditional researcher's quest for neutrality (Dunbar, 2008; Kincheloe & McLaren, 1994). Therefore, in addition to addressing the research questions, the goal of this investigation was to prompt the participants to become more reflective about their practices and beliefs. So, at various times during a semester, which allowed time for reflection, I

conducted open-ended or qualitative surveys and semi-structured interviews of science teacher educators across Virginia regarding their beliefs and teaching practices aimed at preparing future K-12 science teachers to engage African American students. I also examined the science teacher educators' class artifacts, such as class assignments, lesson plans, and instructional materials to discuss during the interviews how they prepared preservice science teachers to address African American (or black) students in K-12 classrooms.

While the theoretical framework for this study is grounded in critical theory, Hays and Singh (2012) also suggest outlining the research tradition and methodology. Therefore, in addition to the theoretical framework, as defined by Atwater et al. (2010) the methodological framework was derived from a phenomenological single exploratory case study (Yin, 2009). Figure 1.1 describes the integration of the theoretical and methodological framework. A single exploratory case study was the chosen method because to the researcher's knowledge there have not been many studies related to teacher educators in science. Yin (2009) says one of the rationales for a single case design is when the objective of the study is to "capture the circumstances and conditions of an everyday or commonplace situation" (p. 48). Therefore, since the objective of this current study was to examine the experiences that may have shaped science teacher educators' beliefs and teaching practices, the single case study design was appropriate. In addition, Yin (2009) suggests the single case study design is also appropriate when "the investigator has an opportunity to observe and analyze a phenomenon previously inaccessible" (p. 48). Therefore, because science teacher educators' beliefs and teaching practices have been virtually absent in the literature, conducting an exploratory single

case study design was the best methodological approach to discovering information about this community of educators.

Figure 1. Theoretical and Methodological Framework

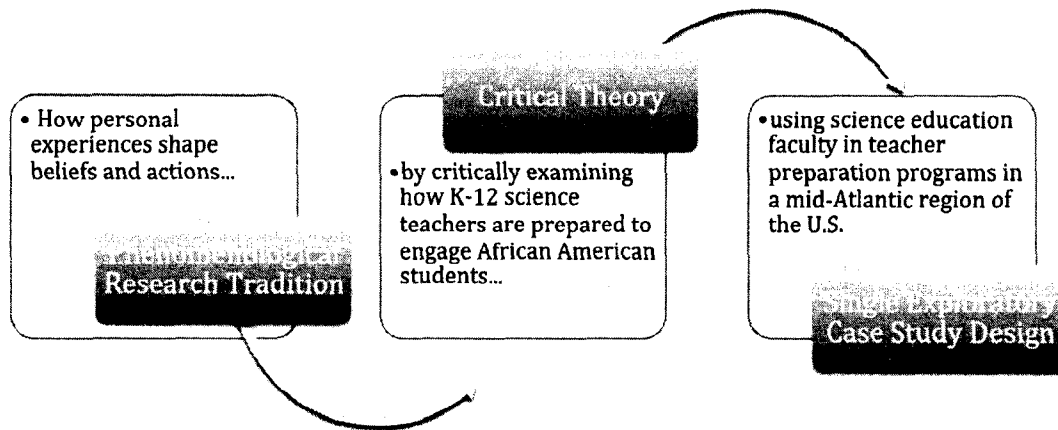


Figure 1: Shows how the research tradition informed the theoretical perspective and design framework.

Lastly, while this study is exploratory in nature, it is supported by literature about cultural relevance (Ladson-Billings, 1995a) and the need for cultural competency in science education (Atwater et al., 2010; Atwater et al., 2013; Mensah, 2013; Rodriguez, 1998; Wallace & Brand). In the context of this study, I used a critical theory lens to examine science teacher educators' knowledge about culturally relevant pedagogy (CRP), the way in which they prepare preservice teachers to address the learning needs of African American students in science, and the life experiences related to race that may have shaped their overall beliefs and perceptions.

Limitations and Delimitations

Merriam (2009) says limitations are constructs within every study that deteriorate the credibility or validity of the findings. With that said, this study, like other qualitative

research, had limitations preventing the results from being generalized to the overall population (Creswell, 2012; Donmoyer, 1990; Eisner & Peshkin, 1990). These results could not be generalized to the larger population of science teacher educators because of a low sample size, a non-random sample, and self-reported data provided by the participants. These limitations will be discussed in more detail in Chapter Three; however, it is important to note as suggested by Yin (2009) there are ways to increase the credibility of case study research. These will also be discussed in Chapter Three.

Mauch and Birch (1993) says delimitations narrow the scope of the study and are purposely controlled by the researcher. As stated previously, the use of the critical approach to investigate science teacher educators was a major delimitation. However, other delimitations under the control of the researcher were:

1. Only science educators in a mid-Atlantic state were invited to participate in the study.
2. Those surveyed or interviewed were asked questions relating to African American students in science; and
3. The participants selected out of the open-ended survey pool to be interviewed further in the study had to self-identify as either white or black and suggest a commitment to teaching in culturally affirming ways.

In what follows, there is a detailed explanation of terminology germane to the investigation. Beyond this, the current study is organized into four more chapters, references, and appendices. Chapter 2 presents a comprehensive review of related literature dealing with the field of science, culturally relevant pedagogy, culturally

relevant science teaching, science educators' beliefs and practices. Chapter Three describes the research design and methodology of the study, wherein the process to develop instruments used for data collection, the procedures followed, and information about the participants are outlined. Then, in Chapter 4, the results of the study are presented, analyzed, and discussed. Finally, in Chapter 5, an overall discussion of the study, to include conclusions, implications, and recommendations, are offered. The study concludes with references and appendices.

Explanation of Terms

Below are terms used throughout this document in order to shape this study. Sometimes educational related language can be ambiguous because terms used in K-12 settings are similar to those used in post-secondary environments. Similarly, conversations about race between the researcher and the participants played a major role in this current study; however, there is considerable terminology fluctuation in the literature regarding race, culture, and ethnicity. For instance, the term "African American" is used interchangeably with "black," which may or may not be capitalized. Also, the term "white," which may or may not be capitalized is used to denote people with European or Anglo Saxon heritage. On one hand, many researchers (Ladson-Billings, 1994, 1998, 2006; Villegas, 1991; Banks, 1995) follow the rules of *The Publication Manual for the American Psychological Association*, 6th ed. (2001), which advocates for the capitalization of "black and white" as part of the rule for noting nationalities (p. 75). For example, Bryan and Atwater (2002) capitalizes the terms "white and black" and Asian American, Latino, and Native American (p. 834). Accordingly, in

a study that rejects using a deficit model to approaching the whiteness of science teachers, Settlage (2011) capitalizes groups of people, such as “Children of Color” “Women of Color,” “White,” and “People of Color,” perhaps to denote reverence, but interestingly does not use the term “black” at all. McCann-Mortimer, Augoustinos, and LeCouteur (2004) suggest that while the word “black” is used around the world to describe people who have racial features indicating African ancestry, the convention of race has been discarded by science because the human-genome project proves all humans have African ancestry. With that said, many African American people accept the term “black” as a general, non-offensive ethnicity classification because it can be supplemented by more meaningful nationality descriptors, such as Black African, Black Canadian, Black American, or Black Latino. This reality is reflected in casual conversations, literature, music, and the African American culture in general (Alexander, 2010).

On the other hand, as is the case in the current study, some do not ascribe skin color the same literary regard as nationality (Delgado & Stefancic, 2012). For example, the Associated Press (AP) in the 2012 AP Stylebook indicates that skin colors, “black and white” are not to be capitalized, but nationalities are, such as African, American, Canadian, Cambodian, Jamaican, Pakistanian, Mexican, Hispanic, or Latino/a. In *Changing the Face of Teaching: Preparing Educators for Diverse Settings*, Collier (2002) uses “black and white” in the lower case form, when talking about the racial disparity in American schooling. Similarly, in *Critical Race Theory: An Introduction*, Delgado and Stefancic (2012) do not use the capitalize form when referencing black or white people. Lastly, Spring (2008) also takes a stand on this issue and uses black and

white in lower case form in his book, *The American School: From Puritans to No Child Left Behind*. Therefore, the current researcher of this study agrees with Delgado and Stefancic (2012) that referring to skin color in lowercase form is appropriate because they state, “a third theme of critical race theory is social construction, which holds that race and races are products of social thought and relations...races are categories that society invents, manipulates, or retires when convenient” (p. 34). For example, “black” represents a convoluted evolution of an American racial label that changed “black” from a skin color descriptor into a race or nationality with historically charged antecedents, such as Nigger, Colored, Negro, Afro-American, and African American (Harper, 2009). Similarly, the terms diverse, disenfranchised, disadvantaged, marginalized, minority, non-dominant, or underprivileged students will refer to any student of color that does not inherently receive privileges from the dominant Caucasian American culture. These students are also often referred to as culturally and linguistically diverse (CLD) students (Cartledge & Kourea, 2008). Consequently, the terms “black and white” will remain in the lowercase form to describe skin color, and nationalities will be capitalized.

For clarity, I will consistently use the terms as described in Table 1 when referring to major concepts, teaching positions, demographic descriptors, and/or ideas to resolve ambiguity about the many terms related to diversity and education (Atwater, et al., 2010). Therefore, Table 1 shows a summary of often-misunderstood terminology to bring consensus on the definitions used in this study.

Table 1

Summary of Diversity Dimensions and Education Related Terms (Atwater et al., 2010)

Term	Definition
Part One	Diversity Terminology Defined
Race	<p><i>Race</i> is a fictional construct related to a person's physical appearance, which genetically determines skin color, eye color, bone structure, and other biological traits.</p> <p>Example: white, black</p>
Ethnicity	<p><i>Ethnicity</i> is a social construct characterized by cultural factors, such as nationality, language, religion, heritage, ancestry, and value/belief systems.</p> <p>Examples: Italian, African, Mexican, Native American, or Irish</p>
Social Class	<p><i>Social class</i> is an economic construct that is guided by social and political influences that controls access to power, tangible and intangible resources, and opportunities for advancement.</p> <p>Examples: poverty, working class, middle class, upper class</p>
Table 1 continued	
Others/Otherness	<p><i>Others</i> are people who are not members of a dominant group and have no access to dominant group privileges and power; Dominant group ideologies are oppressive to non-dominant groups. In the United States of America, the dominant group is represented by Caucasian/European/Anglo Americans (white), and "Others" include Native Americans (Indigenous people of the America's), Africans, African Americans, Asians, Asian Americans, Hispanics, Hispanic Americans, Arabs, Arab Americans, Indian, Indian Americans, Latino/a's, and Latino/a Americans...</p>
Culture	<p><i>Culture</i> is the shared perceptions of class, race, ethnicity, gender, linguistics, sexual orientation, and general otherness. <i>Culture</i> is acquired knowledge used to interpret life experiences through language, nationality, social roles, relationships, traditions, norms, and behaviors.</p>
Part Two	Education Related Terminology Defined
Culturally Relevant Pedagogy	<p>(CRP) is a socio-political teaching strategy developed by Ladson-Billings (1995a) to help teachers' foster high academic success, cultural competence, and critical consciousness in their students. This strategy</p>

Table 1 Continued

	requires teachers to critically examine their own beliefs and biases to ultimately shape learning in a way in which students confront societal injustices.
Culturally Responsive Pedagogy	(CResP) is a style of teaching developed by Geneva Gay (2000) that rests on the proposition that teachers' incorporate students' cultures, interests, and traditions into teaching and the larger school setting. This strategy requires teachers to be aware and appreciate cultural and racial differences.
Inservice Teacher	Any certified K-12 teacher working in a K-12 setting (elementary, middle, or high school).
Post Secondary Settings	Educational environments beyond high school. Example: A trade school or a two or four-year college or university
Preservice Teacher	A person studying to become a teacher in a K-12 school. Example: A <i>preservice science teacher</i> is studying to become a K-12 teacher in any area of science, pure or applied.
Science Education	The field of education dedicated to training and preparing all science teachers to engage K-16 students.
Science Teacher Educator	University professors working in post-secondary/university settings that train aspiring K-12 science teachers.
Educator	Any K-12 teacher, teacher educator, or university professor.
Teacher Education	The field of education that is dedicated to training and preparing K-12 teachers in all disciplines (English, math, science, social studies, special education, elective subjects, etc.).
Teacher Educator	University professors working in post-secondary/university settings that train all aspiring teachers.

CHAPTER TWO

REVIEW OF THE LITERATURE

Given the pressing needs for a high-quality STEM (Science-Technology-Engineering-Mathematics) workforce and the unremarkable impact of traditional efforts to improve the [science] pipeline, it seems time to invest in maximum effort in understanding what strategies are effective in increasing active participation in STEM fields. (Greene, DeStefano, Burgon, & Hall, 2006, p. 55)

In the above quote, Greene et al. (2006) describe the downward trend in science and the need for American science teachers to be uniquely prepared to incite passion in reluctant science learners, of which many agree are usually racially, culturally, and linguistically diverse students (Barton & Yang, 2000; Lee & Buxton, 2010; Johnson, 2011; Nixon-Saintill, 2012) and African American students in particular (Lewis & Collins; Mutegi, 2011; Parsons, 2008; Wright, 2011). Moreover, Greene et al. allude to the idea that all science educators and leaders need to do something differently to excite students in science because current efforts are not working. Mutegi (2011) contends further that current trends in science education segregate African American students from quality science experiences. Specifically, Mutegi asserts there are specific historical antecedents, such as slavery, Jim Crow laws and race-biased traditions that have contributed to the inequitable educational experiences of African American students, especially in science because science was used to justify African Americans as subhuman. Similarly, Wallace and Brand (2012) say inequity in science education has perpetuated throughout generations as a byproduct of various racist ideologies, such as scientific racism, which continues to alienate African Americans in science. As a result, Parson (2008) says too few African Americans seek science careers because on average,

African Americans are disenchanted with K-12 science (Winkleby et al., 2009). Most notably, African Americans are disenchanted with K-12 science because K-12 teachers do not adequately engage African American students, who have unique instructional needs (based on the before mentioned historical antecedents) (Parsons, 2008; Mutegi, 2011, 2013; Wright, 2011a, 2011b). Ultimately, Mutegi (2011) says the current K-12 science teaching workforce does not understand how to address African American students' instructional needs because these K-12 teachers are not being prepared to understand or address these needs by the science teacher educators entrusted to prepare them. So, what remains to be seen is to what extent do science teacher educators themselves understand the instructional needs of African American students in science and are they able to disrupt this pattern?

Mensah (2011, 2013) recommends culturally relevant teaching as a meaningful strategy for science teacher educators and K-12 teachers to increase science interest and achievement among African American students. She and others (Atwater, Lance, Woodard, & Johnson, 2013; Bryan & Atwater, 2002; Cherian, 2006; Rodriguez, 2009) suggest it is the teacher educator's responsibility to prepare future K-12 teachers to address teaching and learning from a cultural lens because the science achievement gap (Parsons, 2008), the overrepresentation of African Americans referred for special education (US Department of Education, 2000), and the mis-representation or under-representation of African Americans in the curricula (Harris, 1971; Jenkins, Hudson, Jackson, & Ryder, 1975; Klein, 2010; Krapp et al., 1999; Pearson, 1985; Spring, 2008; Warren, 1999) continue to deepen the segregation in science education (Barton & Yang, 2000; Mutegi, 2011, 2013). All of these issues have resulted in smaller numbers of

diverse students seeking and benefitting from careers in science (Lewis & Collins, 2011). Consequently, as a result of Greene's et al. (2006) call for deeper understanding of effective strategies in increasing STEM participation, in this chapter, I synthesize the literature regarding culturally relevant pedagogy (Ladson-Billings, 1995a) and science education to appraise the intersection between the two. I also critique the science-for-all initiative, and evaluate the implications of culturally relevant teaching in science education (Ladson-Billings, 1995a; Mensah, 2013) as a meaningful strategy for improving active participation by African American students in science.

As noted in Chapter 1, the purpose of this study was to find out how science teacher educators prepare preservice teachers to engage African American students in K-12 science. Thus, I explored science teacher educators' professed beliefs about culturally relevant pedagogy (CRP) and teaching practices they reported to prepare K-12 preservice teachers to engage African American students in science, explored the personal experiences that may have shaped science teacher educators' espoused teaching beliefs and practices, and facilitated personal reflection among a subset of white and black science teacher educators to more intensely examine how their personal experiences have impacted their beliefs and practices in regards to preparing preservice teachers to engage African American students in science. However, because of the complex racial precursors that surround this phenomenon the literature review in this section illustrate in some detail the historic antecedents of science and racism and the connection between race and discrimination. Therefore, in the following sections, I review how science has evolved in America, which demonstrates the field as an exemplar of inequity for African Americans. Second, I describe examples, near examples, and non-examples of culturally

relevant pedagogy in general and in science education research to deconstruct the cultural complexities inherent in science education.

Science as an Exemplar for Inequity

Nixon-Saintill (2012) and others (Barton & Yang; Lee & Buxton, 2010; Obama, 2011; Parsons, 2008) say the American education system has been slipping as a competitor in the global scientific community, especially in fields of science, technology, engineering, and mathematics (STEM). Moreover, while very few students are pushing for degrees in STEM related fields, students of color are nearly absent in these areas (Landivar, 2013; Lewis & Collins, 2001; Owens et al., 2012). For example, Lewis and Collins (2001) say African Americans make up less than 1% of all students entering science careers and less than 2% of all those holding a PhD in science. Instead, science careers, including teaching K-12 science, are dominated by those having European or Anglo-Saxon heritage (Owens et al., 2012). Most notably, Wright (2011a) says K-12 teachers are struggling to create enthusiasm for seeking careers in science among the African American student population, and Collier (2002) suggests further that enthusiasm for learning in general by all diverse populations is negatively impacted by K-12 teachers.

Historical antecedents for inequity. The lack of diverse students entering careers in science negatively impacts the talent pool, which limits America's innovation and scientific advancement and workforce potential (Lewis & Collins, 2001; Winkleby et al., 2009). However, the question remains as to why African Americans are chronically absent from science careers. Some scholars suggest the genesis for the inequity in science and education dates back centuries (Dupbar, 2008; Wallace & Brand, 2012) and

others suggest racist and hegemonic laws and customs have contributed to the inequitable learning experiences for African American students (Ladson-Billings & Tate, 1995).

Science used to marginalize. Dunbar (2008) says African Americans are underrepresented in science because since the early 17th century, European or Anglo-American scientists considered African or African American scientists incapable of rigorous scientific thought, in which case they were completely disregarded by mainstream science. Furthermore, Woodson (1933, as cited in Dunbar, 2008) wrote about white scholars' pervasive belief in the intellectual inferiority of African Americans regarding their propensity for scientific thought and suggested "Negroes" were better suited only to study other "Negroes" (p. 85). Similarly, President Thomas Jefferson (Jefferson, 1781 as cited by Wallace and Brand, 2012) said Africans were biologically inferior or subhuman to whites. Consequently, Wallace and Brand (2012) suggest the sciences and science education have been historically exclusionary to African Americans (Atwater, Lance, Woodard, & Johnson, 2013; Harris, 1971; Hart, 1997; Jenkins, Hudson, Jackson, & Ryder, 1975; Mutegi, 2011; Pearson, 1985) because scientific measures, such as scientific racism and theories of white supremacy, were used to assert inferiority of black people, which has caused a black inferiority complex.

Laws and customs. Klein (2010) says blacks were purposefully made to feel inferior with laws and customs that marginalized them. For example, during time that slavery was the law of the land in America, African slaves and some free blacks were not legally allowed to read or profit from their ideas; so, often their masters or others took credit for their scientific discoveries or inventions (Klein, 2010). Consequently, Klein says history has advanced deceptive accounts or half-truths of the scientific contributions

of African Americans. For example, most elementary students learn in science class that “Thomas Edison invented the light bulb and Alexander Graham Bell invented the telephone” because nowhere is there mention that these men learned this information from “Lewis Latimer, the son of an escaped slave from Virginia” (Krapp et al., 1999, p. 196). Thus, students usually are not told about such trail blazers as Vivien Thomas, who in the 1940s, without a college degree, developed the procedures to treat “blue baby syndrome” on Caucasian American patients because Dr. Alfred Blalock took credit for Thomas’s ideas. So instead, the extent to which K-12 students learn about African American contributions in science are limited to George Washington Carver and his uses for the peanut as opposed to hearing about the rigorous and significant contributions of others, many of whom changed and improved everyone’s lives (Krapp et al., 1999; Pearson, 1985).

Impact of race. Historically, racial differences between those with white and black skin have been the main factor by which segregation in education has persisted in the United States of America (Ladson-Billings & Tate, 1995). However, when the *Brown v. The Board of Education* ruling formally dismantled “separate but equal,” contemporary segregation seemed to persist further. For example, Kozol (as cited by Ladson-Billings & Tate, 1995) suggests in a comparison of two schools in New York that not only significant racial (white-black) differences exist, but also differences in quality exist, which insinuates that separate and unequal persists in contemporary society. Kozol said, “The [white] school serves 825 children in the kindergarten through sixth grade. This is approximately half the student population crowded into [black] P.S. 79, where 1,550 children fill a space intended for 1,000...” (Ladson-Billings & Tate, 1995, p. 59). Thus,

Kozol's present day description of contemporary segregation echoes what those committed to social justice said at the height of the Jim Crow era. For example, in 1935, W.E.B. Dubois said,

... race prejudice in the United States today is such that most Negroes cannot receive proper education in white institutions ... many public school systems in the North, Negroes are admitted and tolerated but they are not educated; they are crucified ... certain Northern universities where Negro students ... cannot get fair recognition, either in classroom or on the campus, in dining hall or student activities, or in human common courtesy ... at Harvard, Yale, and Columbia, Negroes are admitted but not welcomed; while in other institutions like Princeton they cannot even enroll. (p. 328-329)

Moreover, Ladson-Billings and Tate assert that segregation continues to negatively impact black students; however, the outdated word, "segregation," is replaced by contemporary terms such as "vouchers," "schools of choice," and "gifted or Advanced Placement programs" which gives school leaders the "absolute right to exclude" African American students (p. 60). Furthermore, Ladson-Billings and Tate assert the idea of systemic treatment of black Americans in education was well documented, but most importantly, American schooling is still not inoculated from the racist ideologies of the Jim Crow era. For example, in the *Mis-education of the Negro*, Carter G. Woodson (1935) said that schooling was purposely designed to elevate Caucasian Americans and oppress African Americans. These effects he said were seen at every level of American education and even affect those in higher education settings because the main goal of mis-education is to perpetuate the inferiority of blacks throughout generations. In this way, Woodson confirms that racial inequity seeps from teacher to pupil, which also suggests that examining issues of race with K-12 teachers and teacher educators is critical if the cycle of mis-education is ever to be broken.

Racial differences in the workforce. As stated previously, Prater and Devereaux (2009) and Bryan and Atwater (2002) say much like in the K-12 workforce, there is little racial and ethnic diversity within the academic professoriate (Mitchell & Rosiek, 2006), in which Mutegi (2011) and Russell and Atwater (1995) suggest is a contributing factor to the lack of science achievement among African Americans. Particularly, Atwater et al. (2013b) point out in their study of black science teacher educators that race matters in university settings because in 2001 and 2009, black faculty held less than 6% and 7%, respectively of all associate professor positions in traditionally white institutions of higher learning.

Critical Race Theory

Historically, critical race scholars challenged liberal ideologies regarding the law, such as colorblindness, neutrality, and incremental change because colorblindness disregards the American social construction of race, which stipulates those with white skin are superior and those with black skin are inferior (Delgado & Stefancic, 2012). As a result, critical race theory (CRT) has emerged as an ideology used by many disciplines, such as law, education, medicine, the social sciences, and others to deconstruct the impact of race in American institutions (Delgado & Stefancic, 2012). However, regardless of the discipline, Delgado and Stefancic firmly assert CRT maintains two major themes by which all of its principles have emerged. First, critical race theorists suggest that white supremacist ideologies have persisted throughout time due to laws that perpetuate white privilege. Second, critical race theorists attempt to transform racial injustices by confronting institutionalized racism by fighting against colorblindness, neutrality, and incremental change.

History of critical race theory. Deeply disturbed by the racial inequities in society, CRT was founded by Bell and Freeman in the mid-1970s as an alternative to passive activism (Delgado and Stefancic, 2012). As such, CRT has an illustrious past evolved from the Civil Rights Movement, black national movements, and Critical Legal Studies. However, it formally organized in 1989 after what Delgado and Stefancic describe as an iconic working session, in which the future trajectory of CRT would be set. Most scholars agree that CRT maintains five general principles that provide insight into this ideology (Delgado & Stefancic, 2012). See Table 2, *Major Principles of Critical Race Theory* for a description of each principle.

Table 2

Major Principles of Critical Race Theory (Delgado & Stefancic, 2012)

Major Principles of Critical Race Theory	
Principle 1	Racism appears as normal, ordinary, and natural to members of the status quo in American society.
Principle 2	Storytelling is an acceptable way to confront racial oppression.
Principle 3	“Interest Convergence” suggests that emancipation of racial oppression must simultaneously benefit the elite status quo and must not be too radical.
Principle 4	“Social Construction” suggests that race is a concept that is invented by society.
Principle 5	Because of historical oppression, people of color are more able to voice racial matters to members of the status quo, using a “voice of color and storytelling” (Delgado & Stefancic, 2012)

Critical race theory in education. Though originated in legal scholarship, CRT has begun in recent years to be used to elucidate the influences of race in education (Delgado & Stefancic, Ladson-Billings & Tate, 1995; Wallace & Brand, 2012). Bell (1992) says the most important aspect of critical race theory is understanding how prevalent and enduring racism is in America. He explains in *And We are Not Saved: The*

Elusive Quest for Racial Justice that racism is so engrained in the American conscious that often-times it goes unnoticed or worse, passed off as activism.

The idea of unrecognizable racism disguised as activism is personified with Young (2011), who uses critical race theory to engage eight elementary teachers and administrators in critical discourse about racism in schooling. In her journey toward increasing these participants' race consciousness, she used a critical case study methodology and discovered four personae of racism: (1) racism as acts of the conscious perpetrator; (2) racism as acts of the unconscious perpetrators; (3) racism as acts of deceived perpetrators/activists; and (4) racism as acts of partially enlightened perpetrators/activists. Young found that white educators were largely deceived by their own sense of activism and unable to recognize their contributions to the inequity in American education. For instance, Young says that examples of unrecognizable racism disguised as activism are when white teachers adopt the color-blind mentality, insist they treat all students the same, or if they subscribe to a "savior mentality" (p. 1447), which actually does more to unintentionally promote the dominant or white culture's values on to diverse students.

Wallace and Brand (2012) insist that critical race theory is a useful framework to analyze teachers' personal experiences, which ultimately shapes their teaching beliefs and practices. They summarize Delgado and Stefancic's concept of critical race theory into the following three major propositions: (1) racism is normal in American culture; (2) white people mentally and materially believe they are superior over people of color; and (3) race is socially constructed. Most notably, Wallace and Brand suggest critical race theory is an appropriate vehicle whereby the intersection of culturally relevant pedagogy

and science teacher preparation can be investigated because they say “understanding racial inequities is crucial to the development of sociocultural awareness and is the foundation for... culturally relevant dispositions and practices” (p. 341). Similarly,

Ladson-Billings and Tate (1995) advocate for the use of critical race theory in education. They call for education scholars to abandon what they suggest are weak multicultural education efforts and acknowledge an adapted conceptualization of critical race theory for theorizing the racial implications in education. For example, they argue that the concept of race in the US remains as critical today as it did in the past; yet, it is underestimated or under-theorized in the field of education. Therefore, Ladson-Billings and Tate suggest a theoretical perspective with three major tenets commensurate to CRT for the field of education to address the issues of inequity in American schooling. See Table 3, for a summary of each tenet.

Table 3

The Intersection of CRT and Education

	Main Propositions of Educational CRT (Ladson-Billings & Tate, 1995)
Principle 1	Race continues to be a significant factor in determining inequity in the United States.
Principle 2	US society is based on property rights.
Principle 3	The intersection of race and property creates an analytic tool through which we can understand social and school inequity.

However, Ladson-Billings and Tate (1995) suggest that as opposed to advancing a philosophy of multiculturalism, which stipulates a “unity of difference” (p.62), educational researchers should examine the tensions between and among the many differences represented therein. As such, Ladson-Billings and Tate advance an argument for the separation of democracy and capitalism because as they suggest, democracy insinuates equality for all, but say America was not founded on principles of democracy.

Rather it was founded on principles of capitalism, which relegates African Americans to the lowest position in society.

Impact of Race and Science Inequity

As previously stated, enrollment rates for STEM fields in American higher education facilities remain low overall (Landivar, 2013) and among African Americans especially (Parsons, 2008). Even more, preservice teachers in particular are not being equipped with the necessary skills to change the trajectory of this epidemic, which has drastically reduced the number of African Americans going into science careers (Winkleby et al., 2009) or persisting through undergraduate programs in science (Russell & Atwater, 2005). For example, in a study of 11 African American students in biology degree programs, Russell and Atwater (2005) found that the lack of both teacher encouragement and the facilitation of intrinsic motivation played a major role in the students' persistence and success. Thus, the field of science education is an exemplar that demonstrates the complexities of the racial struggle between black and white people in the United States because of the unique challenges and consequences slavery and Jim Crow laws had, which were intended to marginalize blacks for generations (Mutegi, 2011, 2013). For example, Russell and Atwater (2005) say,

Historically, science and science-related careers were viewed as privileges for the [white] elite. Consequently, students of color fail to achieve in science and are significantly underrepresented in science courses and related careers. Unfortunately, despite the principles of equity, equal opportunity, and fairness that are rooted in American culture, [only] certain groups of people are more likely to gain access to valuable scientific knowledge. (p. 692)

Bryan and Atwater (2002) and Rodriguez (1998) suggest that in some cases, white science teacher educators and K-12 teachers are negatively influenced by racially charged

beliefs and practices that prevent them from delivering equitable science experiences to students who represent a different culture, ethnicity, race, or language background. For instance, despite the scientific contributions of people with African ancestry, it has been the Anglo or the Euro-American contributions to scientific thought or ways of knowing privileged throughout history (Dunbar, 2008; Mutegi, 2011) and in books (Spring, 2008), which has chronically prevented the contributions of African Americans to be adequately recognized in K-12 classrooms (Harris, 1971; Jenkins, Hudson, Jackson, & Ryder, 1975; Pearson, 1985; Warren, 1999).

On the other hand, Wallace and Brand (2012) posit that two teachers' polarized racial experiences provoked a critical awareness of societal constraints placed on black students in science, which propelled these teachers to enact culturally relevant pedagogy as a framework to confront the before-mentioned constraints. Wallace and Brand indicated both teachers (one white and the other black) in their study came from working class families. In describing their experiences growing up in their very different communities and with their families, they reveal that the teachers' critical awareness of how race was constructed in their personal experiences helped to shape their teaching philosophies and practices and the perception of their black students' academic and social needs, which by in large reflected the use of culturally relevant teaching. They each talked about having high expectations for their students, making cultural connections with their students and their families, and having an acute awareness of the societal injustices that black students in particular face, such as being stereotyped as lazy, bad, and inferior.

Unremarkable efforts and outcomes. In an effort to rebuild the educational infrastructure and rekindle interest in STEM careers, corporate America has funneled millions of dollars, in the form of donations and grants, into school systems and higher education programs. For example, Northrop Grumman, the Gates Foundation, the Imperial Oil Foundation, and the National Science Foundation are just a few of the organizations that have invested in the future of STEM education (Nixon-Saintil, 2012). However, as Greene et al. (2006) stated, these traditional strategies are “unremarkable,” (p. 55) as evidenced by the dismal numbers of African Americans and other students of color not being encouraged into these fields of study (Landivar, 2013). Consequently, Wright (2013) says African American students are either being purposefully denied access to these funds of which could potentially remove the financial barrier for post-secondary education and upward social mobility or they are being passively ignored or underestimated. In either case, Bryan and Atwater (2002) say it is essential that educators at every level assist diverse students in developing and maintaining an interest in STEM fields because the number of STEM graduates is declining each year (Owens, Shelton, Bloom, & Cavi, 2012; Watters & Diezmann, 2013). Specifically, the US Census Bureau reported that African Americans (or those self-identifying as black) make up nearly 11% of the workforce but only account for 6% of STEM occupations and these numbers are even less when broken down by specific industries (Landivar, 2013).

Responsibility of Teacher Educators

In light of the rapid increase in cultural, ethnic, racial, economic, and linguistic student diversity (National Center for Educational Statistics, 2010), teacher educators are conduits for transformational change in public schools because they set a template for

teaching and learning that eventually trickles down to K-12 students (Buehler, Gere, Dallavis, & Haviland, 2009; Murrel, 2006). Simply put, teachers teach how they were taught (Bergeron, 2008; Bryan & Atwater, 2002; Lin, Lake, & Rice, 2008).

Furthermore, Prater and Devereaux (2009) say in general while teacher educators testify to the importance of cultural competency to address the inequity in schooling, most do not have experience working with diverse populations and do not demonstrate/model the skills and expertise for critical pedagogy, much like the teacher candidates under their authority. Specifically, Ruiz & Cantú (2013) say teacher educators of the past and present have prepared preservice teachers as an extension of their preparation, which Mensah (2013) says most likely did/does not include a wealth of multicultural expertise, as evidenced by the idea that most science educators in teacher preparation programs are Anglo/Euro-American, middle-class, and mono-lingual with little to no experience with people who represent racial or cultural otherness (Atwater et al., 2010; Bryan & Atwater, 2002; Lewis & Collins, 2001; Rodriguez, 1998). Consequently, Parsons (2008) and others (Atwater et al., 2013) suggest a destructive cycle exists that extends from science teacher educator to K-12 science teacher to K-12 students, as evidenced by poor science achievement in African American students, which surfaces in the early elementary years and continues to escalate in the higher grades. Parsons (2008) suggests a cultural mismatch between African American students and the leaders in K-12 classrooms and science education. Parsons also points out that while the underachievement of African American students in science has been investigated and discussed in a myriad of ways (Lynch, 2001), African American students still earned the lowest scale scores in science of all other ethnic groups from 1996 to 2000, according to the 2000 National Assessment

for Educational Progress (NAEP) results (National Center for Educational Statistics, 2010). Barton and Yang (2000) suggest this is the case because disproportionately, marginalized students are either excluded from science all together or tracked into lower science classes in which science learning is reduced to meaningless activities and rote memorization of facts.

An example for teacher educators. Outraged by the social events that led to the murder of Dr. Martin Luther King, Jr. and a Eurocentric curriculum that perpetuated those events, Jane Elliott in 1968 created a microcosm of American society in her third grade classroom, in which eye color fostered awareness of racial discrimination. Specifically, Elliot divided her third grade class from Riceville, Iowa (total town population 898) into blue and brown-eyed groups because she believed her students were completely oblivious to the social unrest occurring outside of their insulated town (Frontline, 1985). While Elliott's iconic Blue Eyed-Brown Eyed experiment is often thought of as too controversial for today's classrooms, it marks the beginning of a movement for teachers to foster cultural intelligence in them and in their students (Frontline, 1985). Much later, Mrs. Elliott explained in a PBS Frontline interview that she was preoccupied with "fixing the people," which corresponds with Hochschild and Scovronick's (2003) description of educational reform of the 1960s, 1970s, and 1980s. For example, Elliott exclaimed there were no cultural images in her student's textbooks, a phenomenon extensively documented in American textbooks before the 1980s (Spring, 2004). Therefore, Mrs. Elliott supplemented the culturally unrepresentative curriculum with her creative and student-centered activities, which is commensurate with John Dewey's progressive model of education reform (Dewey, 1997, 2008; Hochschild &

Scovronick's, 2003). Thus, with the same conviction as Jane Elliott, all teacher educators (Ladson-Billings, 2000; Mensah, 2011) and science teacher educators in particular (Bryan & Atwater, 2002; Mensah, 2013) must take the lead in transforming how preservice teachers are prepared, so that irrelevant and socially unjust beliefs, curriculum, and practices are eradicated from education.

To eradicate socially unjust educational beliefs and practices in science education, many suggest the use of culturally relevant instructional practices to transform science teaching and to foster critical consciousness and cultural competence among K-16 students and K-12 science teachers (Barton & Yang, 2000; Mensah, 2011, 2013; Morrison, Robbins, & Rose, 2008; Parsons 2008). Cherian (2006, p.128) says and others agree (Atwater, Lance, Woodard, & Johnson, 2013; Mensah, 2013) the missing piece in achievement improvement measures is the lack of genuine critical teaching because many educators and policy makers regard sociopolitical pedagogy as unrealistic “theoretical abstractions that make no in-roads” into K-16 accountability; consequently, K-12 students of color exist marginally in the classroom (Myboya, 1988; Sleeter, 2011b) and science classrooms in particular (Atwater et al., 2013; Maulucci, 2010; Mensah, 2013). Moreover, because teacher educators possess a unique and almost obvious influence over most areas of K-12 education (Mensah, 2013), Bolak (2006), Prater and Devereaux (2009) and Bryan and Atwater (2002) conclude that teacher educators are partially culpable for the problems in K-12 classrooms. Specifically, some of those problems, like the white-black achievement gap (Gregory, Skiba, & Noguera, 2010; Oats, 2009), the disproportionate discipline referrals for students of color (Bickel & O'Neil, 1982), the hidden curriculum (Margolis, Soldatenko, Acku, & Gair, 2001), and the over-

representation of African Americans in special education (Harry & Anderson, 1994; Kearns, Ford, & Linney, 2005; Blanchett, 2006) continue to grow exponentially. Delpit (1988) and Ladson-Billings (1998) say this trend is purposely orchestrated by the dominant culture to disenfranchise and marginalize students who are not taught the rules of power (Delpit, 1988).

The role of teacher educators. Many of the aforementioned racially-charged inequities are usually not ones for which teacher educators accept blame (Atwater & Lance, Woodard, & Johnson, 2013; Bolak, 2006; Prater and Devereaux, 2009), but some say teacher educators in teacher preparation programs (Sobel, Gutierrez, Zion, & Blanchett, 2011) and science teacher preparation programs in particular (Bryan & Atwater, 2002; Lee & Buxton, 2013; Mensah, 2011, 2013) should at the very least examine the snowball effect their actions have on K-12 outcomes. Consequently, Buehler, Gere, Dallavis, and Haviland (2009) and Mensah (2013) say all teacher educators must examine 1) what perpetuates problems with racial inequity, 2) what can be done to eradicate them, and 3) what role teacher educators play in exonerating the school systems of these and other blatant injustices. More specifically, Bryan and Atwater (2002) suggest science teacher educators have a significant role to play as they prepare the next generations of science teachers to contemplate the pedagogical changes necessary to meet the needs of African American and other diverse learners in 21st century classrooms (Atwater, Lance, Woodard, & Johnson, 2013; Mensah, 2011; Resnick, 2010; Rodriguez, 1998). For example, Bryan and Atwater suggest that teacher educators and K-12 teachers must personally examine and resolve their own biases and prejudices, so that [science] teaching and learning can be maximized for all students.

Science teacher educators and science-for-all. In reaction to the perceived inequities in K-16 science classrooms, science teacher educators have promoted science-for-all initiatives. However, despite the aggressive science-for-all reforms, which are intended to make science accessible to all students (American Association for the Advancement of Science, 1989), Mutegi (2011) strongly asserts African American students remain largely marginalized and underestimated in science classrooms (Lewis & Collins, 2001; Maulucci, 2010; Russell & Atwater, 2005; Walls, 2012), and African American science achievement has not increased (Lynch, 2001; Parsons, 2008). In fact, Bryan and Atwater (2002) say, if teacher education programs do not assist science teachers in uncovering their negative stereotypes and prejudices, science-for-all will not become a reality (p. 826).

The National Science Teachers Association has published the *Next Generation Science Standards* (2013), a collaborative effort for states, by states to address science-for-all efforts so that students are college and career ready. These standards suggest science teachers are expected to “establish learning goals in science that give all students the skills and knowledge they need to be informed citizens, college ready, and prepared for careers.” However, Mutegi (2011) and Lynch (2001) say that the current science reform that calls for science-for-all is grossly misleading and exasperates inequity in science teaching and learning and ultimately increases the science achievement disparities between white and black students. Mutegi says the American science curriculum disenfranchises African American [or black] students in particular because the curriculum is espoused from the Western culture, which devalues and completely rejects the contributions or ways of knowing of other cultures or civilizations (Mack, et al.,

2012). Thus, contemporary African American students, who have descended only four or five generations ago from their African slave ancestors, are not given the opportunity to critique or *debate* the Western philosophy of science in conjunction with any other interpretations of science (Mutegi, 2011); so, Mutegi (2011) and Lynch (2001) insist that the science-for-all initiative is flawed in its ability to benefit the actual students it purports to serve (Barton & Yang, 2000).

A science teacher educator example. The National Science Standards (1996) state that K-12 learners must be able to:

1. Experience the richness and excitement of knowing about and understanding the natural world;
 2. Use appropriate scientific processes and principles in making personal decisions;
 3. Engage intelligently in public discourse and debate about matters of scientific and technological concern; and
 4. Increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers
- (p. 13).

Considering this, Mutegi (2011) asks how does an Anglo/Euro-American science teacher educator prepare a future K-12 science teacher to address science instruction in a culturally relevant way for African American students, who have inherited a legacy of oppression and colonization? Mutegi (2011, 2013) suggests if a science teacher educator only values traditional teaching strategies as demonstrated by instruction and activities for preservice teachers that require it, then it is likely this teaching paradigm will show up

in a future K-12 classroom by someone who was trained using those strategies (Atwater, Lance, Woodard, & Johnson, 2013). Conversely, if a science teacher educator models the use of sociopolitical teaching strategies, then it is likely this strategy will be valued by a future K-12 teacher and it will show up in his or her future classroom (Bergeron, 2008; Bryan & Atwater, 2002; Cherian, 2006; Lin, Lake, & Rice, 2008; Mensah, 2011, 2013).

Intersection Between Culturally Relevant Pedagogy and Science Education

Considering the off-limit nature of the Jane Elliott example of the 1960s, the use of culturally relevant pedagogy is a notable alternative to the traditional efforts used to incite passion among African American science learners. Specifically, Mensah (2013) suggests the use of culturally relevant science teaching as a tangible strategy for increasing higher order thinking skills, student achievement, and democratic citizenship for African American students and all students. Mensah says the field of science education is just beginning to explore the implications of culturally relevant teaching to increase science achievement and engagement among racially and culturally diverse students (Bryan & Atwater, 2002). As such, several scholars in science education are committed to perpetuating teaching that advances equity and empowerment. Therefore, in what follows, I describe the literature that informs the field of education about culturally relevant instruction and culturally relevant science teaching.

Culturally relevant pedagogy. Culturally relevant pedagogy (CRP) is a style of teaching in which teachers purposefully affirm diversity and empower students to challenge the status quo (Ladson-Billings, 1995a; Gay, 2000). Culturally relevant teaching was originally birthed to engage African American K-12 learners (Ladson-

Billings, 1995, 2001) because of a growing achievement gap (Fordham & Ogbu, 1986; Gregory, Skiba, & Noguera, 2010), inequitable discipline referrals (Bickel & O'Neil, 1982), over-representation in special education (Harry & Anderson, 1994; Kearns, Ford, & Linney, 2005; Blanchett, 2006), and a hidden curriculum (Bolak, 2006; Margolis, Soldatenko, Acku, & Gair, 2001); however, it has emerged as teaching strategy for all students (Paris, 2012). Ladson- Billings (1998) says the institution of American schooling deliberately advances a hidden curriculum, which is intended to disenfranchise and marginalize African American students who are not taught the rules of power (Delpit, 1988). On the other hand, Ladson-Billings (1995a) says CRP is simply “good teaching,” in which teachers bridge the cultural gap between what is learned at school and what is experienced at home, and offers it as a remedy to racism in education (Ladson-Billings, 2006).

In *Fighting for our Lives: Preparing Teachers to Teach African-American Students*, Ladson-Billings (2000) outlines the struggle for a quality education for African Americans. She details 1) how teacher preparation literature inadequately articulates pedagogical and programmatic strategies, 2) the distinctness of the African American culture, and 3) strategies for teacher education reform. In *Crossing Over to Canaan*, Ladson-Billings (2001) delves into even more detail as she describes her investigation into how nine novice teachers develop cultural competency in working with African American students, which she likens to a spiritual journey across the Jordan River and into the Promised Land. Specifically, she evaluates the current educational and political climate, provides an example of a teacher as an exemplar, explores teaching citizenship, talks about her Teach for Diversity program, suggests areas for teacher education reform,

and shares her observations on eight additional teachers. She says that equipping new teachers to help poor students of color strive for academic success, cultural competence, and social justice reform are the keys to reforming education because due to the entrenched manifestations of racism in education, it is unlikely veteran teachers of today will see a system free of inequity, which she refers to as “The Promised Land” (p. 142). Ultimately, Ladson-Billings (1995a) indicates American schooling boasts a white middle-class culture, in which students of color, especially African American students often do not hold membership; however, when teachers incorporate principles of high academic success, cultural competence, and critical consciousness, they are facilitating critical pedagogy (Freire, 1970) or “pedagogy of opposition” (Ladson-Billings, 1995, p. 160), which is a style of teaching committed to collective empowerment and the deconstruction of the status quo’s marginalizing power. Thus, the three main principles of CRP are described in what follows to begin to operationalize the concepts of academic success, cultural competence, and critical consciousness (Ladson-Billings, 1995a, 2000).

Academic success. Teachers who demonstrate a commitment to CRP highly regard their student’s academic success and provide high quality instruction to promote achievement in science, reading, writing, math, technological competency, social skills, and political advocacy in an effort to cultivate active citizens in a global society (Ladson-Billings, 1995a). In doing so, culturally relevant pedagogues motivate students to choose academic success.

Cultural competence. Ladson-Billings (1995a) clearly states that cultural competence is not simply knowing about one’s culture; instead, cultural competence is fostered when teachers link students’ home culture, language, and traditions with

curricula and subject matter. Therefore, a teacher who highly regards cultural relevancy in his or her classroom would affirm those cultures represented therein each year by adapting the curriculum to the cultures and not the reverse.

Critical consciousness. Fostering the ability to critique cultural norms and the status quo is critical consciousness (Ladson-Billings, 1995a). Specifically, culturally relevant teachers empower learners to fight against such things as racist textbooks, unrepresentative curricula, and societal disenfranchisement.

CRP applied. Ladson-Billings' (1995a) framework has been extended to many environments, cultures, and ethnicities, such as higher education settings (Griffer & Perlis, 2007; Hill, 2009; McDonald, 2007; 2008; Ruiz & Cantú, 2013), counseling (Sue & Sue, 2008), medicine (Seeleman, Suurmond, & Stronks, 2009), and technology (Donnel, 2007), as well as those having Hispanic (Chun & Dickson, 2012; Rodriguez, 2010), Asian (Feng, 2009; Kumashiro, 2006), Arab (Bonet, 2011; Salhi, 2006), and multiple Indigenous backgrounds (Rata, 2012; Verwoord, Mitchell, & Machado, 2011). Picower (2012) presents a concrete framework to incorporate social justice into any traditional curriculum. Her framework demystifies how to incorporate CRP with instructional practices that empower children to fight against societal injustices that oppress marginalized groups of people, while learning the basics of reading, social studies, science, writing, and math.

Significance of culturally relevant teaching. Although Ladson-Billings coined and extensively elaborated about the term culturally relevant pedagogy (CRP), her original premise that empowering students by using cultural referents to facilitate knowledge, skills, and attitudes (Ladson-Billings, 1995a, 1995b, 2001, 2006) has

persisted into other theoretical conceptualizations of cultural teaching and development (Gay 2000, 2010). Consequently, culturally relevant teaching has emerged, with varying models and strategies for increasing the propensity for teacher educators and preservice teachers to embrace and perpetuate anti-racist ideologies (Gorski, 2006, 2009). For example, Gay (2000) discusses ideas of culturally *responsive* pedagogy, of which is mistakenly used interchangeably with culturally *relevant* pedagogy, to include cultural influences of how students think and behave, their preferences and motivations, and the impact of social groups and norms. In addition, Sleeter (2011a) notes three philosophies to address cultural relevance in the classroom. She describes a deficit approach where minority students are determined to be in need of assistance to maximize achievement, a structural approach, which focuses on issues of equity and access, and finally an emancipatory approach, which advances a transformational perspective. Also, Sleeter (2011b) calls for the strengthening of cultural research that links this pedagogy to academic achievement and encourages its advocates to brace for the inevitable backlash they will receive from the neoliberal framework that American schooling advances, which is characteristic of elite hegemony and racism.

Differences among cultural teaching frameworks. Several theoretical frameworks describe cultural teaching, which Paris (2012) says contributes to the widespread ambiguity among the education community. For example, Boutte and Hill (2006) suggest that culture is the most important tenant and should be used to connect student's strengths with school achievement. Boyle-Baise (2005) asserts that teachers must use student's life experiences, cultures, and histories to promote student learning. Howard (2001) states that teachers must be sensitive to individual student expression,

using collaboration, having a critical view of knowledge, and recognizing communication styles, learning styles, and perceptions of what each student deems as knowledge. Lake's (2010) theory suggests that culturally relevant pedagogues *see* skin color and incorporate personal stories to galvanize student's understanding of history, reading, math, and science by providing context to otherwise meaningless facts.

Lastly, a noted difference among frameworks is their relevance to student achievement. Many of these frameworks offer different rationales for student achievement, but one thing is clear, not enough of them experimentally link culturally relevant pedagogy to academic achievement because it is said that linking cultural teaching to academic achievement experimentally is difficult because controlling variables in different classrooms is nearly impossible (Douglas, Lewis, Douglas, Scott, & Garrison-Wade, 2008; Schellenberg & Grothaus, 2011; Sleeter, 2011b).

Similarities among cultural teaching frameworks. Historically, researchers and practitioners have referred to cultural teaching in a myriad of ways to include culturally congruent instruction (Mohatt & Erickson, 1981), culturally appropriate instruction (Au & Jordan, 1981), culturally compatible instruction (Jordan, 1985), culturally relevant teaching (Ladson-Billings, 1994a, 1995a, 1995b), and culturally responsive pedagogy (Gay 2000, 2010). However, Siwatu (2007) says that regardless of what it is called, all culturally related teaching is distinguished by 1) using student's cultural knowledge, experiences, and learning preferences to facilitate teaching and learning, 2) designing culturally compatible classroom environments, 3) providing students opportunities to demonstrate mastery with diverse assessments, and 4) providing diverse students with the knowledge, skills, and abilities needed to function in the

dominant culture, while simultaneously protecting cultural and linguistic identity and connection to their culture.

That said, most multicultural theoretical frameworks and models all contain some element of personal reflection for teacher educators, teacher candidates, or other professionals to reconcile their personal biases, beliefs, and prejudices toward students representing other cultures (Adler, 2011; Buehler, Gere, Dallavis, & Haviland, 2009; Brown-Jeffy & Cooper, 2011; Griffer & Perlis, 2007; Lenski, Crumpler, Stallworth, & Crawford, 2005; Lin, Lake, & Rice, 2008; Morrison, Robbins, & Rose, 2008; Murrell, 2006; Ruiz & Cantú, 2013). Secondly, many researchers and practitioners advocate for European American teachers and teacher educators to uncover their own cultural identity and reconcile with their whiteness (Galman, Pica-Smith, & Rosenberger, 2011; McIntyre, 1997; Sayles-Hannon, 2009; Steyn & Conway, 2010). Lastly, despite the differences between the two frameworks, many authors often use culturally responsive and culturally relevant pedagogy interchangeably (Gallavan & Webster-Smith, 2012; Quezada & Romo, 2004; Sobel, Gutierrez, Zion, & Blanchett, 2011) although culturally responsive pedagogy represents a less critical approach (Paris, 2012).

Multicultural Teaching Versus Culturally Relevant Pedagogy

Ladson-Billings (1995a) says there are many conceptual frameworks that claim to incorporate the principles of culturally relevant pedagogy; however, many of these alleged frameworks provide teacher educators and K-12 teachers misguided information about how to teach in a sociopolitical context, which Ladson-Billings (1995a) asserts must go beyond cultural sensitivity or facilitating a “feel good feeling” (p.160). For that

reason, I have synthesized both historical and contemporary efforts in multicultural teaching to demonstrate a three-part continuum of examples and non-examples of culturally relevant pedagogy. This continuum will include clear non-examples, near examples, and precise examples of teaching that is culturally relevant.

Many terms addressing teaching in culturally affirming ways, such as culturally responsive and culturally relevant, have mistakenly been used interchangeably (Gay 2000, 2010; Wallace & Brand, 2012). Therefore, to evaluate the rigor of these efforts, should these conceptual frameworks ever be used in training preservice science teachers, I assess each against the three main tenets of culturally relevant pedagogy as defined by Ladson-Billings (1995a, 2000). As previously described, CRP boasts three parts: high academic standards for success, cultural competence, and critical consciousness. Accordingly, the conceptual frameworks reviewed in this section must address each of these tenets to be able to be identified as an example of CRP. If one or more of the tenants are missing, the framework will be categorized as either a near or non-example.

In evaluating these frameworks as either commensurate or disproportionate with the ideals of CRP, I reference Nieto's (1994, 2010) conception of multiculturalism to frame the discussion because she describes educational settings by their instructional actions, cultural dispositions, values, and treatment of diverse students. Thus, she says school cultures are characterized as one of five ideologies: a) monoculturalism, b) tolerance, c) acceptance, d) respect, and e) affirmation, solidarity, and critique.

First, Nieto (1994) describes K-12 schools characteristic of *monoculturalism* as those who are staffed by mostly European Americans, operate under the color blind assumption, treat all students the same, and advance the dominant culture's values,

traditions, and histories at the expense of other cultures. Secondly, *tolerance*, her actual first level of multiculturalism, is one that is misused. Nieto says we must move beyond tolerance because while typical tolerant behaviors are sensitive to diversity, much like monoculturalism, the ultimate goal of cultural tolerance is assimilation to the dominant culture's values and traditions. Thirdly, *acceptance* is a genuine shift toward multiculturalism in which schools reject assimilation of the dominant culture's traditions, values, and histories, and every culture is distinctly identified as a separate entity as opposed to melting together in a pot back into one monocultural puree. Specifically, educators working in the acceptance level regard every student as having a distinctive or unique contribution to the class, and differences are not depreciated or disparaged. The *respect* level is where schools and staff demonstrate a high esteem for diversity. At this level, there are fundamental changes among the curriculum, the staff, and the students in that there is a productive shift in the way the staff and students perceive themselves, their school, and the larger society. Nieto says the last and highest level of multiculturalism is affirmation, *solidarity, and critique*, where students are encouraged to challenge social injustices and transformational teaching is based on confronting conflict and controversial topics like racism. So, students glean affirmation by critiquing various world-views and societal assumptions and injustices. A heightened sense of solidarity and critique is achieved with genuine personal reflection to allow the learner the ability to go beyond simply understanding their own perspectives but to consider others' perspectives and experiences as valid and valuable toward shaping higher order thinking capacities. As such, the stage, affirmation, solidarity, and critique is most closely aligned with CRP. Therefore, frameworks that espouse high academic standards, cultural

competence, and critical consciousness will more than likely promote the principles of affirmation, solidarity, and critique.

Non-examples. Cultural teaching models that advance a simple understanding of otherness or that promote only sensitivity for diversity do not encourage learners to foster cultural competence, think critically, or confront the status quo (Ladson-Billings, 1995a; Gorski, 2009). Gorski (2009) suggests such frameworks only prepare teachers to understand and tolerate diverse students' cultures, values, lifestyles, and thinking patterns, which in turn helps teachers to foster student assimilation to the educational system. These types of models are similar to Nieto's (2010) conception of tolerance. Nieto (1994) describes these kinds of liberal pedagogies as "tolerant" because teachers are simply striving for awareness of differences. So, in this case teacher educators would focus on teaching about various identity characteristics of groups of students in an effort to help these students better conform to the culture of American schooling. For example, the culture of poverty framework by Payne (2009) uses the lens of social class as opposed to race, ethnicity, gender, or disability to help teachers learn how to help students' transition between home and school.

When teacher educators promote cultural sensitivity, it allows teachers to become merely aware and tolerant of differences (Wood & Wilson, 1996). Typically, frameworks and models achieve this by encouraging the examination of educators' attitudes against various identity dimensions, such as race, gender, ethnicity, socioeconomic status, etc. Exemplars of this paradigm include the poverty framework (Payne, 2009), Kumashiro framework (2006), and warm demander pedagogy (Ware, 2006). A limitation to these seemingly liberal approaches is that they do not provide a

basis for how teachers can help students confront societal injustices.

Poverty framework. Payne (2009) suggests that American formalized schooling boasts a middle class culture, of which most teachers ascribe; this therefore prevents most teachers from deeply understanding and effectively teaching students who are victims of generational poverty. Thus, the poverty framework helps teachers understand why poor students of color struggle to conform to the middle class culture of American schooling, but it does not provide teachers training on how to foster their students' sense of cultural identity or the ability to critique social injustices. Therefore, this framework mostly advances the concept of otherness is

Kumashiro framework. Similar to Payne's (2009) poverty framework, Kumashiro's (2000) anti-oppressive framework helps teacher educators help K-12 preservice and in-service teachers negotiate sensitivity of otherness. In this framework, teacher educators strive to improve the educational experiences of diverse learners by training preservice teachers about the cultural dynamics of students of color. Specifically, teacher candidates receive instruction about what they do know versus what they should know about diverse students. Thus, only knowledge of otherness is advanced with this framework. Therefore, like the poverty framework (Payne, 2009), the Kumashiro framework falls short in preparing teachers to foster the main tenets of CRP, high academic success, cultural competence, and critical consciousness.

Warm demander pedagogy. Warm demander pedagogy is another framework that facilitates teaching with cultural sensitivity (Gorski, 2009). Ware (2006) describes warm demander pedagogy as a teaching style that prepares educators to work specifically with African American students. She bases her model on the theoretical framework of

the “cultural context of teaching and learning,” which views an African American student’s “culture as essential in improving academic success” (pp. 428-429). She notes that African American students need to be shown caring and nurturing attitudes in order to be motivated to achieve high academic success. So, while this is a useful framework for educating teachers on the learning needs of African American students, it does little to address high academic standards, cultural competence, or confronting the oppressive power structures in society. Therefore, again, much like the Poverty and Kumashiro frameworks, there is recognition of difference, along with an expectation for students to conform to American schooling, as opposed to the recognition that American schooling is inherently, historically, and systematically biased toward African Americans (Ladson-Billings & Tate, 1995).

Near examples. Some teacher educators advance theoretical frameworks that equip K-12 teachers with cultural intelligence necessary to respect and work with diverse students; however, these models of teaching are not as rigorous as transformational teaching strategies, such as culturally relevant pedagogy. In doing so, teachers learn to meet the learning needs of diverse students, but much like the before mentioned non-examples, there is no facilitation of cultural competence or critical consciousness. Instructional practices that are near example frameworks align with Nieto’s (2010) “acceptance” level of multiculturalism because many of the frameworks in this category reject the idea of assimilation to the dominant culture of schooling, and instead, there is a genuine shift toward multiculturalism. Examples of these near frameworks are cultural competency models (Griffer & Perlis, 2007; Quezada & Louque, 2002; Quigley, 2011), peace education (Quezada & Romo, 2004; Quezada & Loque, 2002).

Competency models. Griffer and Perlis (2007) say that cultural intelligence (CQ) builds cultural proficiency in developing competencies for teaching or working with diverse students. The cultural intelligence framework rests on the proposition that educators become more proficient in working with diverse students as their understanding of themselves and multiple perspectives of identity increases. Quigley (2011) used the idea of cultural competency models to transform science instruction by using multicultural strategies, such as reflective science talk, theoretical border crossing, and understanding funds of knowledge to create a safe third space for diverse learners. While this strategy increases a preservice teacher's cultural knowledge, it does not prepare him or her to facilitate academic lessons that simultaneously challenge societal injustices.

Peace education framework. The peace education framework, an outgrowth of the social justice and Civil Rights movements, provides a tangible vision of how to promote multiculturalism, peace, justice, and social equality by challenging preservice teachers and teacher educators to higher heights of inclusiveness (Quezada & Romo, 2004; Quezada & Loque, 2002). As opposed to teaching that confronts hegemonic forces, the goal of peace education is to create better citizens using a peacekeeping, peacemaking, and peace building curriculum that transforms the learning process by teaching about the causes of and alternatives to violence. While peace educators recommend high national standards within a multicultural context and specific themes by which credentialing programs must structure their courses and field experiences, they do not advocate for students to directly challenge oppressive forces or systems of violence.

Culturally responsive pedagogy. Historically, pedagogues committed to teaching in cultural ways attempt to simultaneously value diverse ways of knowing and dominant ways of knowing (Mohat & Erickson, 1981). Moreover, Gay (2000, 2010) explains that culturally responsive pedagogy (CResP) combines student needs, curriculum content, counseling, and instructional practices that are culturally sensitive and empowering to diverse learners. For example, Buehler, Gere, Dallavis, and Haviland (2009) build on the concept of culturally responsive pedagogy to negotiate emotional “fraughtness,” a sense of bewilderment toward dealing with cultural others and contextual dimensions of cultural competence, within a four-year qualitative study of five beginning teachers in the Teachers for Tomorrow program (p. 409). They advocate for teacher education programs to reduce the emotional fraughtness, or uncertainty, new teachers experience as a mechanism to begin a conversation about the challenges of culturally responsive teaching between novice teachers and teacher educators.

Gay (2000, 2002) suggests educators who subscribe to the CResP framework must adhere to five major characteristics: develop a knowledge base about cultural diversity, demonstrate caring attitudes and behaviors toward diverse students, build supportive learning communities for diverse students, communicate with diverse students and their families, and deliver instruction that responds to ethnic diversity. Gay explicitly says that culturally responsive pedagogy is defined as

using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively. It is based on the assumption that when academic knowledge and skills are situated within the lived experiences and frames of reference of students, they are more personally meaningful, have higher interest appeal, and are learned more easily and thoroughly (Gay, 2002, p. 106).

CResP serves as a near example of transformational teaching because CResP fosters only an acknowledgement and appreciation of cultural and racial differences. Further, CResP does not sufficiently foster students' knowledge of oppressive devices and institutions in society nor does it address how to confront those devices or institutions. Thus, while CResP orients teachers to the cultural ways and needs of students, it does not address how teachers can help students challenge societal injustices or confront the power structures to remediate those injustices.

True Examples. True examples of culturally relevant pedagogy (CRP) or transformational teaching are strategies that simultaneously impart academic knowledge, cultivate a positive self image, show how to deconstruct oppressive forces, and confront societal injustices as change agents using principles of social activism (Gorski, 2009; Ladson-Billings, 2000; Young, 2010). Teacher educators working in this milieu would equip preservice teachers with high quality instructional practices that engage students in social activism in community and school settings so they can pass this capability on to their K-12 students. This corroborates with Nieto's (2010) description of her highest level of multiculturalism, affirmation/solidarity/critique. Further, Mensah (2013) advocates for the use of CRP in science teacher education because she says that CRP is what is needed to increase the effectiveness of science teaching and learning because CRP addresses science educators' theoretical and practical understandings of sociopolitical forces. True examples of transformational teaching that are commensurate with culturally relevant pedagogy are the critical approach to teaching, culturally sustaining pedagogy, anti-bias curriculum strategies, teacher as transformational intellectual, and social justice education.

Critical approach. Teacher educators who teach in a sociopolitical context use the critical approach to examine issues of systemic oppression, power, dominance, and inequity in schooling (Nieto, 2010). Topics of study include understanding how racism, sexism, heterosexism, and Islamophobia, etc. contribute to an unjust educational system. Frameworks representative of culturally relevant pedagogy nurture a critical consciousness in preservice teachers, using critical pedagogies such as critical race theory, queer theory, feminist theory and critical multiculturalism (Gorski, 2009). Rubin and Rubin (2012) say the critical perspective, an outgrowth of constructivism, is characterized by a discovery and remediation of societal problems, where the researcher examines issues of oppression by giving voice to marginalized groups. For example, critical race theory (CRT) addresses how people can be used as change agents for racial injustices. Feminist theory involves issues of gender dominance and submission, and queer theory involves the examination of gender and sexual identity of people who identify as LBGT-G (lesbian, bisexual, gay, transgendered, and gender ambiguous) (Merriam, 2009; Rubin & Rubin, 2012). Therefore, culturally relevant pedagogy intersects with critical approach and Nieto's (2010) affirmation, solidarity, and critique level because at this stage educators demonstrate not only a high esteem for diversity by endorsing teaching and curriculum changes, but also advocate for a discovery and remediation of oppression.

Accordingly, culturally relevant pedagogy (CRP) as opposed to culturally responsive pedagogy is well positioned in a sociopolitical and critical context because Ladson-Billings (1995a) married this framework with ideas of critical race theory (CRT) (Ladson-Billings, 1995b). Her concept of CRP, or the practice of sociopolitical teaching

has influenced current ideology about teaching to and for diversity (Brown-Jeffy & Cooper, 2011; Morrison, Robbins, & Rose, 2008; Young, 2010). Her three-fold framework suggests the following: 1) Academic success is related to teachers setting high goals for achievement, 2) cultural competence is fostered when teachers act as a bridge in helping students to honor their identities and beliefs, while simultaneously accessing the expectations of the larger society, and 3) sociopolitical consciousness is when teachers foster the student's ability to question and critique social injustices. Sociopolitical consciousness is built on the first proposition of CRT in that racism is deeply embedded in the tapestry of American culture, so much so that institutionalized manifestations of racist ideologies and practices are viewed as ordinary, normal, and reasonable to the members in the dominant culture (Delgado & Stefancic, 2012). Ladson-Billings (1995b; 1998) more broadly suggests it is the teacher educators' role to increase other educators' critical consciousness, using an overall critical approach.

For example, educators who subscribe to a CRP approach help preservice teachers *critically* dismantle racist ideologies, such as meritocracy (Zamudio, 2011) because students of color have endured racist ideologies and practices in the American educational system (Ladson-Billings & Tate, 1995; Taylor, Gillborn, & Ladson-Billings, 2009). Examples of these oppressive practices are a decreased quality of education connected to a hegemonic strategy for instruction, assessment, funding, and contemporary segregation (Hill; 2009; Hyland, 2005; Ladson-Billings, 1995b), as well as race contingent maltreatment (Oates, 2009). Hill (2009) conducts a historical analysis of desegregation to discuss the implications of transforming teacher education with CRP. She summarizes what teacher educators need to do so that preservice teachers are able to

meet the challenges of an increasingly diverse student population. For example, Hill says teacher educators' need to: 1) implement reflective autobiographies, 2) investigate historical antecedents for American education, 3) foster teacher identity and awareness of white privilege, and 4) train teachers in culturally relevant pedagogy. Lastly, she provides teacher educators a detailed list of ten best CRP instructional practices she calls "resolutions" and a "recommended discursive topics and key references" (p. 134). See Table 4 for a brief summary of Hill's recommendations for teacher education programs. See Appendix A for a complete summary of recommendations for teacher education programs.

Table 4

Summary of Hill's (2009) Recommendations for Teacher Education Programs

Resolutions for Teacher Education Programs	Recommended Readings
<ol style="list-style-type: none"> 1. Implement a dialogue component throughout the program. 2. Examine the concept of whiteness. 3. Dialogue should be used to support inquiry-driven communities of practice. 4. Challenge notions of cultural encapsulation. 5. Openly challenge and reflect on candidates' existing belief systems. 6. Preservice teachers participate in diverse non-school settings. 7. Implement the use of culturally relevant pedagogy. 8. Integrate a theoretical framework that supports literacy development. 9. Students openly discuss racial controversies in urban and suburban settings 	<ol style="list-style-type: none"> 1. Anyon's (1997) <i>Ghetto Schooling</i> and Wilson's (1996) <i>When Work Disappears</i> about marginalized groups 2. McIntire's (1997) <i>Making Meaning of Whiteness: Exploring the Racial Identity of White Teachers</i> 3. The work of Weinstein et al. (2004) offers case studies and suggestions that confront the status quo in a manner that may appeal to preservice teachers. 4. Preservice teachers should be explicitly exposed to Ladson-Billings' (1994) <i>The Dreamkeepers</i> and Delpit's (1995) <i>Other People's Children</i>.

Thus, in line with the critical approach, Ladson-Billings (1998) proposes teacher educators, preservice teachers, and in-service teachers take part in participatory action research (PAR) to build efficacy toward confronting inequity. For example, Lenski, Crumpler, Stallworth, and Crawford (2005) use Ladson-Billings' ideas of CRP and PAR with short-term ethnographic studies to allow preservice teachers the opportunity to get

close to “other” cultures. This instructional strategy is intended to limit preservice teachers’ tendency to make stereotypical assumptions about students, who differ racially, culturally, economically, and linguistically from themselves. It also boasts the goal of increasing the academic success of all students.

In addition to CRP, other conceptual models that reflect the rigorous standards of CRP are culturally sustaining pedagogy, anti-bias pedagogy, teacher as transformational intellectual, and social justice education.

Culturally sustaining pedagogy. Paris (2012) advocates for culturally sustaining pedagogy. While he says his framework is a needed change in stance, terminology, and practice from the work of Ladson-Billings (1995a, 1995b), it actually elucidates a complimentary sociopolitical framework that simply adds a multi-linguistic component as a means for teachers to support students’ linguistic identity in conjunction with their overall cultural competence and critical consciousness.

Anti-bias curriculum strategies. Lin, Lake, and Rice (2008) promote the idea of anti-bias strategies in teacher education, using a theoretical framework of critical consciousness that includes internalized dialogue and unique field-based experiences, such as inviting parent guest speakers, fostering home visits, community based service learning, and role-plays. Cochran-Smith and Little (1999) call this a “knowledge of practice model” (p. 251), where university faculty purposely lessen the research to practice gap by scaffolding evidence-based practices sequentially, using theoretical rationales, modeling, application, coaching, and reflection. This concept of teaching is commensurate with CRP because it is manifested in a transformational framework that advocates for unique service learning projects and activism coaching.

Teacher as transformational intellectual. The teacher as transformational intellectual (TATI) framework is another manifestation of CRP used to teach preservice teachers how to change social injustices in education (Giroux, 2000; Slavich & Zimbardo, 2012). Sevier (2005) asserts that in order to reconstruct teacher education programs and K-12 settings, teacher educators must be trained in both culturally relevant pedagogy (CRP) and teacher as transformational intellectual (TATI) in response to the paradox that exists when teacher educators tell preservice teachers to be change agents without providing them with change-agent instructional opportunities. He says that CRP and TATI offer complimentary perspectives; specifically, CRP is intended to empower K-12 learners to critically examine injustices and then confront them, whereas the TATI framework encourages learners to simultaneously examine and confront societal injustices. Slavich and Zimbardo (2012) operationalize transformational teaching to include a four-way merger of social cognitive theory, intentional change theory, transformative learning theory, and transformational leadership. Transformational teaching is where teacher educators serve as intellectual coaches that guide learners through active learning, student-centered learning, collaborative learning, experiential learning, and problem-based learning in an effort to transform students from passive classroom listeners into passionate world-changers.

Social justice education. Social justice frameworks advance a transformational paradigm of culturally relevant education (Picower, 2012; Ruiz & Cantú, 2013). Ruiz and Cantú (2013) promote the dismantling of racism and teaching for social change in their study surrounding the deep inequities in Arizona schools to address ways teacher preparation programs can offer resistance training for preservice teachers in math and

English methods courses. They focus on specific ways teacher educators can impact curricula and teaching practices that convey social change by addressing 1) equity issues, 2) cultural identity, 3) cultural framing, 4) decolonization strategies, and 5) culturally relevant strategies and teaching modeled by university professors. Ruiz and Cantú (2103) say that teacher educators who model CRP for preservice teachers simultaneously develop a knowledge base about cultural diversity, facilitate caring learning communities, communicate with ethnically diverse students, and deliver instruction that offers resistance strategies to xenophobic laws and tenets of an oppressive government against diverse learners. Picower (2012) provides a tangible six-part framework for implementing a social justice-teaching model in an elementary school that engages young learners in social activism to bring about sociopolitical change for oppressed groups. This social justice education (SJE) framework spells out how to integrate critical socio-cognitive elements within the academic content to make SJE accessible and less obscure to classroom teachers. Thus, teachers can provide instruction in any content area, using a non-traditional context that fosters higher order thinking skills and democratic citizenship through cultural competence and critical consciousness. Specifically, Picower offers six steps, of which she says, are sequentially mandatory. They include:

- 1) self love and knowledge, 2) respect for others, 3) issues of social justice,
- 4) social movements and social change, 5) awareness raising, and 6) social action.

While this framework is used to illustrate what social justice curriculum could look like in an elementary classroom, it appears useful for teacher educators to train preservice teachers to implement the strategies in all K-12 levels and subjects. Worthwhile outcomes of her plan include de-privileging the dominant culture's

conceptualization of history and fostering higher levels of learning by challenging the status quo's oppressive interpretation of history and cultural entitlement. Some of the instructional practices Picower suggests include: publishing culturally relevant books, letter writing campaigns, self-portraits with skin tone identifications, blogging, filming documentaries, speaking at public hearings, organizing community outreach events, and creating on-line petitions (Picower, 2012).

The non-examples, near examples, and precise or true examples of culturally relevant pedagogy are categorized below in Table 5. Table 6 shows how each framework either does or does not relate to the three tenants of CRP. As seen in Table 6, the non-examples have no relation to any parts of CRP; however, the near examples contain at least one or two characteristics of CRP. And lastly, true examples of CRP have high academic standards, cultural competence, and critical consciousness manifested within the frameworks.

Table 5

Non-Examples, Near Examples, and Actual Examples of Culturally Relevant Pedagogy

Non-Examples	Near Examples	Examples
Poverty Framework Warm Demander Pedagogy Kumashiro framework	Culturally Responsive Pedagogy Peace Education Competency Models	Culturally Sustaining Pedagogy Teacher as Transformational Intellectual Teaching for Social Justice Anti-Bias Framework

Table 6

Checklist for Culturally Relevant Pedagogy

	High Academic Standards	Cultural Competence	Critical Consciousness
Poverty Framework			
Kumashiro Framework			
Warm Demander			
Culturally Responsive Pedagogy	X	X	
Peace Education	X	X	
Competency Frameworks	X		
Culturally Sustaining Pedagogy	X	X	X
TATI	X	X	X
Social Justice Frameworks	X	X	X
Anti-bias Framework	X	X	X

Culturally Relevant Science Teaching

There is a growing body of research that suggests science teacher education has begun to consider the merit of CRP (Bryan & Atwater, 2002; Mensah, 2011, 2013). This is largely because Bryan and Atwater (2002) and others (Atwater et al., 2010; Barton & Yang, 2000; Lee, Deaktor, Hart, Cuevas, & Enders, 2005; Mensah, 2011, 2013; Wallace & Brand, 2012) say cultural and racial beliefs have a considerable impact on teaching and learning practices; consequently, science preparation programs must help preservice teachers understand the social and political implications of schooling and their actions (Rodriguez, 1998). Therefore, as a starting point, Bryan and Atwater propose science

teacher educators design instruction that compels preservice teachers to confront racist or prejudiced beliefs and stereotypes. Specifically, they urge science teacher educators to implement meaningful exposures to diverse students (before student teaching) to spark reflection of personal biases and cultural tensions that negatively affect science teaching and learning. Further, Bryan and Atwater suggest educational researchers qualitatively study the impact culture and race has on science teaching, but most importantly, they say teacher educators themselves must engage in reflective practices, such as having explicit dialogues of white privilege with their colleagues and preservice teachers. Going beyond simple personal reflection and in reaction to the lack of tangible examples of CRP in science, Mensah (2011, 2013) advocates for the use of CRP in science education preparation programs to prepare preservice science teachers (and all teachers) to help students achieve high academic success, cultural competence, and critical consciousness. Accordingly, Mensah encourages culturally relevant teaching in which teacher educators confront and resolve their own biases and advance a pedagogy that equips K-12 science teachers to empower their students to learn deeply by challenging the status quo. For example, in *A Case for Culturally Relevant Teaching in Science Education and Lessons Learned for Teacher Education*, Mensah (2011) provides a tangible example for teacher educators to follow as she chronicles the work of three preservice science teachers as they teach a micro-unit on air pollution in a New York City elementary school. She reports that the preservice teachers in this study, all representing diverse ethnic/racial backgrounds, implemented a six-step unit lesson, whereby they facilitated an excitement for science in their 4th and 5th grade diverse students using culturally relevant teaching techniques as provided within the context of her elementary science methods course. In

this case study, Mensah reveals valuable lessons for science teacher educators as she describes how the three preservice teachers, Niya, Hope, and Estelle matriculate through a long process of planning and collaboration to teach in culturally relevant ways. Mensah makes three major assertions about what her preservice teachers learned as they implemented a culturally relevant unit. Mensah (2011) asserts that a) science teacher educators must foster strong mutual partnerships between universities and urban school systems so that preservice teachers can work in collaborative and supportive groups to plan for the instructional and assessment process; b) preservice teachers need to learn how to use language that empowers K-12 students to want to do science and build their sense of cultural competence; c) preservice teachers must learn to connect their personal interests and reasons for teaching science to real world concerns to foster critical consciousness through which they learn to confront oppressive social structures in society; and lastly, d) the use of micro-science teaching experiences (before student teaching) is a useful strategy to build a preservice teachers' self-efficacy because it establishes a "collaborative context to learn and enact the principles of culturally relevant teaching in an authentic science classroom with diverse students, learning styles, and interest."

A culturally relevant science example. As previously stated, Mensah (2011) documents the process and outcomes of a culturally relevant unit on air pollution that three preservice teachers in her elementary science methods course implemented. While the major lessons learned from this article are a noteworthy contribution to the field, articulating how the lesson was implemented from start to finish offers teacher educators a clear example of what culturally relevant teaching could look like, when given the

specific circumstances of the 4th and 5th graders in the article. First, the setting and the students are an important starting point because Ladson-Billings (1995a) suggests that CRP is shaped around the cultural factors of the students. So, it should be noted again that these mostly African American students lived in New York City, many of whom suffered from asthma. Therefore, the three preservice teachers, Niya, Hope, and Estelle collaboratively and extensively planned their unit on air pollution around the culture of their intended audience. This is an important factor because Mensah (2011) says that culturally relevant teaching takes a lot of planning time because culturally relevant pedagogues must get to know their students and cultural nuances before enacting anything. The objectives that informed the micro-unit lesson on air pollution were:

- Students will learn about the different components that make up air and understand what air quality is;
- Students will discover types of emissions that go into the atmosphere as a result of combustible byproducts from manufactured products (i.e., man-made objects including machines/industry, transportation vehicles, and home products);
- Students will understand the negative effects that these pollutants have on human beings, animals, plants, and environment; and
- Students will know how they can help reduce air pollution in their own communities (Estelle & Hope Lesson plans, as cited by Mensah, 2011, p. 300)

It should be noted that in addition to the first three objectives, which shape the science related content, the fourth objective facilitates action by the students to bring about a

desired change in their community, which Ladson-Billings (1995a) suggests is a necessary component of CRP. Mensah also summarizes the unit plan objectives, which includes instruction that cultivates high academic standards, cultural competence, and critical consciousness.

High academic standards. Mensah demonstrates that her preservice teachers are cultivating high academic standards with unit plan objectives, whereby 4th and 5th graders actively participate in an inquiry-based investigation that cultivates scientific literacy.

Table 7 illustrates the unit plan objectives.

Table 7

Unit Plan Objectives (Niya, Hope, & Estelle, as cited by Mensah, 2013, p. 300)

Lesson #	Lesson Objective
1	Pre-assessment: Students will discuss their ideas about the four learning goals of the pollution unit
2	Vaseline Experiment (Part 1): Students will prepare an experiment to investigate visible and invisible components in the air
3	Vaseline Experiment (Part 2): By collecting, observing, recording, and analyzing data, students will understand visible and invisible components of air
4	Researching Air Pollution: By carrying out group research sessions, students will read, listen to, and analyze a brief written passage to determine the causes and effects of a particular air pollutant assigned by the teacher
5	Poster Project (Part 1): Students will create posters to demonstrate what they have learned about air pollution and how it effects their community
6	Poster Project (Part 2): Students will present posters to demonstrate what they have learned about air pollution and how it effects their community

In this unit, the 4th and 5th grade students will be preparing and conducting experiments, recording and analyzing data, presenting their findings, and engaging in literacy development with science content, all of which are critical aspects of fostering scientific literacy according to the Next Generation Science Teaching Standards (2013).

Cultural competence. Ladson-Billings (2000) says fostering cultural competence is often disregarded in multicultural teaching frameworks that espouse to embrace CRP principles. To facilitate cultural competence Mensah (2011) asserts,

In order to teach in culturally relevant ways, preservice teachers must use a language that allows them to elicit student roles that empower students to want to do and learn science; this includes ways to engage students in the knowledge, language, and skills of science—formally (in school) and informally (at home)—and to make personal connections to science. The goals and content for teaching science must be educationally beneficial, such that preservice teachers “develop and/or maintain cultural competence” (Ladson-Billings, 1995a, p. 160) for the students they teach (Mensah, 2011, p. 301).

Therefore, Mensah argues that science teacher educators must show preservice teachers how to engage students in relevant science learning that unites science to their lives. So, in the air pollution unit, the preservice teachers regularly referred to the students as *scientists* to encourage them to begin to see themselves as doing science and being scientists. Secondly, during the lesson, the students were making observations of Vaseline placed on index cards placed throughout the classroom and used real tools of science, like magnifying glasses to analyze their samples. Thus, Mensah reported that the students were excited and proud of what they were doing, as opposed to simply reading about it. Further, these preservice teachers bridged the student’s interests and home lives

with school by engaging the students in a discussion about how their Vaseline index cards might look if they were placed in various places around their homes. Lastly, the 4th and 5th grade students were encouraged to brainstorm ways that air pollution could be reduced in their homes and the community and presented their findings with a poster, which highlights that teacher educators must help preservice teachers shape the curriculum in a way that helps students take pride in offering solutions to science related issues that plague their lives.

Critical consciousness. To facilitate critical consciousness Mensah says,

In order to teach in culturally relevant ways, preservice teachers must also include their personal interests and reasons for teaching science content. The goals and content for the lesson must also be culturally and personally relevant and focus on real-world connections, such that preservice teachers “develop a critical consciousness through which they challenge the status quo of the current social order for themselves and their students through science. (Mensah, 2011, p. 303).

The detailed teaching vignette Mensah (2011) shares is an ideal example of how a teacher educator fostered CRP in preservice teachers because not only were high expectations and cultural competence fostered, but the preservice teachers connected the content to the circumstances the students perceived in their communities to promote a critical consciousness in their young budding K-12 scientists. For example, Estelle, a Latina/African American shared with the 4th and 5th graders that she was motivated to conduct this experiment because she lives in the same community many of the students do and her two sons have asthma, much like the 4th and 5th graders in the class did. So, Estelle supported her reasoning for teaching about air pollution with research and statistics that strongly suggested there was a disproportionate amount of air pollution in their community in comparison to the more affluent white neighborhoods in New York,

which was instigating increased cases of asthma and other health complications. She called this phenomenon “environmental racism” (p. 303), and says it attributes to the many days her sons have to miss school, which adversely affects their school achievement. Thus, the preservice teachers had to conduct a separate analysis before the lesson to gain background information, in what Mensah (2011) calls a micro-teaching paper, about the particulars of environmental racism, so they could speak knowledgeably about this issue in an age-appropriate way for the audience, in this case, 4th and 5th graders. Consequently, the preservice teachers facilitated a discussion and brainstorming activity about how the students could take action against the disproportionate air pollution in their communities.

While Mensah appears to be one of the few who provide tangible examples of CRP in science, there are other science education researchers and teacher educators committed to equity and empowerment of diverse students who have made significant contributions in the field. Therefore, in what follows, the research that contributes to culturally relevant science education are discussed. Specifically, the research foci in science education includes investigating the impacts of inequity on English Language Learners (ELLs), confronting the culture of power, using constructivist theories to explain science inequity, and examining beliefs and practices of teachers and teacher educators.

Racially and linguistically diverse students in science. In addition to working with culturally diverse students in general, the growing body of research surrounding CRP in science has taken a particular focus on preparing preservice or in-service teachers

to work with Hispanic students, who speak English as a second language (Johnson, 2011).

An instructional intervention. Using a pre-post non-experimental design, Lee, Deaktor, Hart, Cuevas, and Enders (2005) examined the impact of an academic remediation intervention on science and literacy achievement of 1,523 culturally and linguistically diverse 3rd and 4th grade students, who normally received instruction on English for reading, writing and math, but received no instruction in content areas like science in their home language. During the study, students were provided additional academic tutoring in both their home language and English. The study focused on three areas: a) overall science and literacy achievement, b) achievement among demographic subgroups, and c) comparisons with national and international samples of achievement. They found statistically significant differences between pre and post-tests on all measures of science and literacy at both grade levels after the intervention. The authors posit the way we teach students who are culturally and linguistically diverse is only effective if we train our teachers (using professional development workshops) to be able to deliver the curriculum in such a way so that the students can access the information through barriers that have been blocking them (i.e. language barriers, reading challenges, disabilities, etc.).

Transformational professional development. Similarly, Johnson (2011) discusses the road toward culturally relevant science for culturally and linguistically diverse students. She says that simply preparing science teachers with inquiry-based instructional practices is no longer enough. Therefore, in a three-year longitudinal study Johnson implemented a transformational professional development (TPD) program aimed

at transforming the participants' beliefs and teaching practices to become more reflective of CRP. She began by examining eight Caucasian American middle school science teachers in an urban school district that served primarily students with Hispanic heritage; however, she reported on only two who completed the three-year process.

During year one, Johnson (2011) focused on building relationships, effective cultural teaching, and personal reflection among the eight science teachers. For instance, they learned about science instructional strategies, such as implementing inquiry-based labs, establishing positive student expectations and cooperative learning environments, and learning about culturally relevant concepts, such as the funds of knowledge framework. Additionally, in the first year, the eight teachers reflected on a home visit of one of their students and on a mandatory Spanish-speaking course during a two-week summer session. In year two, the eight teachers participated in several training sessions aimed at designing lessons that included scaffolding instruction, cooperative learning, teacher empowerment, classroom management, and cultural nuances of the Hispanic students' lives and families. This information was translated into science teaching in a manner that illustrated how science and innovation influences the students' lives. For example, the teachers learned how to incorporate artifacts or current events from the student's lives, such as a tortilla press to demonstrate the importance of simple machines or current sociopolitical issues, such as agriculture or transportation. In doing so, the teachers continued to build rapport with the students and their families whereby they cultivated "communities of learners" (p. 176). In year three, only two teachers, Mr. Roberts and Ms. Fields, remained due to the high attrition of teachers and school closures in the particular school district. In several interactive training sessions, these teachers

learned about how to implement alternative assessments, modify the curriculum, develop common discipline plans, and fully implement CRP into the science class with writing and journaling.

From this research, Johnson (2011) found that the two teachers learned to enact inquiry investigations or experiments that simultaneously helped the students view the world with a critical lens and the teachers to enact a socio-political instructional approach. For example, as opposed to implementing traditional inquiry-based experiments, Mr. Roberts and Ms. Fields facilitated lessons whereby the students critiqued knowledge in science, questioned authority figures about the use of direct instruction in science classes, searched for alternative explanations for the oppressive forces in the student's lives, and discussed community events, such as vandalism by neighborhood gangs, in a way that helped the students critique effective and ineffective ways to have their voices heard by the power structures of society.

Another notable outcome of the socio-political instructional approach is that Mr. Roberts and Ms. Fields learned how to incorporate literacy into science instruction, using cognitive scaffolding to build on the student's prior experiences to generate new knowledge within the science classroom. In the same vein, Ladson-Billings' (2000) would suggest this is just good teaching where educators use high quality instructional practices to engage students. For example, the teachers would start with a concrete activity, build vocabulary around the activity, and then connect the concrete activity to an inquiry investigation based on some scientific phenomenon. An example of this was seen in Ms. Field's class when she first asked her students to use Oreo cookies to model what the moon looked like at various times in the night sky in their neighborhoods. Then she

introduced the concept of moon phases and compared this to the students' Oreo cookie models. Also, although difficult in terms of the time constraints of the district's pacing guide, the teachers learned to use performance-based assessment strategies instead of relying on traditional multiple choice tests that point to only one right answer.

The culture of power. Barton and Yang (2000) considered the culture of power within science education by delving deeply into the life of one participant, Miguel, a homeless Hispanic American male. They defined "culture of power" using Delpit's (1988) framework upon which they made assertions about American schooling and science education in particular in light of Miguel's very personal accounts from his science classes and other school experiences. Barton and Yang reported that Miguel was systematically discouraged from taking rigorous science courses and was discouraged early by his teachers from pursuing his innate sense of inquiry and interest in herpetology, the study of amphibians and reptiles. With his interests not being supported or encouraged by his teachers, eventually Miguel reported that he dropped out of school because he said school was a waste of time. Thus, Barton and Yang suggest that most diverse and socioeconomically disadvantaged students are systemically discouraged from formal science, and science educators and policy makers must move beyond the rhetoric of science-for-all that many national science curriculum developers espouse. Further, they suggest that science teacher educators and policy makers must really deal with the sociopolitical injustices that prevent science-for-all initiatives from becoming a reality because science-for-all initiatives preserve the inequity seen in science education by culturally and economically disadvantaged students, such as Miguel. Barton and Yang say,

In short, the culture of power is present in all domains of science and science education. So, if all students are to be allowed to become full members of the culture of power in science and science education (and be allowed to help shape that culture), then we must seriously consider not only how we teach science, but also [what] science we teach and its relationship to students. (p. 876)

Further, they purport “students learn that boundaries exist which separate who is and who is not capable of science through textbook and class activities and the kinds of out-of-classroom activities valued in school” (Barton & Yang, 2000, p. 875). Finally, Barton and Yang provide recommendations for the science education community to reform instruction that is culturally relevant, especially for student that are economically disadvantaged. First they suggest that researchers continue to capture the science experiences of marginalized inner-city students, so that science-for-all can be genuinely implemented. Secondly, educational researchers must take the “culture of power” into consideration if there is to be honest attempt at transforming science education into an equitable institution. Lastly, Barton and Yang argue that American schooling must stop forcing those who do not have membership in the culture of power from abandoning their cultures or deeming them as subhuman or inferior.

Social Constructivist Theory. Rodriquez (1998) is well-known for suggesting that science education must adapt to the increasingly diverse student populations. However, he suggests that science education should study the cultural mismatch between the teaching force, which is mostly white and middle-class, and the culturally, racially, and linguistically diverse student body, using a sociotransformative paradigm of thought (Rodriguez, 1998). Using a “sociotransformative constructivist orientation to link multicultural education and social constructivist theoretical frameworks” (p. 589), Rodriguez investigated two types of resistance that 18 preservice science teachers

experienced in a diverse middle and high school setting. These two types of resistance were defined as resistance to ideological change and resistance to pedagogical change. Ideological resistance refers to the guilt, disbelief and defensive guards preservice teachers emit when they are asked to face topics like racism. Pedagogical resistance is the cognitive conflict created for the preservice teacher by conflicting messages from their student teacher supervisor and university supervisor. In this seminal piece, Rodriguez differentiates between empowerment and equity in science education curriculum and makes the argument that these concepts are particularly important in science education because underserved and underrepresented populations are purposefully and perpetually excluded from the sciences; thus K-12 science teachers need to be able to impart empowerment and equity as two separate constructs for diverse learners.

In this article, Rodriguez (1998) provides some guidance about how teacher education programs should transform their programs to prepare preservice teachers to meet the challenges of an increasingly diverse classroom as well as outline what concerns Anglo-European teachers have regarding multicultural education. Rodriguez says the science education community must go beyond “recommending minor curriculum adjustments” and truly use multiculturalism as a theory of social justice and “driving principle in the development and implementation of [empowering] policies, curriculum, and assessment” (p. 591). Thus, in this work he provides the science community an excellent explanation of why culturally relevant teaching is not prevalent in teacher preparation programs when he says that Caucasian American teachers disregard teaching in culturally affirming ways because they have adopted the colorblind philosophy toward otherness that has been passed down to them by the culture of American schooling. In

this way, he agrees with Barton and Yang (2000) about preservice and in-service teachers who struggle to confront their own biases and contributions to the inequity that is perseveres in science classrooms. Rodriguez says it is “frustrating and uncomfortable for them as members of the culture of power to confront the social and political complexity of teaching” (p. 606). For example, in Rodriguez’s study, he says Heather’s (member of the student teacher focus group) rejection of multicultural education from start to finish and the other three participant’s (in focus group) preoccupation with ethnicity as the only lens for multicultural education indicates there is a need for further study and a restructuring of the student teacher internship experience.

Rodriguez (1998) found that the participants voiced resistance to broaching the subjects of racism and inequity in science education, which Nieto (1994) would deem as monocultural. Many of the students participated in reflexive discourse activities, and in doing so, Rodriguez gleaned that the student’s comments manifested into feelings of hopelessness and being overwhelmed about how massive the problem is of teaching diverse learners. He found that the students in the methods courses were uncomfortable confronting issues of sociopolitical injustices as members of the dominant culture. Yet, the students reported that the class activities helped them to have an increased awareness of sociopolitical injustices (ideological change), but they still needed concrete tools to make changes in the classroom (pedagogical change). One of the participants, “Heather,” concluded she did not think a teacher should make note of diversity in the classroom because it would lead to stereotypes. Rodriguez noted, “Heather’s well-articulated and deeply entrenched ideological resistance to teaching for diversity provides a good

example of how difficult it can sometimes be to assist preservice teachers to learn to teach for social justice...” (p. 609).

Examining beliefs and practices. Johnson (2011) says “most teachers fail to understand the impact systematic inequities” have on underserved and marginalized students (p. 193). Similarly, Bryan and Atwater (2002) suggest that a starting point to understanding the role of sociopolitical oppression and personal bias in preserving inequity in science education is examining teachers’ and teacher educators’ perceptions and practices.

Using Critical Theory. Atwater et al. (2010) investigated the cultural understandings and actions of two preservice science teachers toward diverse students, who represented a different race or ethnicity from the preservice teachers, using the critical theory framework. The authors discussed the two middle class female participants in terms of their ideas about teaching students who represent “otherness.” Based on a detailed account of many transcribed statements, Atwater et al. found the teacher candidates were unwilling to truly consider “otherness” when trying to create a learning experience for minority students. The authors conclude that both of the participants believed race, culture, and ethnicity were not important factors in learning about science. Atwater et al. (2010) call for critical guidance for preservice K-12 teachers because many science teacher educators and teachers lack cultural understandings and practices. Specifically, Atwater et al. say,

. . . when science teacher preparation programs do not infuse multicultural education, teacher candidates have little opportunity to develop their knowledge and skills to respond to “other” students, so that their future “other” students have an equitable opportunity to learn quality science. (p. 307)

Secondly, Atwater et al. (2010) call for the need for preservice teachers and teacher educators to have structured opportunities for self-reflection regarding their personal biases and ideas about how to teach students with "other" backgrounds. Moreover, the authors demonstrated their findings, using racially explicit comments by the participants, which were vetted using member checking.

Science Teacher educators' beliefs and practices. Mensah (2013) argues that in the wake of increasing student diversity, preparing culturally competent K-12 science teachers is a pressing issue facing science teacher educators. As such, science teacher educators can no longer ignore their role in shaping K-12 science classrooms, many of which contain racially, culturally, and linguistically diverse students. Therefore, Mensah suggests teacher educators consider theoretical and practical issues when teaching preservice and in-service teachers about diversity and equity in science teacher education. First, she recommends that science teacher educators consider five theoretical frameworks: principle of ideology, critical pedagogy, critical reflective inquiry, multicultural education, and issues of diversity. The *principle of ideology* refers to helping teachers examine their thinking, values, and biases while simultaneously examining the mainstream cultural assumptions that may or may not hinder student achievement. *Critical pedagogy* is teaching that challenges the social structures of power. *Critical reflective inquiry* is facilitated when preservice teachers are encouraged to question societal structures and concepts they may have long disregarded. For example a teacher engaging in critical inquiry may begin to acknowledge how the system of education is oppressive to African American students and then begin to change this the teaching practices needed to support it. *Multiculturalism* is more than celebrating

cultural heroes and holidays. Instead it is a philosophy of education that encourages cultural influences in the areas of curriculum, teaching style, and the ethos of a school. Lastly, *issues of diversity* refer to teacher educators conceptualizing multiple perspectives for student learning and assessment and understanding their student's identities, cultures, and subject matter. Secondly, Mensah (2013) suggests practical applications for teacher educators to link theory with practice in preparing preservice teachers to enter K-12 science classrooms. Specifically, she advocates for science teacher educators to examine their own teaching beliefs and practices, and how they talk with preservice teachers, so that preservice teachers can begin to critique how they will interact with their future K-12 students. In this way, Mensah suggests preservice teachers apply pieces of the five theoretical perspectives to see how useful the perspectives are with teaching scenarios. So, she insists that preservice teachers "narrate their emerging understandings of how to teach science to culturally diverse student" (p. 68). Also, she recommends that science teacher educators facilitate discussions, using *Ways with Words*, by Shirley Brice Heath (Heath, 1983, as cited by Mensah, 2013) to foster discussions surrounding diversity, language, and science teaching. Mensah says although this book has traditionally been used in literacy contexts, it is useful for science teacher educators because it is a story about three culturally different communities in Piedmont Carolina in the desegregated South in which teachers work as ethnographers and find ways to more effectively communicate with children and adults in the diverse schools.

Theoretical and Conceptual Framework

Mensah (2013) advocates that science teacher educators "establish both theoretical and practical lessons for preparing preservice and in-service teachers to teach

diverse students” (p. 71). Similarly, using critical theory, Atwater et al. (2010) argue science teacher educators must examine their cultural understandings and actions.

Moreover, though Wallace and Brand (2012) agree beliefs and practices shape pedagogy, they also contend that personal experiences that have racial implications also influence beliefs and practices, which shapes pedagogy. Specifically, Wallace and Brand found that the “beliefs and practices of their participants (K-12 teachers) were informed by [their] critical awareness of the social constraints imposed upon their African American students’ identities” (p. 341). Therefore, using a phenomenological case study approach as described in Figure 2, how personal experiences with race influenced science teacher educators’ teaching beliefs and practices were explored. In doing so, critical race theory was used, which provided an analysis for the sociocultural and political implications of skin color to reveal the enduring influence of race in science education (Wallace & Brand, 2012). In this context, science teacher educators’ knowledge about culturally relevant pedagogy (CRP) and the way in which they prepared preservice teachers to address the learning needs of African American students in science were examined with the following research questions:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their beliefs and personal experiences related to race that have impacted their teaching beliefs and practices?

Contribution to the field of science education. Many of the studies discussed in this chapter represent multicultural efforts in general because there has not been a long-term and comprehensive focus on multiculturalism or social justice in science education, especially with African Americans (Bryan & Atwater, 2002; Mutegi, 2013). The focus of the current study is significant because, as previously noted, African American students are often discriminated against in American schooling and in science in particular, based on historical antecedents, such as slavery and Jim Crow laws, which were purposefully used to impose an inferiority complex on African slaves of past decades as well as contemporary African Americans (Ladson-Billings & Tate, 1995; Mutegi, 2011, 2013). This hegemonic trend is evidenced by the dismal numbers of African Americans seeking STEM careers and the significant science achievement gap between African American and Caucasian American students (Lewis & Collins, 2001; Parson, 2008). Secondly, to the author's knowledge, this study is the first to examine race and culturally relevant pedagogy from the perspective of white and black science teacher educators. Atwater, Butler, Freeman, and Parsons (2013) focused on race and issues of multicultural education, equity, and social justice, but they did it from the perspective of only black science teacher educators. Similarly, Wallace and Brand (2012) examined race and culturally relevant pedagogy, but they did so with K-12 in-service teachers. Therefore, understanding how science teacher educators perceive their personal experiences in relation to their practice, especially regarding preparing K-12 teachers to teach African American students is important. Ladson-Billings (2000) says "teacher preparation is culpable in the failure of teachers to teach African American students effectively" (p. 208), which speaks to the enduring nature teacher educators have on K-12 outcomes.

To conclude, Chapter 2 addressed the historical complexities of race in the US, how the field of science is an exemplar for inequity, and the many teaching frameworks which espouse varying commitments toward teaching in culturally affirming ways, including CRP, which is a transformational approach for engaging students. The next chapter describes this study's methods. It includes a description of the study's design, the role and biases of the researcher, information about the participants and setting, and a detailed section about the collection, analysis, and coding procedures. The next chapter also goes into detail about the steps taken to achieve trustworthiness.

CHAPTER 3

METHODS

The overall purpose of this study was to find out how science teacher educators prepare preservice teachers to engage African American students in K-12 science. The researcher attempted to identify how science teacher educators reported their understanding of culturally relevant teaching in the context of science education by using Ladson-Billings' (1995a) definition of culturally relevant pedagogy. First, the researcher examined the teaching practices the science teacher educators' reported using to prepare K-12 preservice teachers to engage African American students in science. Secondly, the researcher also delved deeply into a subset of white and black science teacher educators to more intensely examine how their beliefs and personal experiences related to race have impacted their teaching beliefs and practices in regards to preparing preservice teachers to engage African American students in science. Finally, as aligned with the critical approach, the researcher facilitated personal reflection among four participants about how their experiences and race impacts them and their practice. Thus, I used qualitative methods to learn *how* science teacher educators prepare preservice science teachers to cultivate an interest in science for African American students.

Denzin and Lincoln (1994) say the qualitative research process should begin with a comprehensive analysis of the epistemological framework of the researcher so as to understand her biases, motivations, study rationale, and chosen methods. Therefore, part one of Chapter 3 begins with a detailed discussion of the rationale, assumptions, and epistemological framework of the researcher because these concepts greatly undergirded the motivation for the current study. Due to the personal nature of this section, the

pronoun ‘I’ will be used. Following the epistemological framework, the main purpose of this chapter is discussed in part two with great detail, wherein a comprehensive explanation of the study’s design, participant selection, measures, and procedures for data collection and analysis are included. Part two of this chapter is further divided into two phases that describe how the research was conducted. Lastly, issues of trustworthiness and limitations are addressed.

The Role of the Researcher

The rationale for this study is based on the emerging interest in cultural relevance and reform in the field of science education (Bryan & Atwater, 2002; Mensah, 2013; Parsons, 2008). Mensah (2013) says there is not an abundance of literature describing best practices in culturally relevant science education to provide examples or non-examples for others in the field. More importantly, Bryan and Atwater (2002) assert, “science educators need to continue to identify those beliefs and practices that undergird desirable and equitable science instruction” (p. 821). Therefore, the purpose of this study was to critically examine the lived experiences of science teacher educators to better understand the beliefs and practices used to prepare preservice teachers to engage African American students in K-12 science. Consequently, I examined the extent to which science educators understood culturally relevant pedagogy and prepared preservice science teachers to teach to and for diversity in an effort to glean examples or non-examples of culturally relevant science teaching. More specifically, I investigated the extent to which a dichotomous relationship existed between what the participants said was important about teaching diverse students versus their professed teaching practices, and in doing so, sparked personal reflection (Sayles-Hannon, 2009; Shandomo, 2010) in

the participants about CRP as a strategy to confront injustices and improve the science achievement gap among African American students. Facilitating introspective reflection among participants is acceptable for research grounded in critical theory because one of the goals of critical research is the declaration and remediation of societal injustices for which the researcher openly admits her biases or personal connection to the topic of study (Dunbar, 2008; Kincheloe & McLaren, 1994).

Epistemological Framework. Harteis, Gruber and Lehner (2006) suggest that understanding epistemological beliefs are important because of their impact on problem solving approaches. The ability to see interconnections among factors that link our human experience helps facilitate creative and responsive problem solving for complex situations; however, overly simplistic and ineffective solutions arise in the absence of these interrelated understandings (Harteis, Gruber, & Lehner, 2006). For example, I realize that my life experiences are uniquely connected to so many others, which have all helped to shape my way of thinking and outlook on the world. Thus, my interest in sociopolitical teaching is directly linked to my experiences from childhood to adulthood; however, my ability to add meaningful contributions to this field rests on being able to perceive my biases, motivations, and epistemology.

I believe that knowledge is constructed by our interconnected experiences; subsequently, America's societal injustices today are uniquely linked to the societal injustices of our interconnected past, such as colonialism, slavery, and European dominance (Dyson, 2006; Klein, 2010; Mutegi, 2010; Spring, 2008). Therefore, the ability to create solutions to institutionalized racism in American schools is connected to our ability to cooperatively examine the "cultural context of our epistemic beliefs" (Hofer

& Sinatra, 2009, p.118) because racial stereotypes and prejudice generate epistemic injustice (Coady, 2010; Hookway, 2010).

I openly acknowledge my beliefs and personal relationship to this topic because my role as a critical researcher is not to maintain neutrality (Kincheloe & McLaren, 1994), but instead is to contribute to the overall remedying of racial maltreatment in American schooling and science education in particular. First, like many others (Lin, Lake, & Rice, 2008; Picower, 2012; Ruiz & Cantu, 2013; Servier, 2005) I believe the authentic incorporation of culturally relevant pedagogical principles, such as fostering cultural competence and critical consciousness in teacher preparation programs, could serve as a potential antidote to the racial maltreatment of African American (or black) students in education. Specifically, I subscribe to the position that if all preservice teachers were able to participate in preparation programs that comprehensively integrated the ideas of setting high academic standards, cultural competence, and critical consciousness, then they would know what culturally relevant pedagogy *looks like* in higher education *and* K-12 settings. Therefore, I believe if all science teacher educators would model CRP, as well as teach preservice teachers how to facilitate it in their K-12 classrooms in such a way that authentically included on-going personal reflection of cultural and racial biases, then K-16 learning outcomes in science would increase (Mensah, 2013; Parsons, 2008). So, instead of science teacher educators addressing preservice teachers who lack cultural competence with a deficit approach (Lowenstein, 2009; Settlage, 2011), they would model CRP in a way that helps them learn how to teach in culturally relevant ways, while uncovering their own culture and sense of ethnicity (McIntyre, 1997), so they in turn are capable of doing the same for their future

K-12 students, thus alleviating all educators' misunderstanding of individual and systemic racism (Young, 2011).

My story. I matriculated in a monocultural PreK-12 school setting in an affluent area in the state of Maryland. In my classes, I was usually one of only a few black students, and there were hardly any Hispanic or other students of color in my elementary, middle, or high school. Further, I came from a working class family; so, I always felt different and believed that my classmates and teachers viewed me as not belonging.

As I reflect on my time as a K-12 student in the 1980's and early 1990's, I realize that my current interest in education reform originated with the many discussions I had with the few teachers of color at my high school. I remember always talking about the fact that I did not see many people of color in my textbooks or as leaders in our school (Spring, 2004). I was culturally, socioeconomically, and racially different from my peers and teachers, and the mostly white teachers and students in my schools rarely fostered a positive relationship with me. Consequently, I always felt somehow inferior to my white teachers and classmates or perhaps I felt they thought of me as inferior. In any case, many of the other black students and I usually sought solace with each other and the few other black teachers, who helped to validate our feelings and experiences. As Delpit (1988) explained, there is a culture of power held by the white educators and decision makers, and I was never welcomed into that culture of power. So, during my 12th grade year, on the advice of the faculty mentor for the Black Student Association, I took matters into my own hands and made myself known. I volunteered for every school position I could. I made sure I stayed after school and participated in clubs and organizations that had a voice in the school, and I spoke up when things were not right.

For example, our senior class picture was conveniently scheduled on a day when the majority of the African American students were scheduled to be on a college tour, which meant that hardly any black students would be included in the iconic senior class photo. So, I successfully petitioned parents and other trusted adults, to hold the administration accountable for such an “oversight,” whether intentional or not.

Even though I was not part of the culture of power, I made sure that my voice was heard because my parents, who were of the working class, never had the opportunity to actively participate in my school experience or attend many of my school functions. It was not because they did not care about my education, but like many poor families in America, it was because they always had to work (Obiakor, 2007). My parents went to extreme measures to work overtime to make enough money to be able to live in an area with such an affluent school system versus living in a less expensive area with inadequate schools. Thus, my family struggled financially just to send me to an affluent school, which was situated in one of the highest real estate markets in the state of Maryland.

Secondly, I believe my schoolteachers’ expectations were somewhat lower for me as compared to my white peers, and I felt that I never truly measured up with my white peers. This translated into a lot of self-doubt and unnecessary comparisons. I believe this is also why I talked myself out of a “pre-med” undergraduate major because I unconsciously thought I could not be successful in such a competitive field. This phenomenon is corroborated by Hochschild (2003) in that she asserts minority students in many cases are not afforded the “opportunity to learn” because of a historical and systemic cloud of separateness and discrimination in the U.S educational system.

As a result of my K-12 experiences, I felt called to the education field to transform it into a more inclusive and affirming institution. I eventually graduated from a multicultural teacher education program in Virginia, whose mission was to train “culturally competent professionals in education.” I used the information I learned in this program and applied it in my second year of teaching because I saw firsthand the inequities for students, teachers, and disenfranchised families, and the consequences of unbalanced funding in an antiquated and discriminatory system, where real estate taxes dictated which schools represent the haves and which represent the have-nots. It was as if my high school mentors knew if given enough time, I would finally understand what had eluded me as a somewhat privileged minority high school student in an overly suburban community. Now, as a special education biology teacher, my under-resourced classroom was riddled with mostly African American students receiving a range of special education services, who voiced no interest in learning science. I was not given resources, such as a room with a sink, microscopes, etc. to provide a high quality science experience; instead, I was expected to facilitate rote memorization activities for the state assessment. I felt like a glorified babysitter for students, many of whom had been tracked into a learning disabilities and emotional disturbances science class.

However, using the skills I learned in my graduate teacher preparation program, I transformed my students’ classroom experiences and not only made their science learning relevant to their ways of thinking and knowing, I showed them and their parents how to challenge the very system that put them in this lower level science class. For example, we wrote letters to the science instructional leader and the principal about the conditions in our science room that did not even contain a sink, a window, lab tables, or

microscopes; whereas, the other classrooms contained these things and so much more. In short, I agree with Russell and Atwater (2005) in that science is a subject area that has been “historically” (p. 692) segregated and advances the dominant culture’s traditional ways of knowing as superior to other ways of knowing (Mutegi, 2011) because black students in this school where I was teaching had substandard science classrooms, but the students in the international baccalaureate program, who were mostly white were equipped with fully stocked science labs.

Because I grew up in an area that is best characterized by its monocultural education system and over-emphasis of the dominant culture’s traditions, I recognize my personal connection to my research topic. Specifically, my K-12 experience was riddled with seemingly benign anecdotal examples of otherness, such as lowered expectations, racial slurs, and feelings of isolation. Accordingly, I subscribe to the first assumption of critical race theory as applied to education in that racism is deeply embedded in American schools and institutions of higher learning, which admittedly influences me as a researcher who is interested in topics of race and culture. For example, I assume many educators, who are members of the dominant culture, unknowingly view racist or oppressive practices in education as normal, routine, or acceptable ways of being/acting (Young, 2011).

Now that the personal experiences that have shaped my epistemological beliefs and biases have been shared, next, I describe the methods by which I examined the teaching beliefs, practices, and personal experiences related to race that may have shaped science teacher educators’ pedagogical practices.

Methodology

Merriam (2009) says, “qualitative researchers are interested in understanding how people interpret their experiences...their worlds...and the meaning they attribute to their experiences” (p. 5). As such, this study married well with the qualitative approach because the purpose of this study was to find out how science teacher educators prepare preservice teachers to engage African American students in K-12 science. As such, I attempted to identify how science teacher educators reported their understanding of culturally relevant teaching and explored these science teacher educators’ espoused teaching beliefs, practices, and past experiences related to race. Therefore, to investigate science teacher educators’ experiences, beliefs, and teaching practices, the following research questions guided the study:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their beliefs and personal experiences related to race that have impacted their teaching beliefs and practices?

Importance of Research Questions. Merriam (2009, p. 9) says that critical research “goes beyond uncovering people’s understanding” because there is an additional emphasis on critique and the remediation of societal injustices. Furthermore, as suggested by Merriam (2009) and Kincheloe and McLaren (1994), critical researchers frame their research questions around issues of power with the goal of transforming hegemonic structures within a society. For these reasons, critical theory was appropriate

because the research questions for the current study were shaped around race and teacher educators, a group which many suggest (Atwater et al., 2010; Atwater et al., 2013; Bryan & Atwater, 2002; Delpit, 1988) has bestowed a specific power to shape and prepare future K-12 teachers, which ultimately affects the future of generations of learners. Research question one was important because the science education community has begun to suggest CRP is a preferred tool in preparing science teachers to engage diverse students because it provides a platform by which the content is contextualized for diverse students (Johnson, 2011; Mensah, 2011, 2013). The basis for research question two was to explore teaching practices science teacher educators' reported using in their science methods courses to find out how they prepare preservice K-12 teachers to engage African American students in science, which many suggest are particularly marginalized in science (Mensah, 2011, 2103; Mutegi, 2011; Parsons, 2008). Lastly, science teacher educators' beliefs and personal experiences related to race were examined with research question three to explore how these experiences may have impacted their beliefs and pedagogy (Wallace and Brand, 2012). Thus, as a result of the nature of this study, critical qualitative methods were most appropriate to investigate science teacher educators' practices, beliefs about CRP, and their beliefs and experiences related to race because these concepts required the participants to confront how their beliefs and experiences have impacted their practices and to personally reflect about how CRP could transform science teaching into a more equitable process.

Critical Theory. Creswell (2012) and Merriam (2009) say a theoretical perspective corroborates a relationship between what is currently being studied and the established literature of a particular topic. The theoretical framework that guided this study was

critical theory because this philosophical lens allowed for an examination of post-secondary science teaching beliefs and practices that impact African American students in science, much like the work of Atwater et al., (2010), who studied preservice teachers, and the work of Wallace and Brand (2012), who studied in-service teachers in the same way. Kincheloe and McLaren (1994) say the goal of critical research is to deconstruct and remedy hegemonic beliefs and practices. Merriam (2009) says critical race theory (CRT) is one of the lenses for critical theory because it addresses how the research process can be used as a change agent for societal injustices. Therefore, in addition to addressing the research questions, an underlying goal of this investigation commensurate with critical research was to provoke the participants to become more reflective about their practices and beliefs. Specifically, CRP was examined in a way that advocated it being used as a social justice reform strategy, a strategy which Young (2010) says is well positioned to close the achievement gap between African and Caucasian American students if ever given genuine consideration. So, for the purpose of this investigation, marrying the critical theory ideas of Kincheloe and McLaren (1994) and others (Apple, 1996; Bernstein, 1976; Lather, 1988; Merriam, 2009) were germane to examining how science teacher educators prepared their preservice teachers to engage African American or black students. Despite critical theory serving as the lens, the principles of critical race theory as suggested by Wallace and Brand (2012) and Delgado and Stefanić (2012) were considered major assumptions by the researcher.

First, and probably most notably, critical theory was the principle lens used to conceptualize the findings of this research because critical inquiry calls for an active dialogue to advance an emancipatory agenda for marginalized people (Lather, 1988). In

the same vein, critical theorists presuppose that research efforts are pursued to confront possible hegemonic forces in society (Apple, 1996; Bernstein, 1976) in which the culture of the dominant status quo may demonstrate a resistance toward liberation ideologies. Apple suggests these hegemonic beliefs and structures in society are deeply entrenched within the dominant culture and become a daily and routine part of everyday life. Furthermore, Apple suggests schools are exemplars for advancing hegemonic systems because public education systems foster economic and intellectual control over already oppressed students. Therefore, critical theory was used because the primary purpose of this study was to critically examine the beliefs, experiences, and practices of white and black science teacher educators in preparing future K-12 science teachers to engage African American students in science classrooms. Additionally, advocates of critical theory confront and reveal the manner in which social power and institutional influence have developed (Kincheloe & McLaren, 1994). Therefore, a secondary purpose was to spark critical reflection among the participants about how their personal beliefs and experiences have evolved to possibly impact their pedagogy.

As an aside to critical theory, Wallace and Brand (2012) insist that critical race theory is a useful lens to analyze teachers' personal experiences, which ultimately shape their teaching beliefs and practices. Moreover, Wallace and Brand suggest critical race theory is an appropriate vehicle whereby the intersection of culturally relevant pedagogy and science teacher preparation can be investigated because they say, "understanding racial inequities is crucial to the development of sociocultural awareness and is the foundation for... culturally relevant dispositions and practices" (p. 341). They summarize Delgado and Stefancic's concept of critical race theory into the following three major

propositions: (1) racism is normal in American culture, (2) white people mentally and materially believe they are superior over people of color, and (3) race is socially constructed. As previously discussed earlier in Chapter 3, it is important to note the following assumptions which also align with the principles of critical theory were held by the researcher while examining white and black science teacher educators' personal experiences, beliefs, and teaching practices:

- Racism is deeply embedded in American culture, so much so that institutionalized manifestations of racist ideologies and practices in education are viewed as ordinary, normal, and reasonable to the members in the dominant culture (Delgado & Stefancic, 2012; Wallace & Brand, 2012).
- Members of the dominant culture must critically examine racially motivated biases that influence their beliefs and practices (Delgado & Stefancic, 2012; Wallace & Brand, 2012); and
- Ideas about race are socially constructed from personal experiences in one's past (Delgado & Stefancic, 2012; Wallace & Brand, 2012).

Design Tradition and Perspective

Hays and Singh (2012) says the phenomenological approach is to “discover and describe the meaning or essence of participants' lived experiences or knowledge as it appears to consciousness” (p. 50). Yin (2009) says the case study approach is an ideal research design for examining “how” questions when investigating contemporary issues. Merriam (2009) and Rubin and Rubin (2012) say the critical perspective is characterized by a discovery and remediation of societal problems, where the researcher examines

issues of oppression. Therefore, these frameworks were integrated because I deliberately examined how contextual conditions, such as past experiences relating to race by science teacher educators, impacted teaching perceptions and practices.

Phenomenological Case Study. While the theoretical framework for this study is grounded in critical theory, as defined by Kincheloe and McLaren (1994) and demonstrated by Atwater et al. (2010) and Wallace and Brand (2012), Hays and Singh (2012) also suggest qualitative researchers should outline the research tradition and methodology. Therefore, in addition to the critical theoretical framework, the methodological framework was derived from a phenomenological single exploratory case study (Yin, 2009).

Phenomenology has been applied in many educational studies where the researcher is concerned with the perceptions of educational stakeholders (Alerby, 2003; Cornett-DeVito & Worley, 2005), but it has also been applied in such studies in which researchers were particularly interested in examining educators' identity and cultural experiences (Dreon & McDonald, 2012; Pipere & Micule, 2014). For the purpose of this study, phenomenology was the ideal tradition because teacher educators' beliefs, perceptions, and life experiences related to race were being explored.

Yin (2009) says one of the rationales for a single case design is when the objective of the study is to "capture the circumstances and conditions of an everyday or commonplace situation" (p. 48). Therefore, since one of the objectives of this current study was to examine the experiences that shaped science educators' beliefs and teaching practices, the single case study design was appropriate because post-secondary teaching is an everyday or commonplace situation. Moreover, Yin also suggests the single case

study design is appropriate when “the investigator has an opportunity to analyze a phenomenon previously inaccessible” (p. 48). Therefore, a single exploratory case study was the chosen method because to the researcher’s knowledge little is known about what motivates the beliefs and practices of science teacher educators regarding how they prepare future teachers to address black students in K-12 science. Additionally, conducting an exploratory single case study design was the best methodological approach to initiating a discovery about this community of educators because white and black science teacher educators’ espoused beliefs and teaching practices have been virtually absent in the literature.

Defining the case. Merriam (2009) says case studies require two levels of sampling in which the researcher first identifies a larger case, and then uses some criteria to select samples within the case, such as participants to interview, documents to analyze, or sites to visit. Figure 3 illustrates a funnel-like design, which is similar to how Merriam (2009) describes how most qualitative case studies designs are performed.

Figure 2. General Funnel Design

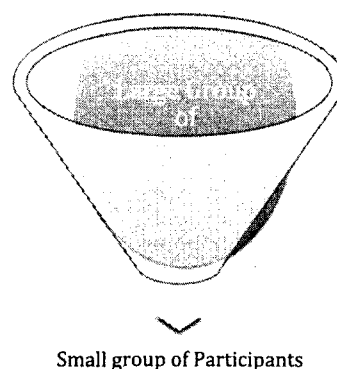


Figure 2. A funnel-like case study design starts with a large pool of participants, which is narrowed down to a smaller group of participants using a particular criterion.

Yin (2009) and Merriam (2009) say that before a researcher can start investigating a case study, the case must be clearly defined. Therefore, for the purposes of this study, the case included science teacher educators from a large southeastern mid-Atlantic state of the United States, which mirrors many parts of the nation. The study was divided into two parts. The first part included a survey of science teacher educators around the state, and the second part of the study included an in-depth examination of a sample of these science teacher educators. The smaller sample in the second part of the study included white and black science teacher educators who agreed to be contacted for further study and who demonstrated a commitment to teaching in culturally affirming ways.

Setting. This large and diverse mid-Atlantic state was chosen for the study because it included varied demographics among its institutions of higher education and public school systems, geography, race, socioeconomic status, and municipality. According to the US Census Bureau (2013), the population estimate for 2013 in this mid-Atlantic state was 8,260,405 as compared to the national estimate of 316,128,839, and this state also contains wide-ranging geographic diversity in that there are highly populated coastal, urban, suburban, mountain, and rural regions. Within these regions are 143 cities or townships, 132 school divisions, and 38 teacher preparations programs among the 77 total colleges and universities (Advisory Board on Teacher Education and Licensure, 2013; US Census Bureau, 2013). This state has the 10th largest economy and enjoys the seventh highest level of per capita personal income in the nation. In 2012, the median income per household was approximately \$63,000. The racial demographics are commensurate with the national estimates. In this state, 71% of the residents identify as

white, nearly 20% identify as black, and the remaining 10% of the population identify as Hispanic, Asian, American Indian, Pacific Islander, Native Hawaiian, or Alaska Native.

Science teacher educators. Bryan and Atwater (2002) and Rascoe and Atwater (2002) suggest in general that science teacher educators are well-positioned to either perpetuate or transform marginalizing schooling practices because they train K-12 teachers to engage students of color, many of whom are marginalized in the public school setting (Mensah, 2013; Mutegi, 2011). For this reason, I explored white and black science teacher educators' knowledge about culturally relevant pedagogy, how they may or may not apply these principles in their teaching, and how they say they prepare preservice teachers to engage African American students in K-12 science. Lastly, within the study, I encouraged the participants to talk about their personal experiences, teaching philosophies, and perceived teaching practices, in an effort to foster reflection about their pedagogy.

According to a large and diverse mid-Atlantic state's Advisory Board on Teacher Education and Licensure (2014), most of the teacher educators in the 38 accredited programs are identified as white, and colleges and universities continue to struggle with racially diversifying their faculty in all areas of study. Furthermore, according to the division for higher education within the state's association of science teachers, of these 38 programs, there are approximately 58 science teacher educators that work in these programs in science education.

Protection of human subjects. The Darden College of Education's Human Subjects Committee identified this study as exempt research because this study, which intended to examine normal educational practices and principles, posed little to no risk to

the participants, who were fully consenting adults. While Kincheloe and McLaren (1994) say having discussions about race can be challenging between a critical researcher and participant(s), many say (Brown-Jeffy & Cooper, 2011; Ladson-Billings, 2000; Lin, Lake, & Rice, 2008) that teacher educators must critically examine the personal experiences that have shaped their worldviews and biases so they can facilitate the same kind of critical consciousness in their preservice teachers. Mensah (2013) and others (Bryan & Atwater, 2002; Parsons, 2008; Mutegi, 2011) say that science teacher educators must engage in these kinds of conversations to begin to examine the contextual factors that have influenced their beliefs and practices because students of color continue to trail behind their white counterparts in science achievement. Therefore, the participants in part one and part two of the study were provided informed consent forms, which outlined specific safe guards. See Appendix B and Appendix C for a copy of the consent forms. For example, I assured both groups in phase one and phase two that they would be given the opportunity to drop out of the study at any time, pseudonyms would be provided to protect their identities, and I confirmed that the data from this investigation would be properly secured and eventually destroyed within three years.

Part I of the Study

In part one of the study, the science teacher educators completed an electronic qualitative survey administered using *Survey Monkey*. The purpose of the survey was two-fold. First the survey helped the researcher gain access to the science educators around a particular state; therefore, the survey was used to invite the possible participants into the study, who otherwise would have been difficult to contact due to the diverse positions held by science teacher educators in the particular region. Secondly and

perhaps more importantly, the survey provided an initial glimpse into the science teacher educators' beliefs, practices, and experiences. Therefore, the qualitative survey explored the participants' perceptions about CRP and how race impacts their teaching beliefs and practices.

This survey had 11 open-ended questions, a demographic protocol, and seven short yes or no questions. The results from this survey informed the second part of the study, which is discussed later. This large pool of science teacher educators that were invited to participate in the qualitative survey represented large, medium, and small universities and colleges. Also, some of the participants represented science teacher educators from small community colleges around the state.

Participant selection process. Merriam (2009) says, "to find the best case to study" the researcher must determine the criteria that will guide the selection of participants (p. 81). With that in mind, there was an interest in examining how preservice science teachers were trained to engage diverse students, African American students in particular, science teacher educators were selected from a diverse mid-Atlantic state's 37 approved teacher preparation programs. This state was chosen because it is large and diverse enough to be representative of many different regions around the nation. For example, there are a myriad of large, small, public, and private colleges and universities around the state's many rural, urban, suburban, coastal, and mountainous regions that prepare future teachers.

Recruitment process. To secure participants, the researcher used a three-part strategy. First, using a list of 37 approved teacher preparation programs according to the state department of education's website, the researcher looked up each school on the

Internet and found a public list of emails for science teacher educators. So, all science teacher educators that were identified from these 38 colleges and universities were emailed an invitation to participate in the study. This first strategy did not yield any participants. Second, the researcher contacted the state department of education's higher education science coordinator to gain support in contacting science teacher educators' across the state. This higher education coordinator contacted the liaison for higher education within a state wide professional organization for science teachers, who sent out an email invitation to all science teacher educators within the 37 approved higher education settings. The higher education liaison within the professional organization for science teachers sent an email web link to the survey three times over the course of four months using a confidential email distribution list, which according to the liaison included 58 science teacher educators. This second strategy yielded 11 complete survey responses. As a result of the low response rate, an additional attempt was made to communicate with the science teacher educators from this mid-Atlantic state, using a different contact person. The researcher thought if the participant pool received another email invitation from another well-respected colleague, then perhaps it would decrease the likelihood the email invitation would be ignored. Therefore, another strategy for recruitment was contacting a member of the Advisory Board for Teacher Education and Licensure for the state department of education, who was part of a state-wide science grant to send out an email invitation to all science teacher educators around the state, which she believed contained the same science teacher educators from the original email distribution contact list. The researcher was never given access to either distribution lists, which meant that the researcher could only forward a cut and pasted web-link generated

from Survey Monkey to each liaison, who then forwarded it to the pool of possible respondents. This also meant that the researcher could not track the IP addresses of those who were invited, entered, or for whom completed the survey. The additional liaison was secured to send out the survey because it provided the researcher another opportunity to deliver the email invitation to the participants from a third party, who was another well known and highly respected figure in the state, which would hopefully increase the likelihood that the participants would enroll or participate in the study.

Thirteen science teacher educators consented to participate in this initial part of the study, but only 11 actually completed the survey. This is nearly a 19% response rate, which represented a relatively low response rate. If this study was aiming to measure effect size or generalize to a larger population this response rate would be completely inappropriate to serve that purpose; however, this survey was used as a tool to gain insight from and access to a relatively insulated population of teacher educators, who to the researcher's knowledge have never been thoroughly studied. Moreover, the topic of race may have intimidated some participants who chose to avoid participating for fear of providing responses that may have been viewed as socially inappropriate. For example, one participant opened the survey in part one, consented and then left the responses blank. It is not entirely clear why he entered the survey and never completed it.

Data tools and collection. There were several methods by which data were collected in part one of the study. What follows is a description of these tools, which includes a demographic protocol and a qualitative open-ended survey.

Demographic protocol. Patten (2001) says that a demographic protocol is commonly used in qualitative studies to collect information about the participants in a

study. Therefore, during part one of the study, a demographic protocol was administered to collect information about all of the participants in the large pool of science teacher educators. The protocol included questions about the science teacher educators' gender, race, ethnicity, approximate years in teaching, description of the college or university they work for, and the extent to which they had participated in any multicultural education activities. The participants answered the items on the demographic protocol before they answered any of the open-ended questions or seven yes/no questions. The open-ended survey and demographic protocol were administered to all of the participants in the largest pool of respondents to gain insight into the participants' perceived race and ethnicity and the level to which they have worked in diverse settings. Respondents were eligible for consideration in the interview portion (part two) of the study if they self-identified as either white or black and suggested they taught in culturally affirming ways. The demographic protocol is found in Appendix D.

Demographics of Survey Respondents. The complete demographics of the science teacher educators on this initial email distribution list are largely unknown; however, according to the higher education liaison for the professional science teacher organization who sent out the survey, it included persons working in higher education with and without terminal degrees and assistant, associate, and adjunct professors. The respondents were asked to disclose demographic information at the beginning of the qualitative survey once they consented to the study. Eighty-one percent of the survey respondents were female. Seventy-two percent of the respondents had terminal degrees, and it appeared that over 63% were over the age of 40. Lastly, they were asked to either select a multiple choice option from the survey or write in a statement to describe

themselves or their university setting in any way they felt appropriate. The demographics of those who consented to complete the survey in part one of the study are outlined in Table 8.

Table 8

Demographics of Survey Respondents in Part One

Participant	Gender	Age range	Highest degree	Race	University demographic
1	M	31-40	Master's	White	Religious Institution
2	F	50+	EdD	White	Predominately White Institution
3	M	41-50	EdD	Black	Historically Black College/University
4	F	31-40	PhD	White	Predominately White Institution
5	F	41-50	PhD	White	Predominately White Institution
6	F	50+	EdD	White	Predominately White Institution
7	F	41-50	PhD	White	Private Institution
8	F	31-40	Master's	Black	Predominately White Institution
9	F	41-50	Master's	White	Public/Research Intensive Institution
10	F	50+	PhD	White	Private Institution
11	F	31-40	PhD	White	Public/Research Intensive Institution

Qualitative Survey. Antonellis, Buxner, Impey, and Sugarman, (2012) suggest that using a short open-ended survey about science literacy of undergraduates was ideal because it provided the ability for the researchers to “assess both the range and the incidence of different ideas and provide a wealth of information...” (p. 1). Further, when talking about using a qualitative survey, Hecht, Wills, and Dwyer (1993) say,

...if the researcher recognizes and accepts that all possible responses can never be known, that there is a need for an "other" category, or that respondents might write ideas around the edges of the paper, then the need for utilizing open-ended questions becomes apparent. Open-ended questions begin with present literature and theory, but allow respondents the freedom to reflect their personal reality in their individually determined responses (p. 3).

Therefore, an open-ended qualitative survey was necessary because the ideas of race and culturally relevant teaching are far too expansive to determine all possible answer choices for a quantitative survey. The open-ended survey is found in Appendix E. The open-ended survey contained 11 short questions that directly related to the participants' perceptions about how race impacts their teaching beliefs and practices. These 11 questions were intended to examine the participants' sociocultural awareness and cultural competence in teaching. In this case, sociocultural awareness refers to the mindfulness of the participants to transmit information about race and society through beliefs, behaviors and interactions (Wallace & Brand, 2012). Cultural competence refers to the extent to which the participants demonstrate culturally affirming teaching practices (Haberman & Post, 1990).

Open-ended survey questions. The qualitative survey questions were created by dividing the research questions into three major categories. Therefore, each survey question corresponded to one of the three research questions. The way in which the questions are categorized is illustrated in detail as part of the analysis in Chapter 4, which shows how the researcher looked for patterns across the categorized responses. And a summary of every question that corresponded to each research question is also provided in Appendix F. Eleven questions on the open-ended survey started with general questions about teaching and then questions related to race and culturally relevant

pedagogy increased as the survey continued to allow the participants the time necessary to authentically reflect about themselves and their experiences. A few sample questions from the qualitative survey are seen in Table 9.

Table 9

Sample Survey Questions

General Questions about Teaching Style	Probing Questions about Race
1. Describe your teaching strengths and weaknesses.	4. What are the advantages and disadvantages of talking about racism in your science methods courses?
2. What is the main theme around which you build your science education method(s) course(s)?	5. Overall, how does race matter in science education?
3. Briefly describe your teaching style in your science methods course(s). Indicate if you teach methods courses related to elementary, middle, and/or high school science.	6. Describe how you prepare your preservice teachers to engage black students in science?
	7. What does it mean to teach in <i>culturally relevant</i> ways?

Yes-or-no questions. In addition to the 11 open-ended questions, the last part of the survey given to the respondent group in part one of the study contained seven quick yes-or-no questions. These yes-or-no questions were used to help screen the participants and determine who would be selected for individual interviews in part two of the study.

While Patten (2001) suggests yes-and-no survey questions may be viewed as restrictive, he also says if formatted appropriately, they can be used effectively. Consequently, the yes-or no-format of these questions were necessary to quantify which participants in the first part of the study (the larger pool of participants) would be selected or funneled into the second part of the study (smaller interview group). The criteria to be funneled into the smaller interview group included scoring between five and seven points on these yes-or-no questions. A score of 5 was determined to be the cut off score because a score of

five would represent over 70% for these questions answered with an affirmation toward cultural teaching, which suggests a majority. A cut score of four was not selected because it would have represented only a reported 57% affirmation toward cultural teaching and the researcher truly wanted to interview only those participants from the survey who suggested they were exemplars for cultural teaching. Therefore, each yes-or-no question was worth one point; so, if a response demonstrated an affirmation of race, ethnicity, and sociocultural awareness, then it earned a point. Conversely, if a response demonstrated a denial or rejection of race, ethnicity, and sociocultural awareness, then no point was earned.

The yes-or-no questions were used to screen the participants' espoused commitment to teaching in culturally affirming ways. Nieto (2010) says teachers who are culturally affirming reject ideas of simple tolerance and colorblindness and demonstrate a high esteem for diversity by endorsing teaching and curriculum changes that aid in a discovery and remediation of oppression. Therefore, these yes-or-no questions corresponded to Nieto's (2010) ideas of multiculturalism: monoculturalism, tolerance, acceptance, respect, and affirmation, solidarity, and critique. For example, the first yes-or-no question aligned with monoculturalism, where Nieto says students of color must assimilate to the dominant culture in power. Ten respondents answered this question and three skipped this question. Fifty percent of the respondents who answered this question indicated, "yes" and 50% answered "no." Therefore, the five respondents who indicated, "yes" to this question did not earn a point because Nieto (2010) suggests that colorblindness is not ideal for teachers who are culturally affirming. Conversely, those five respondents who answered "no" to this question earned a point because Nieto

suggests that everyone physiologically sees the color of skin, but culturally affirming educators ascribe respect and admirations to the different ethnicities represented in a class, which are represented by different skin hues. So, the notion of treating all students the same is not an exemplary teaching philosophy because Nieto (1994, 2010) says that all students are not the same and require individual esteem for their unique perspectives, expertise, and epistemological input. Table 10 lists the seven yes-or-no questions asked at the end of the qualitative survey, which were used to select the interview respondents in part two of the study. The last yes-or-no question did not explicitly relate to Nieto's levels of multiculturalism; however, the idea of an educator wanting to participate in a study that openly admitted to examining issues of race within the context of education and fostering personal reflection suggested to the researcher that the respondent had at the very least demonstrated an "acceptance" of diversity, in which acceptance is signified by educators who are committed to self reflection and are willing to "take a look at how schools' policies and practices might need to change" to reflect a more inclusive paradigm for those who are not members of the dominant culture of power (Nieto, 1994, p. 4).

Table 10

Yes or No Questions Used to Select the Interview Respondents

Level	Statement
Monoculturalism	1. I am colorblind to skin color because I treat all students the same; so, skin color really doesn't matter.
Affirmation, Solidarity, and Critique	2. I teach students how to solve socio-political injustices within the content of the class.

Table 10 Continued

Acceptance	3. I talk to my students about the hidden curriculum that marginalizes African American or black students in science.
	4. I facilitate opportunities for my students to learn how to confront racism in education with real world science projects and inquiry.
Tolerance	5. My goal in teaching preservice teachers to engage students who represent a diverse racial or ethnic group is to facilitate tolerance of racial and ethnic differences.
Respect	6. I believe that understanding my own cultural identity is an important element to teaching my students how to engage their future K-12 students in science.
Acceptance	7. Are you willing to participate in a follow-up interview? If so, provide your contact information.

Part II of the Study

Deeply studying in some way a smaller subset of a larger participant group is a common practice in qualitative investigations in science education (Lewis & Collins, 2001; Mensah, 2007; Parsons, 2008; Rodriguez, 1998; Russell & Atwater, 2005; Walls, 2012). For example, in *Strategies for Counterresistance: Toward Sociotransformative Constructivism and Learning to Teach Science for Diversity and Understanding*, Rodriguez (1998) begins with a large sample size and from that pool of participants, selects two participants to study further. In this way, Rodriguez provides a deeper analysis with two participants to provide credible guidance about how science teacher educators should transform their teacher preparation programs to prepare preservice teachers to meet the challenges of an increasingly diverse classroom, as well as outline what concerns Anglo-Euro American teachers have regarding multicultural education. Likewise, in *A Case Study of Science Teacher Candidates' Understandings and Actions Related to the Culturally Responsive Teaching of Other Students*, Atwater et al. (2010) selected two preservice science teachers from their larger pool of preservice teachers to

explore how important race, culture, and ethnicity were in learning about science. In this way, Atwater et al. (2010) were able to thoroughly examine the perceptions of the smaller group of participants related to these factors. Therefore, similar to Rodriguez (1998) and Atwater et al. (2010), this study used this funnel-like design, where a large pool of participants were eventually narrowed down to a smaller group of participants in order to more intensely study their perceptions and teaching practices.

Participant Selection Process. Merriam (2009) says, “to find the best case to study” the researcher must determine the criteria that will guide the selection of participants (p. 81). See Figure 6, which demonstrates how the funnel design applies to the study, wherein the large survey group is narrowed down to a smaller group of interview participants.

Figure 3. Flow of Participants with the Funnel Design

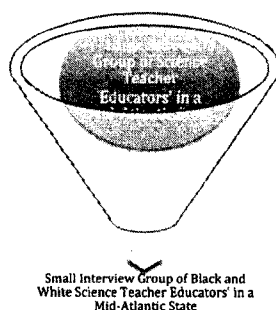


Figure 3: The funnel design begins with a large group of participants and the researcher uses a set criteria to select a subset of the original group to study further.

Therefore, as previously described there was a specific criterion to select the science teacher educators in phase two of the study. To recap, to examine the experiences, beliefs, and practices of the science teacher educators in phase two of this study, seven yes-and-no questions were added to the qualitative survey to select a smaller subset of interview participants from part one. Additionally, to become eligible for phase

two, the survey respondent had to identify as either black or white on a demographic protocol because the researcher wanted interview participants that represented both racial experiences. Interviewing both white and black participants provided a more diverse exploration of their beliefs, practices, and experiences from which to glean insight. Secondly, they needed to demonstrate a commitment to teaching in culturally affirming ways to include their responses on the qualitative portion of the survey and with a score of at least 70% on the yes-or-no questions, which resulted in a score between five and seven. Secondly, to be selected to phase two, the participant had to select they consented to be contacted for more in-depth interviews, in which case the participants were given a second consent form.

Description of the interview participants. As previously stated, all science teacher educators from a mid-Atlantic state were invited to participate in the qualitative survey. In part one, science teacher educators were contacted using an email distribution list (survey portion). From that survey group, four participants were selected for part two (interview portion). From the demographic data of the survey respondents, Table 11 shows, which survey respondents, were selected as interview participants.

Table 11

Demographics of Interview Participants

Participant	Gender	Age range	Highest degree	Race	University demographic
1	F	50+	EdD	White	Predominately White Institution
2	M	41-50	EdD	Black	Historically Black College/University
3	F	41-50	PhD	White	Private Institution
4	F	31-40	Master's	Black	Predominately White Institution

For part two of the investigation, the researcher selected four participants from the survey to study further. These participants were selected based on their responses from the qualitative survey, the yes and no questions, and demographic protocol. For example, a survey respondent from part one was selected for an interview in part two of the study if the survey respondent demonstrated a commitment to teaching in culturally affirming ways and if they self-identified as either black or white on the demographic protocol. Two of the participants self identified as black and two as white. The researcher only wanted to interview black and white participants because she was interested in how the racial socio-history of these people may have impacted their beliefs and teaching practices. Consequently, there were three women and one man. Table 12 further summarizes the demographics of the interview participants.

Table 12

Teaching Characteristics for the Interview Participants

Interview Participant	K-12 teaching experience	Science Methods Discipline
1	16+ years	Bio, E. Sci, Ecology, Chem, Oceanography, Physics
2	6-15 years	Survey of all sciences
3	6-15 years	All disciplines for elem teachers
4	6-15 years	Bio, Chem, Physics

The first participant, Dr. Daly is a white science teacher educator, who grew up in [a large southern state] on a tobacco farm with her mother, father, and four siblings. Dr. Daly reported being explicitly taught as a child to believe that black people were inferior

to white people. On the demographic protocol she noted that she was over 50 years of age, had 16 years or more of K-12 teaching experience, and the highest degree earned was an EdD. She noted that cultural training was a part of her teacher preparation experience as a preservice teacher. Her score on the yes-no questions was six, which suggested she believed teaching in culturally affirming ways was very important. Lastly, as an accomplished associate professor, Dr. Daly reported she worked at a large, research intensive and historical university, where the student enrollment on the main campus is predominantly white. Dr. Daly described the students at her university as mostly white and high achieving.

The second participant, Dr. Williams is a black science teacher educator, who grew up in [a large southern state] in a mostly black suburban neighborhood. As a child, he reported he lived with his mother, but maintained a close relationship with his father. He characterized his parents as conservative, educated, and open minded toward diversity. On the demographic protocol he indicated that he was between the ages of 41-50, had 6-15 years of K-12 teaching experience, and the highest degree earned was an EdD. Dr. Williams also noted that when he was trained to be a teacher, his preparation included cultural training. His score on the yes-no questions was five, which suggested he believed teaching in culturally affirming ways was important. Dr. Williams is an assistant science education professor at a historically black public institution in small urban area within the state.

The third participant, Dr. Jackson reported that she is white, between 41-50 years old, had 6-15 years of K-12 teaching experience, and the highest degree earned was a PhD. She reported she grew up in a rural farm community where there was little

diversity in a [large northern state] and was adopted as a newborn in 1965. She says her father was a middle school science teacher, her mother was a 'stay-at-home' mom, and she spent most of her time outside exploring nature, doing science experiments in the basement, and helping her father grade papers. She noted on the demographic protocol that one of the K-12 schools she taught in was comprised of approximately 80% of students who identified as black or African American. Her score on the yes-no questions was five, which suggested she believed teaching in culturally affirming ways was important. Dr. Jackson is an associate professor and leader at a large private institution of higher learning found in a major city within a mid-Atlantic state. Dr. Jackson reported that her predominantly white institute (PWI) is known to be highly selective and is deeply rooted in the history of the state.

The fourth participant, Ms. Alleyne reported that she is black, between 31-40 year old, had 6-15 years of K-12 teaching experiences, and her highest degree earned was a master's degree. She said she was raised in a sheltered single parent home, where the power of education was stressed by both of her parents. She described herself as having grown up poor, but not knowing it because she felt she never lacked anything and everyone around her was also poor. Her score on the yes-no questions was a perfect score of seven, which suggested she believed teaching in culturally affirming ways was of the utmost importance. Thus, at the beginning of the survey she reported sociopolitical principles of teaching are embedded throughout her science methods courses. Ms. Alleyne is a science educator at a large, urban public university, where the student population is mostly white. Ms. Alleyne reported that she currently teaches science education courses in a program that is aimed at giving preservice teachers the

opportunity to learn from those closest to the field. Consequently, just prior to Ms. Alleyne teaching science education courses at this university, she was a K-12 biology teacher in mostly urban black high schools around the state. She noted that when she was a K-12 biology teacher, her student population was nearly 98% black or African American.

Interview Schedule. For phase two of this study, I interviewed two black and two white science teacher educators to delve deeper into their personal experiences, beliefs, and teaching practices. The participants were contacted for interviews during summer 2014 because it was felt that the participants could more fully engage in the process once their classes were over for the spring 2014 semester. However, though the electronic qualitative survey was sent out over the summer, the participants who consented for the interview were not interviewed until the fall semester of 2014 at the discretion of each participants' personal schedule. Ten interviews were held in person, but when necessary two were conducted using videoconferencing technology. Specifically, two of Dr. Jackson's interviews were conducted on Skype due to the erratic nature of the Dr. Jackson's and the researcher's schedules combined with the considerable distance between the participant and the researcher.

Each participant consented to a series of three interviews. Each interview lasted from 60-90 minutes each. The interview schedule was not regulated by the researcher, but it was more guided by the availability of the participant. Therefore, when scheduling the interviews, the researcher requested that each interview be conducted separately if possible, to allow for a period of reflection. Thus, in most cases there were more than two weeks in between each interview.

Data Tools. Yin (2009) says that “in-depth” interviews are one of the most ideal sources of information for case studies (p. 107). Yin suggests in-depth interviews occur over a period of time, are comprised of several related interviews, and may help foster a positive relationship between the interviewee and interviewer because key respondents provide their insights and propose agendas for further inquiry. So, in this current study, I conducted three semi-structured interviews with the participants who self-identified as either black or white and who scored between five and seven on the yes-or-no questions. It should be mentioned again that this smaller group of interview participants in part two of this study also completed an additional consent form. As previously stated, Appendix C contains this consent form. Each interview was conducted on different days over the span of three months. The interviewing period began in July 2014 and ended in October 2014.

Interview Questions. The interview questions for each of the three interviews were divided into three categories based on the three research questions, wherein the purpose of each interview corresponded to the appropriate research question. Therefore, interview one corresponded to research question one. The three-part semi-structured interview protocol is found in Appendix G. The analysis matrix used to create the questions is found in Appendix F. The first semi-structured interview consisted of 16 questions. The second interview consisted of 15 questions, and the third interview had eight main questions. Each of the interviews ended with the same additional three summary questions that basically asked if the participants had any questions or wanted to add anything before the interview ended. The more thought-provoking questions were purposefully asked toward the end of each interview when a sense of trust had been

established between the researcher and the participant. Also increasingly more reflective probing questions were asked at the final interview when the researcher and the respondent had appropriately fostered a firm foundation of trust. Also, six possible probing questions were created in the event I wanted to ask deeper clarifying questions on any of the three interviews. Most interviews were audio-recorded in-person, while two were recorded using video conferencing software when the researcher and one participant were at a distance. The interviews were transcribed within 48-72 hours after they occurred.

Teaching perceptions and practices summary form. After the three interviews, the participants in part two of the study, were provided ample time to reflect on their teaching style and clarify their perceptions and teaching practices. Therefore, at the end of the interview process, the participants were given a copy of the transcribed interviews and a teaching perceptions and practice summary form. The form was electronically sent to each interview participant as way to allow the participants to change or clarify any of their previous responses. This summary form is found in Appendix H. The items for the summary form were carefully chosen to provide increased clarity into the beliefs and practices of the participants; therefore, the summary included specific statements that represented various interview questions seen in all three previous interviews. Most importantly, this summary form gave the participants the option, at their own leisure, to document any additional relevant evidence of teaching strategies or assignments that corresponded to the statement in each box or change their statements. In this way, they were provided a structured way to ensure their statements were accurately communicated.

Thus, the summary form was used a member checking strategy if the participants felt they were misunderstood during the interviews.

It should be noted, classroom observations were not conducted in this study because the nature of this study was to investigate science teacher educators' espoused beliefs and practices as opposed to authenticating their beliefs and practices in comparison to their actual teaching. Moreover, if classroom observations had been conducted it is believed the participants may have staged the lessons to include culturally relevant principles while being observed. So allowing the participants' the opportunity to explain their position on various teaching philosophies or describing their teaching practices was more helpful in gaining a richer idea of what their classrooms were like from their perspectives, as opposed to creating an "I gotcha" atmosphere between the researcher, a novice, and the participants, mostly veteran scholars. Critics may suggest not including classroom observations may limit the data; however, as Yin (2009) suggests excluding on site observations does not necessarily detract from the reliability of the study because in some situations, direct observations may obscure the findings, when participants feel compelled to display misleading conditions. Therefore, the researcher believed the interview participants may have begun to alter their actual classroom practices and routines as they matriculated through the interviews as they learned more about CRP or how issues of race may have impacted their thinking or practices.

Artifacts. Yin (2009) suggests that case study evidence can come from a variety of sources. Therefore, in addition to the interviews and the summary form, the researcher analyzed various pieces of evidence from the participants in part two of the study to include their class syllabus and specific teaching artifacts they provided. The artifacts

were requested when initial contact was made to set up the first interview with each participant. However, none of the participants provided the artifact before the first interview. Therefore, the artifact was requested again during the first interview, in which case every participant sent his or her artifacts electronically by email.

The teaching artifacts were requested as a result of questions two and four of the yes-or-no portion of the survey from part one of the study. Therefore, in part one, if the participants responded, “Yes” when asked if either they “teach students how to solve socio-political injustices within the content of the class” or if they “facilitate opportunities for students to learn how to confront racism in education with real world science projects and inquiry,” then the researcher asked for evidence of how they approached this in their science methods courses. As such, these teaching artifacts served as a means to spark conversation about how the use of their artifact impacted their students and provided the opportunity for the participants’ to reflect on their teaching practices. The artifacts were not scored or coded per se, but are described in Chapter 4 as teaching activities. Some artifacts were not referenced in the findings because in some cases it was determined by the participant a particular artifact did not demonstrate evidence for teaching in culturally affirming ways. For example, if a participant sent his or her syllabus as evidence he or she teaches in culturally affirming ways, but during the interviews the participant asked to talk about another practice they used, the syllabus was discarded. Consequently, two of the participants, Dr. Daly and Ms. Alleyne, spoke about their artifacts, and two of the participants, Dr. Jackson and Dr. Williams chose to talk about different teaching activities that were not the initial submitted artifact. In the latter situation, the researcher was never provided a copy of the second teaching artifacts.

Examples of artifacts. The interview participants were asked to provide any evidence of teaching strategies that exemplified how they helped preservice teachers confront bias, racism, etc. in their teaching. For example, the participants were asked to submit a copy of their methods course syllabus and examples of student work from the same course that demonstrated how they prepared preservice teachers to engage African American students in science. It should be noted that each participant did not submit the same artifacts; thus, a comparison across artifacts was not possible. On the other hand, the artifacts were used as a source of reflection during the interviews and support for each participants' stance on culturally relevant teaching. Examples of artifacts were syllabi, PowerPoints, journal articles for classroom discussion, and assignment descriptions.

Procedures for Part I and II

As previously established, the data collection tools for part one of this study included a demographic protocol and an open-ended qualitative survey with seven yes-or-no questions added at the end. The data collection tools for the second part of the study included three in-depth interview protocols, a collection of classroom artifacts, and a summary form. Each of these collected rich information about science teacher educators' personal experiences and beliefs and teaching practices. Table 13 summarizes the procedures used to collect data for this study.

Table 13

Summary of Data Collection Procedures

Data Collection Procedures	
Step 1	All science teacher educators in a mid-Atlantic state were invited to complete an electronic qualitative survey, demographic protocol, and quick "Yes-No" survey. The Informed Consent is built into both the first and second part of the study.
Step 2	According to predetermined criteria, the interview participants were selected from those completing the survey, and participated in three separate interviews.
Step 3	Before the three interviews, the interview participants provided their class syllabus and at least one other artifact they believed helped to prepare future K-12 science teachers to engage African American learners. The artifacts were used to probe deeper during the interview process. During the first interview, the participants were asked to share background experiences. At the second interview, the participants were asked to share their perceptions of culturally relevant science teaching. After the second interview, the participants were sent journal articles regarding CRP and best ways to teach African American students. The third interview focused on beliefs and experiences related to race. After each interview memos were written.
Step 4	After all three interviews were complete, each interview was transcribed and sent to the participants for review. At this time, the interview participants were also sent an electronic summary form to provide clarification of beliefs and teaching philosophies and descriptions of teaching strategies that may have been missed or misunderstood by the researcher. Any changes of opinion or further evidence of teaching strategies were requested to accurately document the participants' positions on each item.

The demographic protocol, the open-ended qualitative survey, and the yes or no questions were administered using a free on-line tool, Survey-Monkey. The invitation for the demographic protocol, the open-ended qualitative survey, and the yes or no questions was sent out in June 2014, using an email distribution list for science teacher educators across the state from a liaison connected with the state department of education. The data from the qualitative survey (the first part of the study) was analyzed and used to inform

the second part of the study. For example, science teacher educators who self-identified as either white or black and who scored between five and seven on the yes-or-no questions were “funneled” into part two of the study. Part two of the study contained a series of three semi-structured interviews and a summary form.

Lastly, in addition to addressing the research questions, an underlying goal of this investigation, commensurate with critical research, was to provoke the participants to become more reflective about teaching practices and beliefs that could help preservice teachers engage African American students in K-12 science (Kincheloe & McLaren, 1994). Therefore, as a result of the participants’ suggesting misnomers for CRP and CResP on the survey in part one, procedures were planned to remedy possible misperceptions of CRP with providing various interventions to help the participants better understand how CRP could be used as a tool to engage African Americans in K-12 science. First, during the second interview after the participants provided their unassisted perception of CRP, the researcher provided a brief explanation of CRP vs. CResP and an example of how CRP could be applied. This intervention is discussed in more detail in Chapter 4. Secondly, pertinent research articles about culturally relevant science and best practices for preparing teachers to teach African American students were also provided to the participants. The articles were sent at the end of the second interview after the participants would have already provided their perceptions or misperceptions about culturally relevant teaching. The use of the articles after the second interview allowed the participants an opportunity to reflect on accurate descriptions of culturally relevant science teaching (Johnson, 2011; Mensah, 2011) and characteristics necessary to consider when training prospective teachers to engage black students in American classrooms

(Ladson-Billings, 2000) before the last interview, in which case the participants' could ask questions or provide their input. These articles were also used to synthesize the interview findings in part two of the analysis for Chapter 4. Thus, in line with the ideas about critical research, the articles were chosen as a way to remedy the participants' possible misperceptions about culturally relevant science teaching after they demonstrated a struggle to understand CRP. The first two articles were selected in the event the participants needed assistance in understanding what CRP could look like in science teaching or describing tangible CRP ideologies and practices that would foster more than only a simple awareness of otherness. Therefore, the researcher selected *A Case for Culturally Relevant Teaching in Science Education and Lessons Learned for Teacher Education* (Mensah, 2011) and *The Road to Culturally Relevant Science: Exploring How Teachers Navigate Change in Pedagogy* (Johnson, 2011). The first two articles were specifically geared toward the importance of culturally relevant science teaching. However, the third article was *Fighting for our Lives: Preparing Teachers to Teach African American Students* (Ladson-Billings, 2000), which more broadly introduced the ideas of tailoring teacher education to the needs of black children. Specifically, Ladson-Billings (2000) suggests that in order to provide a quality education, teacher educators' must explicitly address the learning needs of African American students as opposed to general ideas about multiculturalism.

Data Analysis for Part I and II

Hays and Singh (2012) say that the purpose of the phenomenological approach is to "discover and describe the meaning or essence of participants' lived experiences or

knowledge as it appears to consciousness” (p. 50). Epistemologically speaking, Moustakas (1994) asserts phenomenological data analysis is based on the subjective perspective of the participant, and the sole focus is to learn the depth and meaning of the participants’ lived experiences. Therefore, for the purpose of this phenomenological study, both a deductive and inductive analysis was applied to the data from the qualitative survey, interviews, and the summary forms to gain rich information about the participants’ perceptions of their teaching beliefs and practices. Thomas (2006) says the principle purposes of the general inductive approach is to

...condense extensive raw data into a brief summary format in a way that establishes clear, transparent, and defensible links between the research objectives and the summary findings in an effort to develop a model or theory about the underlying structure of experiences that are evident in the text data (p. 238).

However, Hyde (2000) says qualitative studies can also employ both an inductive and deductive reasoning, wherein inductive reasoning and deductive reasoning may have very different goals within one investigation. Specifically, he says,

Inductive reasoning is a theory building process, starting with observations of specific instances, and seeking to establish generalizations about the phenomenon under investigation, and deductive reasoning is a theory testing process, which commences with an established theory or generalization, and seeks to see if the theory applies to specific instances (p.83).

Therefore, the coding scheme from the open ended qualitative survey and the three-part interviews were coded inductively and deductively (Hyde, 2000) using Moustakas’ (1994) modification of van Kaam’s (1959, 1966) phenomenological data analysis strategy. The deductive process allowed for data to be classified according the CRP framework or preconceived categories derived from the research questions, which was important because very little is known about science teacher educators’ personal

perceptions of race, teaching beliefs, and teaching practices in terms of preparing preservice teachers to engage African American students in K-12 settings. Secondly, once categories were applied, the categories were clustered into contextual themes by finding common patterns among the categories. This inductive process was also important because it allowed for data to naturally emerge forming the final structural themes (Hyde, 2000; Thomas, 2006).

In qualitative research, it is customary to liken the researcher as the instrument (Merriam, 2009). Therefore, in the following discussion about the survey and interview analysis, the researcher is identified often as engaging in actions related to the analysis.

Survey Analysis. To analyze the survey, “listing and preliminary grouping,” as developed by Moustakas (1994) was used to organize the data. Specifically, each response to the on-line survey was listed and grouped by individual question. The researcher engaged in “horizontalization,” in which every expression relevant to the experience was listed (Moustakas, 1994, p. 120-121). For example, all responses to question one and so on were grouped together. The researcher carefully read through the responses several times to gain closeness to the data and each expression pertinent to beliefs, teaching practices, and experiences related to race were coded, using each complete response by each respondent to a question, as the unit of analysis. To reduce and eliminate repetitive and vague data, I determined the *invariant constituents*, or the pertinent data related to the experience by testing each expression for whether it was related to the research questions or whether it was possible to categorize it using descriptions that emerged from the research questions. For example, for research question one, the category descriptions that were deductively applied to the data were

“high academic expectations, cultural competence, and critical consciousness,” which are the three main tenants in culturally relevant pedagogy (Ladson-Billings, 1995a, 2000).

For research question two, the categories that were applied to the data was “teaching beliefs” and “teaching practices.” For research question three, the categories were “beliefs related to race” and “experiences related to race.”

Based on the researcher’s judgment, when an expression did not meet the previously above two requirements, it was eliminated. A codebook was created, which chronicled how the invariant constituents formed the initial categories, which emerged from the transcript of the survey responses. The categories were color-coded on the transcript and emerged from the research questions. For example, when a survey response demonstrated it was unrelated to the research questions or if the statement was not possible to be categorized using descriptions that emerged from the research questions, it was removed. For example, one response to question 14, “scientists work in communities, the more diverse the community is, the more ideas we have to make discoveries” was eliminated because it did not address the question, which was “What does it mean to teach science in culturally relevant ways?” Thus, what remained, were the *invariant constituents* of the experience, which were data pertinent to beliefs, teaching practices, and personal experiences.

Next, statements in these categories were inductively clustered to identify textural descriptions, which were integrated accounts that provided a context for the invariant constituents. So, this means, each color-coded category was broken down further by exploring what the category had in common. Direct quotations from the survey respondents were used to support these textural descriptions as contextual themes. These

contextual theme descriptions were reviewed until patterns were established. A peer debriefer and the researcher validated the invariant constituents and the themes against the other statements made by the survey participants and reviewed the textural descriptions to suggest possible patterns. The contextual themes for part one that emerged inductively were high quality instructional teaching practices, cultural awareness/recognition of otherness, culturally responsive pedagogy, science-for-all, cultural otherness, race matters in science education, and early awareness of race and otherness.

Lastly, the researcher defined the final meanings of the structural themes, which were based on the invariant constituents of the categories and contextual themes to create the composite description of the phenomenon. The final structural themes worked in concert to articulate a general narrative about the participants. These structural themes combined the data from the categories and the contextual themes to shape a final motif that represented the group of eleven science teacher educators' as it related to their beliefs, teaching practices and experiences related to race. Verbatim quotes were used from the respondents to fully capture the essence of these experiences. Table 14 illustrates how the structural themes formed from the categories and contextual themes for the survey for part one of the study.

Table 14

Summary of Categories, Contextual Themes, and Structural Themes for the Survey

Categories →	Contextual Themes →	Structural Themes
High Academic Expectations	High Quality Instructional Practices	CRP is an emerging skill used by STEs and is not fully incorporated in science teaching.
Cultural Competence	Cultural Awareness/Otherness	
Critical Consciousness	Culturally Responsive Pedagogy	

Table 14 Continued

Teaching Beliefs	Science-for-all	STEs subscribe to conventional science teaching practices and beliefs to prepare PSTs to engage all learners.
Teaching Practices	Cultural Otherness	
Beliefs Related to Race	Race matters in science education	There is a call to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.
Experiences Related to Race	Early awareness of race and otherness	

Survey analysis example. What follows is an example of the process used to analyze the data from research question one. The analysis for research question two and three also followed this general process and are illustrated in Chapter 4.

To start, all responses for survey questions 11, 12, 13, 14, and 16 were listed and grouped together (Listing and grouping stage) by the question it answered. Secondly, only statements relevant to studying the beliefs, teaching practices, and experiences of the respondents were listed and any unrelated statements were removed (Horizontalization). Some of the removed statements came from survey question 13 and 14. Question 13 asked the respondents to describe their teaching style, and one of the respondent reported, “elementary science methods PKG” and another respondent reported, “Not sure what you mean here.” Question 14 on the survey asked, “what does it mean to teach in culturally relevant ways?” One of the respondents to question 14 reported, “scientists work in communities, the more diverse the community is, the more ideas we have to make discoveries.” Therefore, these unrelated statements were eliminated and what remained were the invariant constituents. Next, the researcher carefully re-read through every statement and made note of the characteristics that appeared to exemplify the three parts of the CRP framework as previously defined by Johnson (2011) and Ladson-Billings

(2000) as coding criteria. So statements to each question were categorized or labeled deductively, using the categories, high academic expectations, cultural competence, and critical consciousness. There were no exact statements that perfectly exemplified any of the three parts, but statements that suggested a turn toward these concepts were identified. All of the statements that were related to high expectations were color-coded yellow, the statements that illustrated a suggestion of cultural competence were highlighted green, and any statements that hinted at critical consciousness were color-coded pink (categories). Then, these color-coded statements from the three categories were listed together. So, all of the statements that were highlighted yellow were listed together and so on (textural descriptions). Following this, the researcher identified what the textural descriptions had in common by looking for thematic patterns across all of the yellow coded statements, the green coded statements, and the pink coded statements (Contextual themes). These contextual themes described the circumstances each category had in common. So, the contextual theme that appeared to emerge from the statements representing high academic expectations was “high quality instructional teaching practices” because all of these statements seemed to list unanimously reliable and constructivist teaching practices and ideologies, such as inquiry teaching, modeling, problem-based learning, literacy to build science content, and hands-on experiments. Similarly, the contextual theme that emerged from statements representing cultural competence was “cultural awareness and recognition for otherness” because these statements coded as cultural competence appeared to relate to the respondents’ desire to help their students appreciate and understand how diverse students are different from themselves. Lastly, the contextual theme that emerged from statements that represented

critical consciousness was “culturally responsive pedagogy” because all of the statements coded as pink epitomized principles of CResP, such as activities that help preservice teachers get to know their students, acknowledge diversity in general, and using cultural knowledge when designing lessons.

To come to consensus on the coding criteria for the categories and contextual themes for research question one, a peer debriefer assisted the researcher in this process. The peer debriefer reviewed the data and helped to either offer alternative interpretations or helped develop the contextual themes by asking clarifying questions to help the researcher manage the researcher’s influence on the study (Hays & Singh, 2012). Finally, these three contextual themes were combined to articulate a composite narrative that described in what ways do science teacher educators describe CRP principles? Therefore, since the respondents seemed to identify some of the elements of high academic expectations and other prerequisite dispositions and practices of cultural competence, it was logical to assert the respondents demonstrated an emerging understanding of CRP, but since they mostly described CResP, it was also clear that CRP was not fully incorporated into their teaching. Thus, the final structural theme that emerged from the contextual themes was “CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teaching.”

Interview analysis. As previously mentioned, four-science teacher educators’ from the qualitative survey were selected to participate in multiple semi-structured interviews. The interviews spanned from July 2014 to November 2014. Each interview was approximately 60-90 minutes and was transcribed within 48-72 hours of it occurring. During the interviews, the researcher made memos, or simple notes to document and

contextualize her thoughts when the participants may have mentioned something she either agreed or disagreed with. Secondly, immediately after each interview, the researcher journaled her feelings, assumptions, and impressions of what was said, of what may have not been mentioned, and the big take-aways from interview. This was a significant step to process the data and develop probing questions for each subsequent interview, but this data was not coded. At the onset of analysis, the researcher cautiously and thoroughly read through the transcripts several times to gain closeness to the data. Data reported from the survey was often found repeated in the interviews; thus, the interview analysis was informed from the survey responses. Consequently, because much of what the participants discussed in the interviews was previously reported on the survey, it was very easy for the researcher to determine which survey Respondent each participant was. Therefore, Moustakas' (1994) strategy for phenomenological data analysis was also used in the analysis of the interviews because considering the qualitative survey served to introduce the study and gain preliminary access to the participants it was useful when delving deeper into the participants' interview responses in comparison to what they said on the qualitative survey.

To analyze the interview data, the researcher carefully listened to the audio files several times and transcribed the data using Microsoft Word. Immediately after each interview and during the transcription of the data the researcher wrote memos about the experience to document her impressions and feelings. This was an important step because the researcher realized during the interviews she was already forming ideas about how the data should be grouped. For example, one of the memos after Dr. Jackson's

second interview revealed how the researcher was feeling about this participants' belief about tolerance. For instance, the researcher wrote,

During the interview, she said that she "hated" the word tolerance for much of the same reasons Nieto describes, and would prefer the word "inclusive" than "tolerance." It was interesting that she was able to articulate this difference, which is difficult for many to see because so many view the word, "tolerant" as the best practice as opposed to part of the problem.

However, during the transcription of Dr. Jackson's interview, the researcher wrote the following memo,

It occurs to me that [Dr. Jackson] is *saying* all the right things...however, she seems to embrace culturally responsive pedagogy and has little knowledge of culturally relevant pedagogy. However, I am quite impressed by her responses. It seems that her life experiences and exposures have led her to have a respect for diversity...such as working in programs to expose African American and Hispanic students to high quality science and having an black advisor for her master's thesis, who asked her to write 2 chapters for his book on black scientists and inventors...I truly think these types of experiences have allowed her to broaden her horizons and embrace what I think many others either ignore or dismiss.

After the data was transcribed, electronic copies of the transcriptions were sent to the participants to ensure their statements were not misrepresented. A summary form was also sent with the transcriptions to give the participants a structured process to clarify, change, or refine their interview statements. Only one copy of the summary form was received during the time of the data collection phase and the results from this one form corroborated the data from the transcription. This suggested to the researcher that the participants were satisfied with the way in which their interview statements were captured in the transcription.

As was mentioned earlier, the researcher used a modified process for analysis developed by Moustakas (1994) to both deductively and inductively explore the

interview data using elements from the research questions. In the first phase, during the reading of the interview transcripts, the researcher highlighted statements that represented CRP descriptions/mis-descriptions, CRP applications, teaching practices, teaching beliefs, general comments related to race, experiences related to race, and beliefs related to race. All of these initial categories were highlighted with a different color directly on the transcript, and a color-coded legend chronicled how the researcher deductively assigned the initial categories. While these statements were being carefully read and highlighted into a one of these before-mentioned categories, the researcher made notes in the margin to remind her of impressions or possible alternative explanations. For example, the researcher wrote the following memo in reaction to a statement that was initially highlighted as “general comment related to race” when Dr. Daly reported her sister, a liberal Democrat was the only person in her family who dated a black man, but was now married to a card carrying Republican:

I think she used the terms Democrat and Republican to highlight the currently polarized political scene we are experiencing where most Democrats are more inclusive, open-minded, and support policies that address inequity, and most Republicans are more exclusive, closed-minded and support policies that aim to increase inequality. She even said, “that’s just who she is,” which suggests to me that Dr. Daly was suggesting that her sister was open minded enough to date outside of her family’s race and go against her father’s wishes.

In the next step, all color-coded statements were removed from the transcript and listed and grouped by category into a separate document (textural descriptions). For example, all statements highlighted dark pink represented “experiences related to race” and were listed on a separate document, which constituted the listing and preliminary grouping phase. All other color-coded statements also were listed and grouped by category onto separate documents. Following this, the researcher engaged in Moustakas’

(1994) “horizontalization” (p. 120-121) process, in which every statement on these documents only relevant to CRP beliefs, teaching practices, and beliefs and lived experiences related to race, using the full statements from the participants as the unit of analysis were differentiated and extrapolated. Accordingly, the researcher determined the invariant constituents of these statements by testing each color-coded expression for whether it contained any part of the experience necessary for understanding the phenomenon and the possibility of each expression being further categorized. So, when an expression did not meet the requirements necessary to be further categorized as CRP beliefs, teaching practices, and beliefs and lived experiences related to race, it was eliminated. Also expressions were eliminated if they demonstrated overlapping and vague language. For example, the “general comments related to race” category initially emerged when a general racial reference was made in the transcript that could not be categorized as a personal belief or direct experience by the participant. As previously mentioned a “general comment about race” was noted when Dr. Daly spoke about her sister dating a black man. Another statement that represented a general comment about race was when Dr. Daly described how *her mother* felt after the election of the first black president of the United States. This statement was initially categorized as a “general comment about race” as opposed to “experience related to race” because Dr. Daly referenced the experience of someone else as opposed to describing an explicit event she experienced. For instance, Dr. Daly said,

When Obama won the election my mother was afraid that she would be accosted by black men on the sidewalk that wouldn’t go around her. She thought they would block the sidewalk.

So, the general comments related to race category that contained statements such as this

previous statement about Dr. Daly's mother was eventually deleted because it did not explicitly speak about Dr. Daly's racial beliefs or experiences, and instead it only served as an ambiguous or vague example of a possible personal experience by proxy. After all the statements unrelated to CRP beliefs, teaching practices, and beliefs and lived experiences related to race were eliminated, what remained were the *invariant constituents* of the experience, what Moustakas (1994) calls the pertinent data related to the experience. These revised categories emerged from the research questions and the more relevant textual descriptions of the survey responses and were color-coded on index cards. So, the initial categories were CRP descriptions/mis-descriptions, CRP applications, teaching practices, teaching beliefs, general comments related to race, experiences related to race, and beliefs related to race. However, after unrelated statements were eliminated and the initial categories were combined to reduce vague or overlapping data, the categories that emerged were CRP mis-descriptions, teaching practices, and experiences and beliefs related to race.

CRP mis-descriptions were color-coded on red index cards, teaching practices were listed on blue index cards, beliefs related to race were listed on light pink cards, and experiences related to race were listed on dark pink index cards. Following this, the researcher carefully read the statements (textual descriptions) within the more relevant categories and identified what the textual descriptions had in common by looking for thematic patterns across all of the statements on the color-coded index cards (contextual themes).

The contextual themes described the circumstances each relevant color-coded category had in common. Statements in these categories were inductively clustered to

identify common textural descriptions that provided a context or description for the category. So, this means, each color-coded category was broken down further by discovering what the category had in common and these descriptions were reviewed until patterns were established. Direct and verbatim quotations from the interview participants were used to support the textural descriptions for the contextual themes, which often required long quotes to fully demonstrate the essence of the experience. The final contextual themes for the interviews were CRP near examples/CResP, beyond CResP, reflection of a struggle, science-for-all teaching practices, racially influenced teaching activities, early experiences, and manifestations of racism. A peer debriefer and the researcher validated the invariant constituents and the contextual themes against the other statements made by the survey participants to either confirm the theme or suggest possible alternative explanations.

Lastly, the researcher defined the final structural themes, which were based on the categories and the contextual themes to create the composite description of the phenomenon. These structural themes worked together to shape a final narrative that represented the four science teacher educators' as it related to their CRP beliefs, teaching practices and beliefs and experiences related to race. Table 15 illustrates the categories, contextual themes, and structural themes for the survey data in part one of the study.

Table 15

Categories, Contextual Themes, and Structural Interview Themes

Categories →	Contextual Themes →	Structural Themes
CRP mis-descriptions	CRP near examples (CResP)	There is a struggle to understand and implement CRP in science education teaching.
	Beyond CResP	
	Reflection of a struggle	

Table 15 Continued

Teaching practices/actions	Science-for-all teaching practices Racially influenced teaching activities	Modeling conventional science teaching strategies and ideologies are preferred for preservice teachers to engage all learners as opposed to identifying specific learning needs of African American students.
Experiences related to race	Early experiences	Racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.
Beliefs related to race	Manifestations of racism (achievement gap, colorblindness, tolerance, and racist teachers)	

Interview analysis example. To illustrate how the interview analysis emerged, what follows is an example of the process used to analyze the data for the first research question.

To start, the interview data that responded to research question one, addressed in what ways science teacher educators describe CRP principles. So, the two initial deductive categories applied to the raw transcript were CRP descriptions/mis-descriptions and CRP applications. All statements representing CRP descriptions or CRP mis-descriptions were highlighted with a red highlighter and statements that described how the participants applied CRP were highlighted with an orange highlighter. The statements that represented each category were taken out of the transcript and placed in a separate Word document. These statements were carefully examined and any overlapping or irrelevant category was eliminated. For example, the participants did not provide any actual descriptions for CRP or CRP principles, so these categories were collapsed and revised into one category, CRP mis-descriptions, because the statements did not appear to reflect the CRP framework. Next, the researcher conducted an

inductive analysis by carefully examining the statements in the Mis-descriptions category to discover what the statements had in common and while the researcher did not find any authentic CRP descriptions or applications, she did find examples of CResP, descriptions that seemed to go beyond CResP, and reflection statements about not being able to fully understand CRP or how to implement it (contextual themes). So the textural descriptions from these examples were clustered into contextual themes that appeared to emerge from the statements representing CRP mis-descriptions. Consequently, the contextual themes were CRP near example/CResP, beyond CResP, and a reflection of a struggle. The first contextual theme, CRP near example/CResP, appeared to emerge because when the participants were asked to describe CRP, they described ideologies and practices representative of CResP as opposed to CRP. Additionally, some of the participants explicitly indicated that they were unfamiliar with the CRP. For example, the following statements were reported that characterized the CResP contextual theme and demonstrated a lack of understanding for CRP:

I am not sure what that is, but I could maybe guess. I don't know what the literature says about culturally relevant pedagogy, but culturally responsive pedagogy is the theoretical framework that has guided a research line I do...the research on the [XXX Scholar Program] and their preparation for teaching in high needs schools...we use Sleeter's definition. (Dr. Daly)

I actually haven't heard of culturally relevant, I mean I read a lot about culturally responsive pedagogy. I haven't heard the word relevant before... but culturally responsive pedagogy means looking at the way students learn and taking into account where they come from, where they are, who they are, and meeting their needs where they are and it is not what the teacher thinks it needs to be, that's my take, but no, I've never heard the two used separately." (Dr. Jackson)

However, the "beyond CResP" contextual theme developed because when given some clarification of what CRP actually was, the participants began to describe what

appeared to go beyond CResP but did not quite epitomize CRP. Accordingly, this suggested the participants struggled to understand CRP. Lastly, the contextual theme “reflection of a struggle” emerged from CRP Mis-descriptions because the participants reported specific statements that reflected a struggle to understand the difference between CRP and CResP and how culturally relevant science teaching could be implemented in their science methods courses. For example, Ms. Alleyne made the following comment that demonstrated she was reflecting about her experience within the study:

Like now that I’m thinking about it and listening...and things I’ve learned here and articles you’ve sent...and our conversations...I’m really thinking that just having one day for our class discussion on the burden of acting white is not enough... (Ms. Alleyne)

To come to consensus on these contextual themes, a peer debriefer assisted in this process. The peer debriefer reviewed the data and helped to either offer alternative interpretations or helped develop the contextual themes by asking clarifying questions to help the researcher manage the researcher’s influence on the study (Hays & Singh, 2012). Finally, these three contextual themes that described CRP mis-descriptions were combined to articulate a composite narrative that described in what ways do science teacher educators describe CRP principles? Therefore, when the respondents reported CResP beliefs and practices when asked about CRP it seemed to identify a lack of understanding about CRP. Secondly, the participants’ struggled to provide an example of how CRP could be implemented into their teaching to help prepare their preservice teachers to engage African American students; therefore, it was logical to assert the respondents articulated a concern about how to implement CRP in their science education teaching. Thus, the final structural theme that emerged from the contextual themes was

“there is a struggle to understand and implement CRP in science education teaching.”

This structural theme seemed to modify the structural theme found in part one of the study, which stated, “CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teaching.”

Summary Form. The summary form was originally intended to confirm and triangulate the beliefs, practices, and experiences of the interview participants once the interviews were concluded. An electronic copy of the transcribed interviews were provided to each participant along with a request to complete the summary form. This was done so that the participants could have access to their previous responses and suggest any changes, clarifications, or revisions. However, only one form was received during the data collection period. Ms. Camille Alleyne completed this on-line summary form within the time frame of the study. To no avail, the researcher repeatedly asked the other three participants to complete this summary form to ensure their voices and the essences of their experiences had been accurately captured. Therefore, the researcher used the one summary form received to corroborate what this participant indicated in the initial qualitative survey and interviews. For example, each response on the summary form that matched with a similar comment from the survey and interview was compared and confirmed. Conversely, if a response on the summary form was coded as contradictory to what was indicated on the survey and/or within the interviews, it was re-coded as either a disparity or a transformation in belief or practice based upon the narrative description on the summary form. For example, on the survey Ms. Alleyne indicated in the affirmative that she taught her students to confront racism in education with real world science projects and inquiry. However on the summary form, Ms.

Alleyne's comments indicated a realization that she did not do this within the context of her science methods course when she said,

I haven't done this on the university level but am trying to incorporate it as I move forward in my course. (Ms. Alleyne)

Therefore, this previous comment was noted on the summary form as a transformation in belief.

Peer Debriefers. Hays and Singh (2012) say that having a peer debriefer adds credibility to a study because a peer debriefer causes the investigator to think deeply about research decisions and alternate explanations in data analysis. There were two peer debriefers in this study. They were doctoral colleagues within the Curriculum and Instruction program at Old Dominion University. They were purposely selected because they both were knowledgeable about ethical research standards as outlined by the university's human subjects' training and had experience with ethical qualitative research. One peer debriefer represented a different race from the researcher, but similar to most of the participants. The other peer debriefer was the same race as the researcher. Having a peer debriefer both racially different and the same as the researcher was important because although the researcher, who has such a connection to the study, was the research instrument, the peer debriefers helped to manage my already admitted bias. Specifically, the peer debriefers reviewed the research tradition, challenged the process for analysis, and helped the researcher to come to a consensus on the initial categories and contextual themes from the survey and interview transcriptions to "propose alternate interpretations" in an effort to increase the researcher's accountability and efficacy in the role as the researcher (Hays & Singh, 2012, p. 151). The peer debriefing team also

worked together to come to consensus on the categories of the three interviews, and they provided a source of emotional support as the data was managed.

Lastly, Rubin and Rubin (2012) say “activist” interests, ideologies, and personal experiences heavily influence critical researchers (p. 234-235). So, while Hays and Singh (2012) and Merriam (2009) strongly suggest that bracketing of researcher bias is an important step to add trustworthiness to qualitative studies, this contradicts the premise of the critical perspective that undergirded this study. Therefore, as suggested by Hays and Singh (2012) in place of bracketing, memoing and journaling can be an important tool used to be transparent about my bias. Consequently, I wrote extensively in a research journal, which documented my thoughts, feelings, hunches, and emotions as I planned the study, collected the data, and analyzed the data. These reflexive practices during data collection and analysis allowed me to look for alternative explanations in the data and reconcile a deeper understanding of my role as a novice researcher, which were all important elements that helped to increase the credibility of my data analysis (Hays and Singh, 2012). Furthermore, since researcher bias was an important factor in this study, in what follows is a further discussion of the steps taken to ensure credibility and trustworthiness, commensurate with qualitative research.

Credibility and Trustworthiness

For the purposes of critique and evaluation, many agree that conventional uses or quantitative conceptions of reliability and validity are not prudent for qualitative research (Denzin & Lincoln, 1994; Donmoyer, 1990; Hatch, 2002; Hayes & Singh, 2012; Kincheloe & McLaren, 1994; Lincoln & Guba, 1985; Merriam, 2002, 2009; Sanchez-Jankowski, 2002). Similarly, Hayes and Singh (2012) describe how “the notion of

trustworthiness replaces the concepts of reliability and validity for establishing rigor” in qualitative research (p. 194). In *Naturalistic Inquiry*, Lincoln and Guba (1985) advance well-respected criteria to evaluate trustworthiness of qualitative data, which includes controlling for credibility, transferability, dependability, and confirmability. In order to sustain the trustworthiness of this current study, the researcher employed two widely accepted strategies -- credibility and transferability measures (Hays & Singh, 2012; Merriam, 2009; Thomas, 2006; Yin, 2009).

Strategy to evaluate credibility. To evaluate the trustworthiness of a study, Lincoln and Guba (1985) suggest discussing issues of credibility as an alternative rationale for quantitative explanations of internal and external validity (Hays & Singh, 2012; Merriam, 2009; Thomas, 2006). Member checking is a strategy used to increase credibility in which the researcher engages in on-going dialogue with participants to offer more internally valid interpretations of the phenomenon studied (Hays & Singh, 2012; Merriam, 2009). While member checking is an accepted strategy for judging credibility (Creswell, 2012; Hays & Singh, 2012; Lincoln & Guba, 1985; Merriam, 2002, 2009), this process can be challenging as the researcher and participant(s) work toward agreement in the analysis (Janesick, 1994; Kincheloe & McLaren, 1994). It is meant to be an intricate and continuous process whereby the researcher(s) check the accuracy of the data by providing the participants the opportunity to inspect transcripts and interpretations of findings for fairness, authentic representation, and “goodness of fit” (Hays & Singh, 2012, p. 206). Critical research further complicates member checking because disagreement between participants and critical researchers, in particular are common and difficult to resolve in that “the researcher may see the effects of oppression within...those

researched” (Kincheloe & McLaren, 1994, p. 151), which may not be acknowledged by the participant (Denzin & Lincoln, 1994; Young, 2011). In this situation, Kincheloe and McLaren suggest that the researcher participate in several interview sessions to reconcile and document the participants’ perspectives as a meaningful layer to the overall interpretations.

In *Language in Science Education as a Gatekeeper to Learning, Teaching, and Professional Development*, Mensah (2007) describes her member checking process whereby she conducted several interviews of black in-service science teachers about the impact language has on science learning. Mensah suggests critical researchers must build trust with multiple interactions with the participants by gathering the participants’ “narrative and life history accounts” (p. 323). However, while the benefits of member checking have been widely discussed (Creswell, 2012; Lincoln & Guba, 1985; Merriam, 2002, 2009; Rubin & Rubin, 2012), there has been little research on how to engage in this sometimes-tricky process when the critical researcher and the participants come from vastly different racial backgrounds. Nevertheless, naturalistic researchers embrace authenticity as the number one ambition of qualitative inquiry (Lincoln & Guba, 1985); therefore, allowing the participant(s) to provide additional clarification to the researchers’ contrary interpretations adds a level of credibility to the findings (Merriam, 2002, 2009).

In the current study, member-checking procedures were used to engage in ongoing dialogue with the four interview participants (in the smaller group for part two of the study) to ensure there was a consensus with the interviews (Hays & Singh, 2012; p. 206; Merriam, 2009). For example, during each interview, I checked for meaning with the participants or paraphrased their statements if I was uncertain about a statement.

Secondly, during the second and third interview, I provided opportunities for the participants to clarify statements from the previous interviews. Additionally, if a response was unclear I asked the same question again on a subsequent interview and compared the responses. Once the interviews were complete, I sent the participants a copy of the transcribed transcripts to approve or re-clarify as necessary. Lastly, I provided each participant an electronic summary form after all three interviews were complete, so they could explain, clarify, or describe their beliefs or teaching practices in more detail. Only one participant responded to the online summary form.

Strategies for transferability. Hays and Singh (2012) say thick descriptions and audit trails are very popular transferability measures for qualitative studies. Strategies to increase the transferability of a study include providing thick detailed descriptions of the research process, methodology, rationale, limitations, delimitations, and context of the setting, participants, and time frame, so as to increase the likelihood the study will yield confidence and support by the readers (Hayes & Singh, 2012; Merriam, 2009). To increase the propensity for readers to understand and transfer the phenomenon of study, Shenton (2004) suggests qualitative researchers explicitly describe with thick descriptions the organizations taking part in the study and where they are located, the characteristics in the type of people who contributed data, the number of participants involved in the study, the data collection and analysis methods used, the number and length of the data collection sessions, and the time period over which the data was collected. Thus, all of these constructs have been described in detail.

Hays and Singh (2012) refer to thick description as vividness of the research process, data collection, and outcomes. One way they encourage this is with audit trails.

An audit trail is a mechanism to increase transferability because the researcher maintains physical evidence of the data collection procedures, so that in the event someone wants to review or reconstruct the work, it can be done systematically (Morse, 1994). Popular items in an audit trail include: a) consent forms, b) observation rubrics, c) field notes, d) memos, e) reflexive journals, f) transcriptions, g) interview protocols, h) timelines of research activities, i) rubrics and matrices, j) all drafts of data analysis and coding, k) documents explaining funding and entry, and l) data management tools (Hayes & Singh, 2012; Janesick, 1994; Merriam, 2002; Patton, 2002). Therefore, in this study, the researcher took care to document every step of the “qualitative research process” and maintain hard copy records in three-ring binders should anyone ever want to inspect the physical evidence to perhaps replicate the study in another context (Denzin & Lincoln, 1994). For example, evidence, such as study rubrics and matrixes, survey blueprints, consent forms, interview protocols, coded transcriptions, data collection and analysis procedures, and a detailed timeline have been documented for the current study. This audit trail was done so that anyone could easily audit or recreate my research process without compromising the confidentiality of any of the participants. Specifically, I saved copies of the transcribed interviews (which were scrubbed with any personal identifying information), field notes, data matrices, and data collection tools. Secondly, I maintained a reflexive journal where I wrote electronic memos and personal notes about the planning, collection, and analysis stages of the study, and I stored a chronological copy of the coding process to reveal the process of inductive coding.

Thick description of the participants’ responses is another strategy to increase transferability (Hays & Singh, 2012). Creswell (2007) says providing thick description in

the form of participant quotes is necessary because there must be evidence to document the researcher's analysis as well as the participants' perspectives (p.41). Therefore, in this current study, the researcher supported her analyses using representative quotes from the participants to permit the consumers of this study to assess the credibility of the conclusions made regarding the lived experiences of the science teacher educators in this study. This was especially important because this study did not incorporate actual classroom visits because the purpose of the study was to examine *espoused* beliefs, practices, and experiences of science teacher educators; so, it was critical to accurately capture the genuine perspectives of the participants to avoid misrepresenting them. Examples of these verbatim quotes are found in chapter four and five of this study.

Limitations and Delimitations

As suggested by Merriam (2009) and Berg (2001), limitations are an unavoidable part of any type of research that deteriorate the credibility or validity of the findings. Therefore, while this study has implications for advancing discussions about race and privilege within science education, it also has limitations. One of the limitations that are commensurate with qualitative research was the geography of the sample and the sample size. The 11 participants in this study all came from one southeastern Mid-Atlantic region of the US, which prevents the results from being representative. However, a large diverse state was selected for this study as to address this issue. With that said, generalizability issues with case studies have been long argued in research circles (Becker, 1990) and science disciplines in particular (Lee, Deaktor, Hart, Cuevas, & Enders, 2005). Case studies with small sample sizes simply do not convey enough information to assert meaningful research findings. However, as cited by Barton and

Yang (2000), Becker (1990), Donmoyer (1990), and Eisner and Peshkin (1990) suggest the practice of education is without a doubt focused upon each individual. Using this paradigm of thought, generalization develops as “a form of personal knowledge often revealed in the narrative of the parable or story; and we generalize each time we try to learn lessons from the past” (Eisner & Perkins, 1999, p. 172). Furthermore, Donmoyer (1990) argues for naturalistic generalization, in contrast to formal generalization, because it provides an authentic value not inherently seen in quantitative data. Thus, the current case study involving both a larger qualitative survey sample with approximately 11 respondents, and a smaller interview sample with four participants yielded valuable data that allowed the participants to deeply reflect upon their individual pedagogy. Thus, by the nature of the design, I sought information from the participants about how they approached teaching and the world as they knew it, which would not be gleaned from a quantitative platform (Yin, 2009).

Other limitations for the current study included not observing the science teacher educators’ classrooms or students, and not being able to correlate student achievement with culturally relevant practices. Future plans to extend this research include addressing these limitations.

It has been the researcher’s intention that this study provide a useful framework for discourse about the need for increased cultural competency with science teacher educators at postsecondary settings, which may lead to changes in thinking and classroom practices to support African Americans in K-16 science. Moreover, the topic of culturally relevant pedagogy required engaging in many conversations about race and privilege; therefore, the idea of the Hawthorne effect, in which the participants may have

provided socially acceptable answers, bears mentioning. While it would have been prejudicial of the researcher to assert that the limited self-reported data in this case study of science teacher educators is comprehensive of their total perceptions, it would have likewise been naïve to think that there is not a preponderance for participants to offer socially acceptable answers, as is the case in many cultural studies (Kincheloe & McLaren, 1994). Thus, critics of this study might say the participants may have given socially acceptable answers for fear of being viewed as either culturally insensitive or racist (Young, 2011). In response to this, the researcher purposefully constructed the three-part interview protocol to include thought-provoking questions that could cross-reference prior responses, such as using a scenarios to corroborate a previously unclear or convoluted statement.

Summary

This chapter has described the methods taken to explore how science teacher educators' train future preservice teachers to engage African American students in K-12 science. As explained in this chapter, the researcher employed Moustakas' (1994) methods of qualitative analysis to answer the research questions. The next chapter, findings, describes how these research questions were answered in both part one and part two of the study. Chapter 4 also includes a discussion of the personal reflection of each participant.

CHAPTER 4

FINDINGS

The main purpose of this study was to find out how science teacher educators prepare preservice teachers to engage African American students in K-12 science. Thus, using Ladson-Billings' (1995a) definition of culturally relevant pedagogy (CRP), the researcher attempted to identify how science teacher educators reported their understanding of culturally relevant teaching principles in the context of science education. So, each part of the CRP framework was clearly operationalized to reduce the ambiguity between CRP and culturally responsive pedagogy (CResP) (Ladson-Billings, 1995a, 2006; Young, 2010). In addition to exploring CRP principles, science teacher educators' espoused teaching practices and beliefs and past experiences related to race were explored. Lastly, in line with the critical research process, the researcher invited specific participants in the study to engage in personal reflection.

Culturally relevant pedagogy (CRP) as opposed to CResP, is a style of teaching in which teachers purposefully affirm diversity and empower students to challenge societal injustices that oppress themselves or others (Ladson-Billings, 1995a, 2000). Specifically, advocates of the CRP framework (Ladson-Billings, 1995a, 2000; Young, 2010) highlight that it fosters deeper learning from a combination of teachers maintaining high *academic expectations* (the use of rigorous and meaningful curriculum and high quality instructional practices), facilitating *cultural competence* (identifying the oppressive nature of the status quo, while simultaneously facilitating identity development), and teaching in such a manner as to empower a sense of *critical consciousness* in learners (fostering democratic citizenship by teaching students action-oriented ways to confront

societal injustices that oppress themselves or others). As was examined in chapter two but bears mentioning again, CResP is a useful style of teaching because it serves as a near example of CRP. Specifically, Gay (2000, 2002) suggests educators who subscribe to the CResP framework must adhere to five major characteristics: develop a knowledge base about cultural diversity, demonstrate caring attitudes and behaviors toward diverse students, build supportive learning communities for diverse students, communicate with diverse students and their families, and deliver instruction that responds to ethnic diversity. Gay explicitly says that culturally responsive pedagogy is defined as

using the cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively. It is based on the assumption that when academic knowledge and skills are situated within the lived experiences and frames of reference of students, they are more personally meaningful, have higher interest appeal, and are learned more easily and thoroughly (Gay, 2002, p. 106).

Thus, CResP fosters an acknowledgement and appreciation of cultural and racial differences of students in education, which certainly is a first step emergent culturally relevant pedagogues must take. However, CResP does not sufficiently foster students' knowledge of oppressive devices and institutions in society nor does it address how to confront those devices or institutions. Undoubtedly, CResP is an essential piece of CRP because the principles of CResP serve as prerequisites to CRP, but it is incorrect to assume that CResP and CRP are one in the same. Therefore, both CRP and CResP both advocate that curriculum content is modified to reflect the interests and cultural needs of students. However, the five propositions that have traditionally characterized the CResP framework ultimately suggest educators affirm a respect for otherness by fostering cultural appreciation for diversity, which is usually exemplified by expecting the best of all students and delivering culturally sensitive instruction. In contrast, the CRP

framework proposes that culturally appropriate curriculum modifications nurture students' cultural identity, while revealing the hidden and hegemonic intentions of the status quo, so that students can recognize their potential, understand their influence, and confront these social injustices. Figure 5 illustrates a comparison between CResP and CRP, which shows that it is a theoretical misnomer to suggest they are identical because CRP demands educators go beyond affirming cultural otherness (Gay, 2000; Ladson-Billings, 2000). Instead culturally relevant pedagogues affirm diversity *and* empower students' individual and community consciousness. The major areas of agreement and disagreement between these frameworks will be addressed in greater detail later in this chapter.

Figure 4. Comparison of Culturally Relevant and Responsive Pedagogies

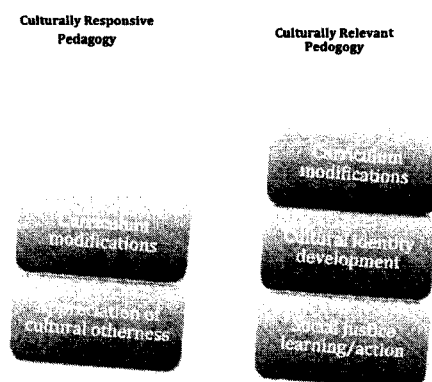


Figure 4: Culturally relevant pedagogy and culturally responsive pedagogy have important similarities and differences.

In what follows is a discussion of the sources of data, a detailed data analysis organized by research question, and a summary of the findings for part one (the survey group) and part two (the interview group) of the study. To investigate science teacher

educators' beliefs and teaching practices, the following research questions guided the study:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?

As described in the methods section of chapter three, this study used a phenomenological case study approach under the auspices of critical race theory to examine these research questions. Data from a qualitative survey, interviews, and a summary form were analyzed inductively and deductively to glean the depth and meaning of science teacher educators' beliefs, practices, and personal experiences. A phenomenological analysis strategy was used to reduce the data with both the qualitative-survey responses and interviews (Moustakas, 1994).

Qualitative Survey

In part one of the study, the on-line survey contained 28 total questions and was administered using Survey Monkey. The first ten items were demographic in nature, survey items or questions 11 through 21 were in a qualitative short-answer format, and the last seven questions, items 22 to 28 were in a yes-or-no format. Fifty-eight science teacher educators were invited by email to participate in the survey, 13 entered the study, and 11 electronically consented and completed the survey.

Survey Questions. The questions were organized in such a fashion that if a participant did not want to respond to a particular question, it could be skipped.

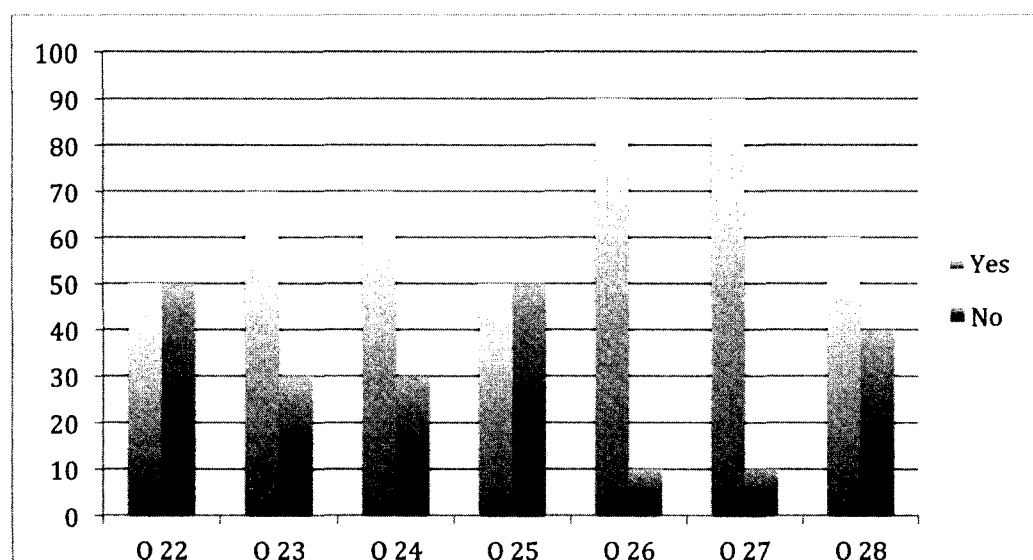
Consequently, not every participant responded to every question and each respondent number did not remain constant throughout, but there were at least 9-11 responses for every question. Therefore, it is not possible to track a respondent's answers to the survey questions from start to finish because respondent nine for example, on question 11 is not necessarily the same respondent nine for question 12, and so on. So, as the data is discussed, the respondents will be identified corresponding to each specific survey question. Accordingly, the survey was only used to crack open the study and gain access to the participants. Thus, part one of the study only provided an introductory glimpse into the beliefs, practices, and experiences of science teacher educators. Subsequently, the responses ranged from short two-word expressions to several sentences long.

Yes-No Questions. The yes-or-no questions were used to select the interview participants from the pool of survey respondents. The yes-or-no questions were also used to situate survey responses with the whole group, as will be seen later in the analysis. The results of the yes-or-no questions are shown in Table 16 and Figure 5. Admittedly, the yes-or-no questions were limiting because it was not possible to determine how the participants interpreted the questions. Also, these questions by nature did not allow for explanations by the survey respondents, but despite their obvious limitations, they were a useful device used later to spark discussion with the interview participants, who provided clarification and deeper self-reflection.

Table 16

Yes-or-No Questions

Yes-or-No Questions
<p>Q22 I am colorblind to skin color because I treat all students the same; thus, skin color really doesn't matter. Answered: 10 Skipped: 3</p>
<p>Q23 I teach students how to solve sociopolitical injustices within the content of the class. Answered: 10 Skipped: 3</p>
<p>Q24 I talk to my students about the hidden curriculum that marginalizes African American or black students in science. Answered: 10 Skipped: 3</p>
<p>Q25 I facilitate opportunities for my students to learn how to confront racism in education with real world science projects and inquiry. Answered: 10 Skipped: 3</p>
<p>Q26 My goal in teaching preservice teachers to engage students who represent a diverse racial or ethnic group is to facilitate tolerance of racial and ethnic differences. Answered: 10 Skipped: 3</p>
<p>Q27 I believe that understanding my own cultural identity is an important element to teaching my students how to engage their future K-12 students in science. Answered: 10 Skipped: 3</p>
<p>Q28 Are you willing to be contacted for a follow-up interview? If yes, you must provide your contact information in the box below. If no, proceed to #29 (the end of the survey). Answered: 10 Skipped: 3</p>

Figure 5. *Results of Yes-or-No Questions*

Survey Findings

The reported beliefs, practices, and experiences of the survey participants contributed to the discovery of multiple contextual themes, which described how a group of science teacher educators in the southeastern part of a mid-Atlantic state reported culturally relevant teaching principles, their teaching beliefs and practices, and their beliefs and experiences related to race. As a result, three structural themes were constructed from these contextual descriptions on the on-line qualitative survey, which demonstrated ideas of cultural otherness influenced most of these science teacher educators.

The final three themes of the survey were:

- CRP is an emerging skill,
- Science teacher educators subscribe to conventional science teaching practices and beliefs to prepare PST to engage all learners, and
- Race matters in science education because career gaps in STEM and achievement gaps are linked to racial disparities.

A detailed explanation for the analysis follows, which demonstrates the development of the coding criteria, the contextual factors/themes, and the final structural themes. Table 17 shows how the survey items were grouped by the research question it addressed.

Table 17

Survey Questions Categorized by Research Questions

RQ 1: In what ways do science teacher educators describe culturally relevant pedagogy (CRP) principles?	RQ 2: In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?	RQ 3: How do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?
(11) Describe your teaching strengths and weaknesses.	(20) Describe how you prepare your preservice teachers to engage black students in K-12 science?	(15) In your opinion, who is the most notable African American scientist? And why do you think this?
(12) What is the main theme around which you build your science education courses?		(17) Describe the first time you had to interact with someone of African heritage (a black person). What was that like for you?
(13) Describe your teaching style in your science education courses. Indicate if you teach elementary, middle, and/or secondary methods courses.		(18) What are the advantages and disadvantages of talking about racism in your science methods courses?
(14) What does it mean to teach science in culturally relevant ways?		(19) Overall, how does race matter in Education?
(16) What does it mean to be tolerant of racial differences?		(21) What role(s) do science education faculty play in ameliorating the K-12 science achievement gap between African-American (black) and Caucasian-American (white) students?

The categorizing of the survey questions by research questions was particularly useful because each response was considered within the context of each question because without the ability to follow up with the survey respondents, the researcher had to accept each response was in direct relationship to the question posed. For example, if a survey item was specifically asking about black students, then it was assumed the responses provided were directly associated with the given question. Therefore, the responses on

the survey were taken for face value because probing further was not possible on this anonymous survey.

CRP is an emerging skill

The first research question was “In what ways do science teacher educators describe culturally relevant pedagogy (CRP) principles?” In response, the data on the qualitative survey revealed that the science teacher educators who responded were not completely knowledgeable about culturally relevant pedagogy and by in large were describing teaching beliefs commensurate with culturally responsive teaching (Gay, 2000, 2010). Admittedly, culturally relevant teaching and culturally responsive teaching have many similarities; however, the literature discreetly suggests two fundamental differences in that culturally *relevant* pedagogues not only affirm cultural and racial differences, they acknowledge the existence of an oppressive status quo who perpetuates inequitable structures in society and work to develop a critical consciousness in their students to foster action against those inequitable structures (Ladson-Billings, 1995a, 2000; Paris, 2012; Young, 2010). Table 15 illustrates these similarities and differences, which demonstrates that culturally relevant teaching expands the sociocultural principles of culturally responsive pedagogy and includes social justice learning that is situated within the context of culturally appropriate curriculum. Specifically, culturally *responsive* pedagogy (CResP) is a necessary part of culturally *relevant* pedagogy (CRP), but does not go far enough in teaching children to confront and remedy societal injustices faced by marginalized people. Thus, the principles of CResP serve as a starting point to CRP. A detailed comparison of the similarities and differences of CRP and CResP is provided in Table 18.

Table 18

Summary of Culturally Relevant Pedagogy (CRP) and Culturally Responsive Pedagogy (CResP) (Gay, 2000; Ladson-Billings, 2000)

Culturally Relevant Pedagogy	Comparison	Culturally Responsive Pedagogy
1. High academic expectations are set for students, using high quality teaching practices and culturally appropriate curriculum situated within multidisciplinary subject areas.	Same	1. High academic expectations are set for students, using high quality teaching practices and culturally appropriate curriculum situated within multidisciplinary subject areas.
2. Teachers and students develop a cultural competence by gaining an awareness and appreciation of themselves as racial and ethnic beings, but teachers also introduce students to the oppressive structures of the dominant culture, while preserving the unique culture and identity of the students.	CRP extends the ideals of CResP and acknowledges the existence of racist and unjust ideologies perpetuated by oppressive forces	2. The development of a cultural awareness and appreciation of diverse students, where teachers learn about students' interests, home life, and family dynamics to make decisions about instruction and curriculum.
3. Empowering students with a critical consciousness to confront inequitable policies and structures that oppress themselves or others.	Culturally relevant pedagogues demonstrate caring attitudes for their students by fostering sociopolitical learning that confront social injustices faced by students in their communities, but this kind of civil action is not explicitly nurtured in CResP.	3. Teachers are encouraged to communicate caring attitudes and develop relationships with students and their families.

Research question one asked, "In what ways do science teacher educators describe CRP principles?" Survey questions, 11, 12, 13, 14, and 16 addressed research question one, which was subtly posed to find out if the respondents subscribed to the philosophies or principles of culturally relevant pedagogy without directly asking. Survey questions 11, 12, 13, 14, and 16 were:

- (11) Describe your teaching strengths and weaknesses.
- (12) What is the main theme around which you build your science education courses?

- (13) Describe your teaching style in your science education courses.
- (14) What does it mean to teach science in culturally relevant ways?
- (16) What does it mean to be tolerant of racial differences?

It was believed that the respondents may have provided socially desirable answers to questions that directly asked do they subscribe to CRP; therefore, the questions were purposefully crafted to examine the respondents' general knowledge and practices related to CRP principles. Table 19 summarizes this process of analysis.

Table 19

Summary of Analysis for Survey Questions 11, 12, 13, 14, 16

Research Question	Categories	Contextual Factors/Themes	Structural Themes
RQ 1: In what ways do science teacher educators describe CRP principles?	High Academic expectations	High quality instructional teaching practices	CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teacher education.
	Cultural Competence	Cultural Awareness and Recognition of otherness	
	Critical consciousness	Culturally Responsive Pedagogy	

None of the survey responses for questions 11, 12, 13, 14, or 16 directly mentioned CRP; so, these five questions were coded deductively by looking for expressions representative of high academic expectations, cultural competence, and critical consciousness, which are the three parts to the CRP framework (Ladson-Billings, 2000; Johnson, 2011). While these respondents do not explicitly identify culturally relevant teaching principles as their strengths or the way they would describe the overall theme of their class, many of their expressions describe activities or attitudes that hint at

the respondents' describing a high regard for their student's academic success, providing high quality instruction to promote their student's achievement, and motivating students to choose academic success. Therefore, the contextual themes, high quality instructional practices, cultural awareness, recognition of otherness, and culturally responsive pedagogy will be used to show the building of the final structural theme, CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teacher education.

High academic expectations. Ladson-Billings (1995a) suggests teachers who demonstrate a commitment to CRP highly regard their student's academic success and provide high quality instruction to promote achievement in science, reading, writing, math, technology, social skills, and political advocacy in an effort to cultivate active citizens in a global society. In doing so, culturally relevant pedagogues motivate students to choose academic success and expect achievement. Furthermore, high academic expectations are fostered when educators provide high quality instruction and teaching strategies, using curriculum modified to reflect the students' culture.

Some of the survey respondents mentioned having high expectations and reported teaching beliefs and practices they use that may lead their preservice teachers to foster academic success. However, a closer analysis of the responses also suggests that the idea of teaching in culturally affirming ways is not a priority. For example, in question 11, when asked to describe teaching strengths and weaknesses, only three out of 11 respondents mentioned the word "culture," and no one mentioned "culture" at all when asked to describe the overall theme by which the respondents structured their science methods course in question 12. However, possible CRP dispositions and actions were

described that could be categorized as prerequisite behaviors for high academic expectations because the respondents appear to describe beliefs and practices that help their preservice teachers choose academic success. As previously mentioned from Chapters 2 and 3, Ladson-Billings (2000) and Johnson (2011) say culturally relevant pedagogues who foster high academic expectations motivate their students to choose academic success. Similarly, the following responses epitomized having high expectations because they represented actions that lead their students toward being successful, such as taking interest in the students and their families and demonstrating quality content knowledge. For example, when reporting teaching strengths, respondent four indicated, “building great rapport with students, faculty, and parents” and respondent five wrote, “I have strong content knowledge, I read and keep up with research in the field, and I try new activities and approaches every semester.” Respondent six mentioned that he or she “takes interest in every student.” Respondent 10 provides the most notable example by saying,

“I have a passion for science, a belief that all students benefit from committed and knowledgeable teachers, and a belief that preservice teachers' abilities are enhanced by well-planned and executed teacher preparation programs. I am willing to sensitively confront students when they do not meet deadlines and when they read Facebook during class.

Respondent 10 clearly articulates a personal teaching belief about his or her passion for science transcending into high quality instruction for his or her students. This respondent also explains when her students demonstrate inadequate behaviors, he or she redirects their off-task behaviors so his or her students can achieve success.

Question 14 on the survey explicitly asked what it means to teach science in culturally relevant ways. The responses included beliefs and practices. For example,

respondent five and ten of this question mentioned “high expectations” in their responses. Respondent five reported, “I believe it means having high expectations for all students,” and respondent ten indicated,

It means communicating high expectations while showing your students every day that you know them, like them, care about them, and expect them to work hard and be engaged in the discussions and learning in your class.

While it is not known whether these two respondents referenced the term “high expectations” because they knew it was as a part of the CRP model, they did however, provide it within the context of this question. On the other hand, seven out of 11 of the respondents for question 14 did not mention the three parts of the CRP framework, but instead identified various teaching practices they suggested meant ‘teaching science in culturally relevant ways.’

High quality instructional teaching practices. Some of the survey respondents mentioned having high expectations and reported teaching beliefs and practices they use that may lead their preservice teachers to foster academic success

Survey questions 12 and 13 can be used to position the idea that the Respondents reported conventional teaching beliefs and practices to prepare their students to later engage all students. Specifically, many of the participants provided short descriptions of popular science teaching ideologies, which suggested conventional science teaching strategies and principles commensurate with constructivistic teaching advocated in the field of science education (AAAS, 1993; Christensen, 1995). The use of conventional science pedagogical teaching practices reported by respondents when being asked to describe their class theme and their teaching style, respectively, which provided insight into how many of the respondents prepare their preservice teachers to engage all students.

Specifically, the respondents reported the following conventional teaching strategies for survey question 12 when describing their class theme:

Inquiry for all (Respondent 1)

Using hands-on activities to learn science (Respondent 6)

Inquiry (Respondent 7)

All students can be successful in science and math (Respondent 3)

Using inquiry to solve problems (Respondent 9)

Teaching science to all, with a focus on developing skills that are effective with high need students. (Respondent 10)

Secondly, many respondents reported using hands-on activities and modeling the teaching dispositions and practices they hope to see in their students, future K-12 science teachers. For example, on item 13 on the survey, the respondents reported the following teaching practices that they identified were representative of how they delivered instruction. For example,

I try to use hands-on activities as much as possible and model good teaching practices at all time. (Respondent 3)

I model strategies and students try them out. I generally use a learning cycle model in class (Respondent 5)

using manipulatives. (Respondent 6)

inquiry, hands on (Respondent 7)

I utilize Socratic questioning as a means to get students involved in the discussion. I have them complete inquiry activities from the student perspective as a means of modeling, and then we dissect the lessons. (Respondent 8)

My style is to engage students in discourse with each other about topics, and then do a quasi-learning cycle lesson on the topic. Explore before Explain is my mantra to students and I try to follow it myself. I activate prior knowledge using probes such as the Keeley probes, which is an example of how I model

instructional approaches that I want my students to use. (Respondent 10)

Question 13 requested the respondents to describe their teaching style in their science methods courses. Mostly teaching practices were reported with this question. The teaching practices reported across all respondents included “using hands-on experiments, modeling practices, manipulatives, inquiry-based teaching and inquiry-based activities, Socratic questioning methods, discourse circles/groups, constructivist practices, literacy to build science course content, and building teacher pedagogical content knowledge.”

Cultural competence. Ladson-Billings (1995a) clearly states that cultural competence is not simply learning about someone’s culture; instead, cultural competence is fostered when teachers link students’ home-life, language, traditions, and community priorities with curricula and subject matter (Ladson-Billings, 1995). Therefore, a teacher who fosters cultural competence in his or her classroom would adapt the curriculum to the student’s cultural needs and teach students about the rules of the dominant culture, while preserving the student’s home culture and identity. Therefore, cultural competency is gained when culturally relevant pedagogues simultaneously teach their students about how to protect and honor themselves, as well as deconstructing the rules of an oppressive system or society. This cultural competency piece is noticeably missing in CResP. On the qualitative survey, the respondents never directly reported the words “cultural competence, but statements were reported that may insinuate a basic understanding of cultural awareness and recognition of otherness.

Cultural awareness. The respondents did not directly report the development of cultural competence, nor focused on the idea of augmenting the curriculum to address the

existence of oppression or racism. For example, question 12, when asked “what is the theme around which you build your science course,” respondent ten indicated, “teaching science to all with a focus on developing skills that are effective with high needs students.” No other respondents reported anything else that implied teaching preservice teachers to adapt the curriculum to the students’ needs. Rather, most responses to this question included a brief statement about “inquiry, hands-on, or science-for-all.”

However, on survey item 13 when asked to describe teaching style, respondent four for this question possibly suggested building preservice teachers’ capacity to acquire cultural competence. It is unclear what “real life applications in school systems means,” but in response to the question posed, this respondent for question 13 seems to suggest his or her focus in the science education classroom is based on real world examples of what is happening in diverse schools as opposed to theoretical or abstract textbook explanations. For example, he or she wrote,

I teach about real life applications in school systems. I address teaching diverse populations as it relates to gender, class, race, exceptional learning needs, etc. I teach on how to incorporate your own creativity to make learning fun and engaging. (Respondent 4)

In question 14, when asked “What does it mean to teach science in culturally relevant ways?” there were a myriad of responses that suggested a continuum of interpretation. First, respondent six did not attempt to answer this question and simply reported, “not sure.” Secondly, three of the respondents suggested a novice understanding of cultural competence because these statements, which Young (2010) might say fosters cultural awareness and appreciation as opposed to identity development because they are mostly representative of CResP. For example, respondent four wrote, “I

also think that teaching science in culturally relevant ways means knowing where your students come from and knowing their value systems.” Respondent eight said, “If students believe that you are invested in who they are as individuals, including their culture, they are much more likely to buy in to the content you are teaching and appreciate its relevance to their lives.” Lastly, respondent ten seems to provide the most salient response regarding cultural competence. He or she described a belief that goes beyond an awareness of otherness in diverse students and seemed to describe an importance for self-reflection and an ever-changing environment. Specifically respondent ten for question 14 reported,

Effective teaching means doing whatever you can do to not only get to know your students, but also the community that is part of your students' world. It means maintaining a lifelong learning philosophy yourself, particularly learning about your school/community culture and how it changes and will change.

Recognition of otherness. Finally, question 16 asked, “what does it mean to tolerant of racial differences?” While this question seems like an obvious question related to a racial belief (research question three), it was selected to examine the survey respondents possible CRP beliefs or practices as they relate to applying tolerance in their science education classroom. Overall, there was a rejection of tolerance as defined when educators endure cultural otherness rather than embracing it as an asset to learning (Nieto, 1994). While the respondents never directly reported principles of cultural competence as outlined by Ladson-Billings, they did report ideals that were prerequisites for building cultural competence, such as, considering varied perspectives, a rejection of stereotypes, and the existence of a dominant world-view. For example, the following statements from various respondents on question 16 (what does it mean to tolerant of

racial differences?) were coded as prerequisites for cultural competence because they were more characteristic of CResP's goal for cultural appreciation and awareness as opposed to cultivating identity development within the context of a society that may or may not affirm their identity.

Understand differences between us and see it from someone else's perspective (Respondent 1)

Just because people don't think, speak, or do things, as you are accustomed to doing them doesn't mean that they do it incorrectly. Also, racial differences don't necessary mean economic differences. It can't be assumed that all African American students grow up in poverty. (Respondent 4)

I think it means we understand that people see and view the world differently and we don't judge or criticize them when their views or approaches are different from our own or from the norm of society. (Respondent 5)

Tolerance means putting up with differences, allowing them, but maintaining one's own separation. Therefore, I do not equate tolerance with my goals for myself or my students. Instead, I want to embrace racial (and other) differences and enjoy the variations, and I encourage this in my preservice teachers. Also, I encourage an understanding of racial NON-differences. Just because someone's race is different, they are also people with families, goals, and needs, just like all of us. (Respondent 9)

Critical consciousness. Fostering the ability to critique cultural norms and injustices perpetuated by the status quo is critical consciousness (Ladson-Billings, 1995). Specifically, culturally relevant teachers empower learners to take action against such things as racist textbooks, unrepresentative curricula, and societal disenfranchisement. No responses were coded as representing critical consciousness because there was no data that could be coded as emergent sociopolitical teaching as outlined by culturally relevant teaching framework.

Culturally responsive pedagogy. Many of the responses that suggested an action-oriented intention of preparing preservice teachers on the qualitative survey were coded

as culturally responsive pedagogy because they esteemed a passive recognition of otherness as opposed to empowering preservice teachers to confront social injustices in science. For example, on question 14, the following descriptions were provided when talking about the meaning of culturally relevant science teaching:

It means discussing culturally responsive instruction and background knowledge. The teacher uses this cultural knowledge when designing lessons and teaching strategies to best reach every child in a way that is meaningful to the child.
(Respondent 1)

Using student's culture as a basis for learning (Respondent 5)

Acknowledging student diversity and using it as an asset to reaching students.
(Respondent 8)

Summary. Most of these survey responses actually suggested what it meant to teach science in culturally *responsive* ways because using cultural knowledge of diverse students to modify instruction or curriculum without cultural identity development or action oriented measures to confront inequitable structures in the community or society, is only fostering cultural awareness and appreciation of otherness. However, it appears that the respondents demonstrated an understanding of one of CRP's main principles, having academic expectations for students. Ladson-Billings (2000) and Johnson (2011) suggest teachers who embrace CRP use high quality instructional strategies to encourage students to want to excel. For instance, the respondents described they use high quality instructional teaching practices, such as modeling, inquiry-based learning, problem-based learning, literacy strategies, discourse circles, Socratic questioning, and hands-on experiments to motivate their students. Thus, while the respondents did not fully

articulate practices or beliefs completely commensurate with all the CRP principles, they reported, CRP is an emerging skill and is not fully incorporated in their science teaching.

Science-for-all

As was previously established, the analysis of research question one suggested the participants expressed a superficial understanding of CRP because the statements were commensurate with CResP as opposed to CRP. Therefore, the researcher looked for meaningful prerequisites or precursors to CRP threaded throughout the participants' comments. However, the second research question more directly addressed, "In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?" To answer this question, the researcher inductively analyzed item 20 on the qualitative survey, which asked the respondents to describe how they prepare the preservice teachers in their science methods course to engage black students in K-12 science. While survey question 20 may have initially been crafted to exclusively and explicitly examine teaching practices used to engage black students, the respondents actually provided statements related to general teaching practices and the beliefs about why their chosen teaching practices were ideal. Table 20 illustrates how the analysis for research question two emerged. First, expressions from the survey that represented beliefs and teaching practices were deductively identified and separated. Secondly, these reported beliefs inductively suggested a pattern of knowing and considering the needs of all students because many of the statements were characteristic of a science-for-all ideology. Similarly, the reported teaching practices suggested a commonality in understanding the needs of all students by using practices that may help preservice teachers understand how diverse students are different.

Table 20

Summary of Analysis for Survey Question 20

Research Question	Categories	Contextual Factors/Themes	Structural Themes
RQ 2: In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?	Teaching beliefs Teaching practices	Science-for-all Cultural otherness	Science teacher educators subscribe to 'science-for-all' rhetoric to prepare PST to engage all learners.

Beliefs. Consistent with their responses reported for RQ1, they used a science-for-all rhetoric and grouped black students with other kinds of diversity. The expressions that represented beliefs for survey question 20 were characterized by only two statements that encouraged preservice teachers to know and engage all of their students as opposed to highlighting the specific needs of black students in K-12 science. These belief expressions were offered without providing details of how their ideas were accomplished within the context of their classrooms, which is why these expressions were not labeled as teaching practices.

All students need to confront what they already know so they can make connections to keep the knowledge. (Respondent 2)

A science experiment doesn't have a color, so I expect preservice teachers to actively engage ALL students (Respondent 7)

Teaching practices. When the respondents were asked in item 20 to describe how they prepared preservice teachers to engage black students in K-12 science, most provided science-for-all rhetoric and no specific examples (AAAS, 1989).

Science-for-all. The word "all" was used a total of seven times among all of the responses to survey question 20. Two of the respondents skipped the question all

together. Also, most of the respondents described specific teaching strategies that corresponded to understanding otherness and considering the needs of all students, such as simply addressing learning styles of all students and not singling out the needs of any one particular race. Additionally, these statements do not include specifics on how they do what they report, and it appeared the respondents' grouped black students with other kinds of diversity. For example, despite being explicitly asked, in what ways do you prepare preservice teachers to engage African American students in science, the following practices were reported, which demonstrate a suggestion toward facilitating a colorblind science-for-all platform (AAAS, 1989, 1993; Christensen, 1995):

I prepare them to work with all culturally diverse folk through activities in class, discussion, and lesson planning (Respondent 1)

Beyond addressing learning styles and trying to capitalize on prior knowledge, I don't do anything differently. (Respondent 4)

I don't know that I single out one race group in particular. I emphasize the importance of knowing your community and student population in designing curriculum to make sure that lessons are relevant for all students. (Respondent 6)

First and foremost, I prepare my preservice teachers to engage ALL students, despite their color. Furthermore, a science experiment doesn't have a color, so I expect preservice teachers to actively engage ALL students. (Respondent 7)

I prepare my pre service teachers to interface with everyone (Respondent 9)

Cultural otherness. Of the before-mentioned teaching practices reported when asked how these science teacher educators prepare preservice teachers to engage black students in K-12 science, three respondents for question 20 provided specific teaching examples related to race or general diversity they use with their students. These specific examples provided a cursory glimpse into how these science teacher educators train future K-12 science teachers to engage black students in the classroom. Conversely, the

statements also represented a suggestion toward training preservice teachers to only highlight differences between them and their future students. For example,

I teach them to listen to music. From my experiences, black students LOVE music. I also teach them to take the time to ride around the neighborhoods that the children live in to get a real sense of why they display certain behaviors. Even when they act out, find a way to offer positive reinforcement. Encourage them with hands-on activities. Allow them to call out in class if you can keep your class under control. Let them be creative. (Respondent 3)

Draw a scientist, how we represent diversity in science; diversity of inventors (Respondent 5)

PSTs complete a culture bump assignment, helping them recognize and develop strategies for engaging with others who are different than they... (Respondent 8)

First, Nieto (2010) may disagree with these previously reported strategies because they may be viewed as stereotypical and analogous of tolerance. For example, Respondent three, a black science teacher educator appeared to use past experiences to situate his or her belief about black students (“From my experiences, black students LOVE music...”) in an effort to describe why he or she advocates for his or her preservice students to also use the strategies reported. For example, Respondent three indicated she encourages her preservice teachers to ride around black student’s neighborhoods. Nieto (2010) may suggest it is possible this may or may not lead those preservice teachers to draw superficial conclusions to believe their black students are only different from them as opposed to finding commonalities and ways to affirm their students’ cultural identity.

Secondly, Respondent five of question 20 reported that she addresses how the diversity of scientists are represented. In this question, it is not clear how this respondent operationalizes “diversity;” however, this ‘Draw a Scientist’ strategy will be clarified

further in the second part of this study because this Respondent provides additional information about her motivation and the particulars for this teaching strategy during her interviews.

Lastly, but perhaps most notably, respondent eight offered the most specific reply, which incorporated teaching strategies to help her students interface with all students, such as implanting a book club discussion that highlights how a black woman's stem cells have been exploited in the name of research. This respondent also described how he or she helps his or her students prepare, individualize, and reflect on their student teaching experience. These teaching strategies, which seemed to be aimed at helping the students tap into the interests of their K-12 students and understand an example of a societal injustice faced by a black woman will be explored further in part two of the study. Furthermore, these strategies could be extended and modified to foster sociopolitical science teaching should they be framed to foster cultural competence and critical consciousness.

Students lead each other in discussions during our book club about *The Immortal Life of Henrietta Lacks*...Students develop and administer surveys to their high school students to determine how to shape instruction. Students write units and lesson plans using survey information. Students develop problem-based learning lessons and units where relevance is an important factor. PSTs teach full lessons on their placements in the first semester of their program, videotape their lessons, analyze their teaching, and incorporate feedback from me and their own observations including whether they engaged and challenged ALL students. (Respondent 8)

Summary. The respondents reported teaching beliefs commensurate with science-for-all rhetoric. For example the respondents reported teaching ideologies that suggested they prepare their students to engage all K-12 students, in which black students are combined with all forms of diversity. Secondly, teaching practices that personified

building an awareness of cultural otherness were also reported. Specifically, the respondents shared they use various activities to impart a cultural understanding in their students, such as using the ‘draw a scientist’ test and the Henrietta Lacks book, to help preservice teachers understand the nature of otherness. Thus, these before-mentioned contextual factors build the structural theme: Science teacher educators subscribe to ‘science-for-all’ rhetoric to prepare preservice teachers to engage all learners

Race Matters

The third research question was intentionally reflected in a cursory way on the survey because the researcher realized that the survey was not an ideal medium to probe into possibly sensitive anecdotal issues of race. However, general beliefs and personal experience related to race were addressed on the survey with items 15, 17, 18, 19, and 21. Respectively, the survey questions addressed in this analysis are listed in Table 21.

Table 21

Summary of Survey Questions for Research Question Three

Category	Survey Questions
Beliefs	<p>15. In your opinion, who is the most notable African American scientist? And why do you think this?</p> <p>17. What are the advantages and disadvantages of talking about racism in your science methods courses?</p> <p>18. Overall, how does race matter in Education?</p> <p>19. What role(s) do science education faculty play in ameliorating the K-12 science achievement gap between African-American (black) and Caucasian-American (white) students?</p>
Experiences	<p>21. Describe the first time you had to interact with someone of African heritage (a black person). What was that like for you?</p>

Table 21 summarizes the survey questions that were categorized as beliefs and experiences related to race. Item 21 was the only question categorized as an experience related to race because one of the intents of the survey was to only form an introductory preview of science teacher educators' perceptions and experiences; so, this question was added as a gateway question to probe deeper later in the interviews. However, interestingly enough, some unexpected "experiences" were also reported from questions 15 and 18, which will be discussed further.

Based on the introductory nature of this survey, it should be noted that an explicit connection could not be made between the survey responses to these questions about beliefs and personal experiences related to race and how these beliefs and experiences may have impacted their teaching beliefs and practices. However, as will be seen in the analysis of these last five survey questions, possible suggestions are made regarding how racial beliefs and experiences could impact teaching. Furthermore, the responses to these questions were analyzed based on what was provided or not provided within the context of each question. Table 22 shows how the inductive analysis emerged for survey questions 15, 17, 18, 19, and 21.

Table 22

Summary of Analysis for Survey Questions 15, 17, 18, 19, 21

Research Question	Categories	Contextual Factors/Themes	Structural Themes
RQ 3: How do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?	Beliefs related to race Experiences related to race	Race matters in science education Early awareness of race and otherness	There is a call to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.

Beliefs related to race. Mensah (2013) and others (Barton and Yang, 2000; Parsons, 2008) would suggest having certain beliefs related to race are prerequisite dispositions of culturally relevant science educators, such as subscribing to the idea that race matters in focusing on solutions to alleviating the white-black science achievement gap and the identification of oppressive societal structures that marginalize black students in education (Nieto, 2010). Similarly, beliefs directly connected to race and African American students in science in particular also emerged with survey questions intended to address research question three. Specifically, research question three was, “how do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?” What follows documents the responses for the survey questions related to beliefs that build toward the contextual theme

Race matters in science education. Survey question 15 explicitly asked, who is the most notable African American scientist and why do you think this?” Despite it being an obviously additive strategy, including more diverse scientists into the K-12 curriculum is a popular solution discussed in the literature because black scientist role models are lacking in science curricula (Parsons, 2008; Wright 2011a, 2011b). Furthermore, the researcher believes knowing the contributions of black or other scientists of color contributes to a science teacher’s overall knowledge in science. Therefore, this question was added to the survey because the researcher wondered what science teacher educators would say when directly asked, who is the most notable African American scientist and why?” because this knowledge may provide insight into how this belief may impact their teaching practices with their preservice students. For

example, examining this awareness may provide insight about which contributions by black scientists these science teacher educators may be passing on to their preservice teachers, who in turn will be passing onto their K-12 students. Of ten responses, nearly half indicated “George Washington Carver” and the other half had mixed responses. Table 23 shows the scientists who were noted as the most notable African American scientist.

Table 23

Most Notable African American Scientists Reported by Survey Respondents

Respondent	African American Scientist
1	George Washington Carver
2	George Washington Carver
3	Benjamin Banneker
4	Dr. S. James Gates
5	Lewis Latimer
6	Wangari Maathai
7	Neil deGrasse Tyson
8	Neil deGrasse Tyson
9	George Washington Carver
10	George Washington Carver

Overall, the list of most notable scientists was somewhat varied, but a deeper analysis of the scientists reveals a more interesting story. For example, Neil deGrasse Tyson was mentioned by two respondents. Respondent eight mentioned Tyson’s name with no reason provided and respondent seven suggested Tyson has made science popular in today’s society. Specifically, respondent seven said, “I think that in today's society

Neil DeGrasse Tyson has brought a lot of popularity to science with his books and remake of *Cosmos*.” So, respondent seven reported that Tyson is the most notable black scientist and the reason provided appears to be because he has brought a new and refreshing attention to the field. However, if this response was passed down to black K-12 students, it could facilitate a possible disconnectedness in science by black students because it unintentionally overlooks the overwhelming historical influence that blacks have contributed in science. Secondly, respondent six mentioned Wangari Maathai, an African Environmentalist from Kenya, who was an incredible force in sustainable development and women’s rights. While she was the first African woman to receive the Noble Peace Prize, she was not an American, and the question directly asked for the most notable African *American* scientist. This may not be a major distinction because critics may say that African Americans descended from Africa, but it is interesting that this respondent bypassed all the African American scientists from which he or she could have chosen and selected a scientist from another continent all together. Lastly, four respondents to question 15 identified what many call the standard response, George Washington Carver. Admittedly, Carver was an amazing scientist, who blazed trails in botany, but he is most famously remembered for his contributions to farming and the use of the peanut (Jenkins, Hudson, Jackson, & Ryder, 1975). Three of the respondents identified Carver with no reason provided, but respondent nine offered a detailed explanation that begins to delve into a personal experience related to race, which interestingly enough will be explored later as one of the interview participants. What appears most notable in this response to question 15 is how she was personally affected at

the portrayal of violence against Carver and perhaps against blacks in general. For example, respondent nine said,

I guess George Washington Carver because he not only developed a body of research about plants but also invented numerous uses of certain crops, which improved the quality of life for farmers who applied his ideas. He did this all in a culture that did not support African American achievement at all. I read a biography of Carver when I was a teenager and I remember the portrayal of the Klan, which attacked his home, and I was horrified at the cruelty and ignorance of certain groups.

In addition to having an awareness of African American scientists, another belief that promotes the contextual theme that race matters in science education is understanding the elements that contribute to the white-black science achievement gap. Therefore, question 21 asked, what role do science teacher educators play in ameliorating the K-12 science achievement gap between black and white students?" Ten of the 11 respondents answered this question. This was an important belief to examine because it uniquely requested the respondents to share what they believe their role is or should be, in lessening this gap by asking what the role is for science teacher educators in general. Interestingly, one of the respondents suggested it was the job of elementary science teachers, which may have suggested science teacher educators' had no contribution either in preparing those elementary science teachers or by reforming the teacher preparation system to include better preparation for elementary level teachers.

Elementary education teachers must embrace science concepts in their teaching so that there is a curiosity at the upper levels for all students (Respondent 2)

For the most part however, the responses suggested science educators believed they should be addressing the injustices that black students and other students of color face in science classrooms. While many of the responses suggested that science

education faculty play a role, many of the respondents avoided providing specific examples for how they could achieve their own advice and instead suggested more general expressions. For example, after the researcher read the following responses, the researcher could not help but rhetorically ask, “but how?”

A huge one. (Respondent 1)

We need to model teaching with cultural relevance. We also need to be sure our students fully understand how important it is to work towards closing the achievement gap. (Respondent 3)

Huge- should do more. (Respondent 6)

Discuss data and highlight the gaps. From this discussion, faculty need to actively focus on preparing preservice teachers on effective ways of using data to improve learning. (Respondent 8)

I think science teacher educators are critical in helping to close the achievement gap. We know the research, where the pitfalls are, and what's working. We also know our own institution/student body culture, and can/should problem solve about how to match the needs to schools with who our students are. (Respondent 9)

The role is not exclusive to science teachers, we all as faculty have a part to play in bridging the gap. However I am not sure of the specifics on how to address this. (Respondent 10)

Conversely, two responses to question 21 personified a call to action for science teacher educators to address the white-black science achievement gap and interestingly suggested science teacher educators bear some liability for the gap. For example, Respondent Four, suggested that science teacher educators should include conversations about race.

Science teacher education faculty play a huge role that I don't they realize. When race isn't discussed and incorporated in methods courses, white and even some black preservice teachers have a difficult time in meeting the educational needs of black students. I don't think it would ameliorate the achievement gap but it could narrow it. (Respondent 4)

Respondent Four's call to discuss and incorporate topics of race is theoretically proposed by Johnson (2011) who suggests science teacher educators' should foster discussions about race to help prospective teachers understand how students of color may be marginalized. Also, Respondent Five offered an initially vague proposal regarding preparing knowledgeable teachers in "content and pedagogy," but he or she also proposed a distinctive strategy in which science teacher educators could take responsibility for the achievement gap.

Our job is to ensure that we prepare teachers knowledgeable in content and pedagogy that can plan instruction for all types of students. I also believe we should be spending time in schools where the gap is pronounced. (Respondent 5)

Grossman, Hammerness, and McDonald (2009) also would agree with this this theoretical suggestion where teacher educators' collaborate with K-12 schools because they suggest preparation programs must redefine the teacher and reinvent teacher education by dismantling the divide between universities and K-12 schools. However despite the ingenuity of these ideas to address the white-black science achievement gap, Respondent Four and Five did not provide a clear direction for action to move this theoretical call into practice by science teacher educators.

The responses to question 21 demonstrated the respondents suggested that science teacher educators' somewhat contributed to the overall achievement of K-12 students in that they play a part in lessening the white-black achievement, but despite their general appeal for action, most did not suggest explicit strategies for doing this. Mutegi (2011) calls for curriculum reform and instructional paradigm shifts in how black students experience science education. More recently, Atwater, Lance, Woodward, and Johnson

(2013) call for teacher educators to address the science achievement gap by preparing K-12 teachers to understand the unique relationship between the learning needs and the essential science instruction modifications necessary for teaching African American, Latino, and Asian American students. With this mind, question 18 asked, “What are the advantages and disadvantages of talking about racism in your science methods course?” This was an important racial belief to examine because it provided a subtle signal as to the possible commitment the respondents make to talking about the existence of unjust policies, procedures, and structures in American society that work to oppress black students and how racism impacts science education. Interestingly, on the yes-or-no questions, 70% of the respondents indicated that they did talk to their students about the hidden curriculum that marginalizes black students in science. Similarly, 50% of the respondents indicated, “Yes” that they facilitate opportunities for their students to learn how to confront racism with real world science projects. So, it would seem likely that most of the respondents to question 18 would suggest an increased advantage to talking about the existence of racism. Ten science teachers provided responses to this question. Each response usually contained at least one advantage and one disadvantage, and for the most part, most indicated that the advantages outweighed the disadvantages. However, Nieto (2010) would suggest the responses that noted the disadvantages of talking about racism are characteristic of why the topic of racism is rarely broached in higher education, such as talking about racism in class may make students feel uncomfortable or there is not enough interest or time. For example, the disadvantages reported were:

Uncomfortableness; some students are not willing to face their own racism
(Respondent 2)

I do worry about offending someone (Respondent 3)

The disadvantage is that I've been told that it isn't apart of [my university's] culture and framework. (Respondent 4)

I have little time to address all the issues I must now. I feel less inclined to do this because our students spend a semester studying issues of diversity in schools. I do address it, however briefly, when we discuss nature of science and science as a social endeavor. (Respondent 5)

Some people just don't care (Respondent 8)

Disadvantages is some PSTs think this is "dead" topic, no longer relevant, "haven't we solved this problem already?" Also neglecting other aspects of disadvantage, also creating a deficit mentality in PSTs about AA. (Respondent 9)

This discussion could make some uncomfortable, so I avoid it. (Respondent 10)

Despite the previously mentioned disadvantages, the reported advantages of talking about racism were characteristic of educators who suggest that issues of race and cultural otherness matters in general and/or in science education. For example, the advantages noted by the respondents were:

Advantage is that it puts that which is often hidden by students on the table for discussion; clears up misconceptions (Respondent 2)

Advantage is that racism is real. It is relevant in the science methods courses because students will be teaching diverse learners if they teach in this area. I prepare my students for the reality of teaching. I teach them that teaching is more than knowing the content, you have to find some way to connect with your students. Black students have to feel as though they can trust someone who doesn't look like them. When you are white, many minority children have been raised to see you as an oppressor. (Respondent 4)

I don't see any disadvantages. Advantages are numerous. It may reveal hidden biases in students that they are not aware of which may impact their teaching. (Respondent 7)

It's important to discuss the disparities among race(s) in the STEM fields (Respondent 8)

It makes people aware of the history of racism (Respondent 10)

In addition to the before-mentioned advantages, respondent nine provided an interesting twist on why discussing issues of race matters based on his or her experiences that have impacted his or her teaching. He or she suggested that preservice teachers must be prepared to address racism as a sort of defensive measure because her students should be equipped with a strategy should he or she ever be called a racist by a student or parent. This is an interesting justification for discussing racism, but even more interesting is that this respondent does not seem to address the possibility of her students being called a racist because he or she demonstrated racism. For example,

Preservice teachers need to confront the issues in schools and society and race is a component of those issues. PSTs need to prepare for events like being called a racist by a student or a parent, and know ways to respond. This has happened to several of my students over the years and the first time it happened it really threw me. I figured this was an easy avenue of attack for black students, a test for the new teacher (how will she respond), and it reinforced my belief that we needed to strategize in class about responses (Respondent 9)

The discussion about advantages and disadvantages for talking about racism is related to question 19 because it directly asked respondents to specifically identify how race matters in science education, which actually encapsulates all of the previous survey questions coded for research three. This belief related to race was answered by nine of the 11 respondents who consented to the survey. Eight of those who responded affirmed that that it matters, seven actually identified how it mattered, and one science teacher educator, Respondent nine, reported that race does not matter in science education at all. Most of the responses that suggested race matters in science education, also contained explanations that for the most part summarized many of the previously mentioned factors in the survey, such as the lack of black role models in science, science educators play a role in lessening the science achievement gap, and shaping curriculum to reflect students'

academic and sociocultural needs, which may insinuate that race appears to be one of the factors these respondents identify as why the science achievement gap is so pronounced. For example, those who suggested in question 19 that race matters in science education reported,

It's important for students to be able to identify with the content, scientists, and teachers. (Respondent 1)

Race is evident in science education. Many African Americans do not go into science education, or into teaching at all. (Respondent 2)

It matters tremendously. Race isn't discussed in science education as it should be. Minority students oftentimes don't have a person that they can relate to with science. There are thousands of notable blacks who have contributed to science and only a handful are taught in textbooks. It matters in reaching black students in preparing them to excel school, look towards college, and even in the workplace. (Respondent 3)

It matters in all areas of the curriculum. I don't think it needs to be treated differently in science education, we just need to acknowledge that it is a factor and that these students often don't find their ways to careers in STEM fields. (Respondent 4)

With such an achievement gap in minority students in STEM fields race is a huge factor. We need to figure out how to reach these students and make them believe that they are part of the community in order to relieve the gap. (Respondent 6)

It matters a great deal. Race matters in all subjects because it can hinder students if not addressed properly or it can enhance the learning experience if embraced. (Respondent 7)

Race is a key component of cultural assumptions, it is not the only component. Along with race, science educators should address the whole array of factors that influence motivation and engagement in science classes. (Respondent 8)

These persuasive statements on how race matters in science education provide a preliminary glance into the beliefs these science educators' hold about the influence race has on nearly every area previously discussed within the context of research question three. Specifically, many of the respondents to question 19 mentioned science

achievement disparities, STEM career gaps between black and white students, the lack of black role models in science, and needs in the curriculum, which all conceivably could impact how these science teacher educators prepare their preservice teachers.

In summary, despite reporting various beliefs that suggests race matters in science education, no well-defined actions were provided in how to reduce these before-mentioned racial and cultural disparities. Accordingly, many of the responses to the survey questions suggested a call to action in theory without clear ideas for practice. For example, on survey question 21 when specifically asked what role science teacher education faculty play in ameliorating the K-12 science achievement gap between black and white students, many of the respondents suggested general actions, without providing specific ways they would or do accomplish these actions. Therefore, to illustrate a call to action, action-oriented statements in responses for question 21 were underlined, but the responses do not describe how these broad action-oriented statements could be achieved. Thus, these call to action statements depict no clear action to move from theory to practice:

We need to model teaching with cultural relevance. We also need to be sure our students fully understand how important it is to work towards closing the achievement gap. (Respondent 3)

Science teacher education faculty play a huge role that I don't they realize. When race isn't discussed and incorporated in methods courses, white and even some black preservice teachers have a difficult time in meeting the educational needs of black students. I don't think it would ameliorate the achievement gap but it could narrow it. (Respondent 4)

Our job is to ensure that we prepare teachers knowledgeable in content and pedagogy that can plan instruction for all types of students. I also believe we should be spending time in schools where the gap is pronounced. (Respondent 5)

Huge- should do more. (Respondent 6)

Discuss data and highlight the gaps. From this discussion, faculty need to actively focus on preparing preservice teachers on effective ways of using data to improve learning. (Respondent 8)

I think science teacher educators are critical in helping to close the achievement gap. We know the research, where the pitfalls are, and what's working. We also know our own institution/student body culture, and can/should problem solve about how to match the needs to schools with who our students are. (Respondent 9)

Experiences related to race. Experiences related to race were not examined in great detail on the survey. However, survey question 17 asked the respondents to describe the earliest time they had interacted with someone who was black. While this question may have been redundant for those who were black, it provided a glimpse into the other respondents' past, who were white.

Early awareness of race and otherness. Independent of respondent four and eight, who reported they were black, most of the other respondents provided descriptions that suggested these respondents sustained an early childhood awareness of otherness.

For example, it was reported that

I was in Jr. high school - she and I became close friends, which continued through high school. (Respondent 2)

In elementary school I had one black classmate. We enjoyed spending time together in school, but I never saw her outside of school. (Respondent 5)

I grew up on a tobacco farm in North Carolina (1950's) and played with the black sharecropper children who lived just down the road. We had a great time together and I began then to think that people are people and this race thing (bigotry) didn't make sense. (Respondent 9)

A classmate in junior high was my first exposure to the African Americans. I don't remember much but I do remember him being alone often. (Respondent 10)

Summary. In summary, some reported beliefs related to race promoted the

contextual theme that race matters in science education. While many belief statements were clustered to show a call that race matters on various issues in science education, the respondents did not provide well-defined strategies to change the reported theoretical suggestions into actual practices actions. Secondly, some reported early experiences related to race, which may suggest the respondents had an early awareness of race and otherness. These contextual themes worked in concert to develop the final structural theme, there is a call to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.

Summary of Part 1

To conclude, the analysis of part one of the study included an inductive and deductive examination of 11 short-answer questions and the reporting of results for seven yes-or-no questions. The major structural themes concluded from the survey were:

- CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teaching,
- Science teacher educators subscribe to ‘science-for-all’ teaching practices and beliefs to prepare preservice teachers to engage all learners; and
- There is a call to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.

What follows is the analysis of the second part of the study, which included 12 interviews among four participants, who were selected from the qualitative survey.

Interviews

The participants for the interview portion of the study were chosen from the results of seven yes-or-no questions on the qualitative survey. These yes-or-no questions

were scored to determine a rough estimate of the level of cultural competency perceived by the survey respondents. To be selected from the survey into part two, the survey respondent must have scored between five and seven points on these yes-or-no questions. Therefore, each yes-or-no question was worth one point; so, if a response demonstrated an affirmation of race, ethnicity, and sociocultural awareness, then it earned a point. Conversely, if a response demonstrated a denial or rejection of race, ethnicity, and sociocultural awareness, then no point was earned.

As was discussed earlier, the yes-or-no questions corresponded to Nieto's (2010) descriptions of multiculturalism. Moreover, the scores to the yes-or-no questions varied, and although scoring between five and seven on these questions was necessary to be promoted to phase two, there were some respondents who scored within this range, but were not selected because either they did not consent to the interview portion or they consented and curiously did not provide contact information. Of the thirteen respondents who entered the survey, four were selected because they met the requirements necessary to advance to phase two of the study, which included a series of interviews. The respondents who were selected for phase two had scores between five and seven, consented to part two of the study, which included a series of interviews, and provided either their email address or cell phone numbers to be contacted for an interview.

While it was not mandatory to provide feedback at the end of the survey, it is interesting to note the comments provided by a few of the respondents, especially by those who were not included in phase two. Table 24 shows the scores for all survey respondents and any comments they may have provided. For example, respondent one replied, "no" to question 28, which asked, "are you willing to be contacted for a follow-

up interview...” So, while he or she was not interviewed, it is possible to conclude that this survey experience may have sparked meaningful reflection because survey respondent said, “This has given me a lot to think about...professionally and personally.” Secondly, respondent four did not meet the interview criteria and did not consent to the second part of the study, but mentioned in the comments that he or she would “be happy to do an interview;” however, this respondent shared he or she was concerned about anonymity being lost once consenting to the interview portion of the study, wanted more information about the interview protocol, and did not want his or her information shared. Also, respondent six did not meet the interview criteria, but appeared to be very interested in learning more about culturally relevant ways of science teaching. Respondent six earned a score of three on the yes-no questions, which might not suggest an affirmation toward teaching that reflects sociocultural and racial constructs; however, his or her comments suggest a desire to learn more, but respondent six could not be contacted because although he or she consented to part two of the study, he or she did not meet the criteria and did not provide any contact information. Specifically, respondent six mentioned in the comments section of the survey,

I would love more teaching materials to use to teach these important messages. I just reviewed Dr. XXX’s tenure file and she had some interesting studies/commentary about this similar subject matter. Worth checking out!
(Respondent 6)

Lastly, it should be noted that respondent 12 consented to part two of the study and met the criteria of the yes-no questions; however, he or she did not provide contact information at the end of the survey. Therefore, by the nature of how the survey was distributed, the researcher had no way of retrieving personal information of the respondents, which allowed the survey to be truly anonymous. On the other hand, this

safeguard proved to be challenging when trying to include any respondents who consented to part two but did not provide a way for the researcher to contact him or her. As a result, several email alerts went out to members of the original distribution list that requested any respondents interested in participating in a follow up interview to contact the researcher by email or phone. However, respondent 12 did not reply to this call.

Table 24
Summary of Yes-No Scores and Comments

Respondent #	Consent to interview	Yes-No Score	Comments Provided on the Consent Form to Part Two of the Study
1	No	1	This has given me a lot to think about...professionally and personally.
*2	Yes	6	No comments
*3	Yes	5	No comments
4	No	3	I believe that providing contact information within this survey invalidates the anonymity. I would be happy to do an interview, but I would not necessarily want my answers to be shared and attached to my name. I'm not comfortable adding my contact info .
5	---	---	None (Respondent entered the survey and did not complete the yes-no questions)
6	Yes	3	Thank you! I would love more teaching materials to use to teach these important messages. I just reviewed Dr. XXX's tenure file and she had some interesting studies/commentary about this similar subject matter. Worth checking out! Thanks!
7	No	0	No comments
*8	Yes	5	No comments
*9	Yes	7	No comments
10	No	4	No comments
11	---	---	None (Respondent entered, but did not answer the yes-no questions)
12	Yes	6	I felt like the color blind question was misleading. One cannot ignore what one sees of their students; however, it is important to recognize one's own biases toward those who are different from one self.
13	No	5	No comments

* These participants were selected for interviews

Interview Participants. Phase two of the study included three semi-structured interviews by two black and two white science teacher educators. Each one-on-one interview lasted approximately 60-90 minutes. Each interview participant shared their perceptions on CRP, the teaching practices they used to prepare their preservice teachers to engage African American students and all students, and their experiences and beliefs related to race. As was specified earlier, Table 8 described the demographics of the four interview participants selected for part two of the study, and detailed descriptions of each interview participant was provided in Chapter 3. Pseudonyms have been provided for each of the four interview participants, Dr. Daly, Dr. Jackson, Dr. Williams, and Ms. Alleyne.

Interview Findings. The three research questions that guided the study were all addressed in part two of the study, and the analysis will be organized by each structural theme that addressed the research questions. The research questions were:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?

Table 25 summarizes the initial deductive categories, inductive contextual factors, and the final structural themes that emerged from the interview participants. Therefore, what follows is a detailed description of how each structural theme emerged from the coding process (Moustakas, 1994). Specifically, pieces of the analysis of part one, informed part

two. For instance, responses from the qualitative survey from part one were used to situate the interview data in part two.

Table 25

Summary of the Interview Analysis

Categories →	Contextual Themes →	Structural Themes
CRP mis-descriptions	CRP near examples (CResP) Beyond CResP Reflection of a struggle	There is a struggle to understand and implement CRP in science education teaching.
Teaching practices/actions	‘Science-for-all’ teaching practices Racially influenced teaching activities and group discussions	Modeling conventional science teaching strategies and ideologies are preferred for preservice teachers to engage all learners as opposed to identifying specific learning needs of African American students.
Experiences related to race Beliefs related to race	Early experiences Beliefs in the manifestations of racism	Racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.

Struggle to understand and implement CRP

The first research question in this study was “In what ways do science teacher educators describe CRP principles?” To recap from Chapter 2, culturally relevant pedagogy (CRP) as opposed to CResP is a style of teaching in which teachers purposefully affirm diversity and empower students to challenge societal injustices that oppress themselves or others by fostering high *academic expectations*, facilitating *cultural competence*, and teaching in such a manner as to empower a sense of *critical consciousness*. On the other hand, CResP is a near example of CRP because it fosters an acknowledgement and appreciation of cultural and racial differences of students in

education. However, CResP does not sufficiently foster students' knowledge of oppressive devices and institutions in society nor does it address how to confront those devices or institutions. Undoubtedly, CResP is an essential piece of CRP because the principles of CResP serve as prerequisites to CRP, but it is incorrect to assume that CResP and CRP are one in the same.

When asked about culturally relevant pedagogy, every interview participant suggested they were not sure what *relevant* meant, but instead each spoke about culturally responsive teaching by name. In mis-describing CRP, the participants largely reported they were not familiar with CRP or provided principles of cultural awareness and racial otherness, which is exemplified with the CResP framework.

Mis-descriptions. When initially asked to explain culturally relevant pedagogy, the interview participants for the most part provided examples of culturally responsive science teaching, which Wallace and Brand (2012) say is “using knowledge about the culture and life experiences of students to structure learning that is conducive to their needs” (p. 341) as opposed to culturally relevant science teaching, which Jenkins (2011) and others (Green & Medina-Jerez, 2012; Johnson, 2011; Mensah, 2011, 2013) say is when science teaching and learning is situated in the context of improving students' communities and transforms intangible learning into more of an action oriented inquiry that is aimed at addressing community injustices. Thus, it appeared that none of the teacher educators in phase two were knowledgeable about CRP. In fact, many of them said they had not heard of “relevant” pedagogy. However, all of the interview participants suggested they were familiar with culturally responsive pedagogy. For example, when asked to differentiate between CRP and CResP, all of the participants

suggested they were not completely sure about the difference. Moreover, Dr. Daly, Dr. Jackson, and Ms. Alleyne appeared to be knowledgeable about CResP as evidenced by their comments, and Dr. Williams, appeared unsure of how to respond and requested clarification before he responded. For instance, when asked to describe CRP, the participants said,

“Can you give me some background on it before I make...[Long pause].” (Dr. Williams)

I am not sure what that is, but I could maybe guess. I don't know what the literature says about culturally relevant pedagogy, but culturally responsive pedagogy is the theoretical framework that has guided a research line I do...the research on the [XXX Scholar Program] and their preparation for teaching in high needs schools...we use Sleeter's definition. (Dr. Daly)

I actually haven't heard of culturally relevant, I mean I read a lot about culturally responsive pedagogy. I haven't heard the word relevant before... but culturally responsive pedagogy means looking at the way students learn and taking into account where they come from, where they are, who they are, and meeting their needs where they are and it is not what the teacher thinks it needs to be, that's my take, but no, I've never heard the two used separately.” (Dr. Jackson)

I haven't heard of those terms, but I'm assuming it means culturally responsible, perhaps responding to the students. (Ms. Alleyne)

As a result of the participants reporting an unfamiliarity with CRP and providing descriptions of culturally responsive science teaching as opposed to culturally relevant science teaching, the researcher spent a short amount of time during the second interview talking about what CRP was and how it differed from CResP because the researcher felt it was necessary to remedy this area of misunderstanding. This was particularly important because as extensively noted in chapter three, the researcher believes CRP is a formidable tool that could be used to lessen the white-black achievement gap, if ever given serious consideration in teacher preparation programs.

With that said, a few items should be clarified. First, while the researcher predicted this would happen based on the responses from the survey, this intervention only took place after the participants suggested a lack of knowledge about CRP. Secondly, when the researcher interjected about CRP and CResP, only general descriptions and non-science examples were given, so as not to unnecessarily steal an opportunity from the participants to demonstrate their knowledge of CRP principles within the context of their science education courses. Therefore, it is believed that this intervention did not necessarily bias the participants because the researcher's intention was to help the participants better understand the nuances between CRP and CResP to be able to possibly apply them as opposed to allowing the participants to remain unknowledgeable about CRP. Also, the intervention was scripted and was read in a conversational way to each participant. For example, when describing the difference between CRP and CResP, the researcher said,

So culturally responsive pedagogy according to the literature was popularized by Dr. Gay and basically she asserted that, you know teachers need to get to know their students background, likes, dislikes, interests, preferences, etc. and use those as assets for instruction. On the other hand, culturally relevant pedagogy was popularized by Dr. Ladson Billings and she says, you need to not only get to know your students and who they are, their likes, dislikes, preferences, cultural background, so on and so forth, but also teachers need to understand their personal biases and facilitate a structured process so that the students also gain that understanding to be able to work towards a critical consciousness against social injustices. So ultimately, the major goal of culturally relevant pedagogy is that the teacher provides instruction on the curriculum content, but does it in such a way that you're teaching the students to foster a cultural competence and critical consciousness and be able to go out and fight against societal injustices in addition to getting to know the students' likes, interests, and preferences. The three parts the culturally relevant pedagogy teaching framework are having high academic expectations, building a cultural competence, and fostering critical consciousness. So for example... and this is just a quick simple example...in third grade, students need to learn how to write a letter. So they learn about the heading, the body of the letter, and how to end the letter. And so for example a teacher who was teaching under the culturally relevant pedagogy

guidelines would provide instruction on the components of writing a letter, probably within the context a larger unit, let's say a civil rights unit. So, this teacher would go through a personal process of gaining critical consciousness for him or herself as well as for the students. The teacher would provide instruction on self-identity and personal bias. But then perhaps would teach about writing a letter in the midst of the larger unit and they would facilitate a process for the students to use what they learned about letter writing to write a formal letter to the U.S. Mint and say, they want Andrew Jackson taken off of the twenty-dollar bill, because of his crimes against African Americans and would like Martin Luther King replaced on the \$20 bill.

Once the participants were instructed on the general differences between CRP and CResP, they were asked to brainstorm how CRP could be implemented in their science methods courses. To reiterate the discussion from Chapter 2, culturally responsive ideologies and strategies were considered “CRP near examples” because these beliefs and practices served as precursors for CRP. So, the CRP near examples, or CResP the participants provided from their classrooms or other ideas they believed to exemplify CRP contained some element similar to or leading toward CRP.

CRP near examples/CResP. As a result of the participants reporting their lack of knowledge regarding CRP, the researcher differentiated between CRP and CResP and provided a non-science related example of CRP demonstrated in a third grade class. Despite being given this general definition and example, the participants continued to struggle to understand how to implement CRP into their own science teaching. For example, after having heard the researcher's description of the CRP vs. CResP, most of the participants either regarded it as either a process of debate or described ways they felt CRP principles could be applied in their science teaching by slightly adapting one of their class topics. For instance, they all seemed to unknowingly demonstrate the CRP principle of high academic expectations by reporting high quality instructional practices

to explore a social injustice in science, but neglected the ideas of fostering a cultural competence and critical consciousness in their students before addressing how the class content would be used to expose a social injustice. However, the idea of only exposing injustices to students without fostering a structured process to allow students to build cultural competence and a critical consciousness to do something about the injustice is a near example because these very important pieces are missing. Similarly, Picower (2012) says to foster an ethical and effective social justice learning experience, teachers must follow a strategic process in which cultural competence and critical consciousness are developed before teachers reveal societal injustices or show students how to take action against societal injustices.

Dr. Daly provided a near example of CRP when she shared that she believed the problem-based learning framework (PBL) is a “close” example of CRP because she indicated that it has a “culminating project.” This may be considered a near example because having a culminating project is not absolutely necessary for every classroom teacher who implements CRP; additionally, fostering cultural competence or critical consciousness is not a fundamental principle of the problem-based learning framework (Reigeluth & Carr-Chellman, 2009). However, the problem based learning framework requires higher order thinking on the part of students; therefore, it is considered an advanced metacognitive teaching practice that helps students excel beyond lower levels of thinking (Reigeluth & Carr-Chellman, 2009). On the other hand, advocates of CRP suggest CRP is a social justice tool for solving social justice problems and could possibly result in an individual or group project. Therefore, PBL could be considered a near example for CRP because it promotes high academic expectations. However, Dr. Daly

mentioned that she struggles to implement CRP discussions in her classes and she appears to limit CRP to discussions about environmental injustices. Specifically, Dr. Daly said,

I think my friend from XX University applies culturally relevant pedagogy to science better than I do. She talks about eco justice and environmental inequities a lot in her classes. She's exposed me to that. I just haven't figured out how to embed it; however, my students come up with ideas like that...the closest I've come to using culturally relevant pedagogy is teaching my students problem based learning. And I think that's a good vehicle because with problem-based learning you have a culminating project, which could be going to the school board, writing letters to the editor, mock trial etc... (Dr. Daly)

Dr. Williams appeared to incorrectly equate CRP with only debate. Accordingly, debating a topic in science doesn't necessarily parallel CRP, but culturally relevant teachers could use a debate approach to possibly promote a sense of critical consciousness about a marginalized group or systemic inequality. Moreover, he seemed to misunderstand that CRP is a framework that extends the CResP framework because getting to know one's students', a best practice he equated with CResP is also a necessary part of CRP. Dr. Williams suggested a near example of CRP when he said,

Oh, okay, well I think we need a combination of both. I do believe it should be a debate in science. There's not enough debate. Normally when you debate, you address a lot of those issues. And you know, you get students to really dig deep and say, 'I didn't know this about myself and I didn't know about that.' But at the same time, you're getting to know your students and you're getting the students to really think about things like, 'Wow I didn't know I was that conscious of the environment.' However, one shouldn't dominate the other. I would strongly emphasize 50% here and 50% there because by doing that you can always bring in the practice of debating topics as you get to know your students, especially around science topics. (Dr. Williams)

Dr. Jackson suggests that the closest she gets to CRP is with problem-based learning because she envisioned CRP as an action project, which as previously stated is not an absolutely necessary construct of CRP.

We do hands-on problem based learning and I take them through a sample of a problem based learning question. I show them examples of one which is for sixth grade and it's about energy resources in the state. (Dr. Jackson)

Problem based learning is a considered a near example because action projects could be combined with lessons fostering cultural competence or critical consciousness if these projects advocate for solving a social justice problem. Moreover, problem-based learning is believed to be a high quality instructional strategy in which teachers have higher expectations of students; however, it does not provide a process where students' develop a sense of identity or critical consciousness (Reigeluth & Carr-Chellman, 2009).

So, while Dr. Jackson was not able to identify how she could implement CRP into her own high education classroom, she seemed to begin to reflect on how a K-12 classroom teacher, who teaches in an inner city could implement a fresh food unit to compare food resources between inner city students and suburban students. However, in this example it appears that Dr. Jackson assumes the students in her fictitious example have a need to address this. It could be suggested that this assumption is commensurate with the assumption that all inner-city students are poor and have little access to healthy foods as opposed to possibly suburban students. Thus, Dr. Jackson demonstrated a near example of CRP when she spoke about a K-12 classroom teacher leading his or her students in a food unit because her scenario seemed grounded in how the students could impact a possible problem in their community, which could lead the students toward a critical consciousness about food inequity. However Dr. Jackson did not address how the classroom teacher in her example would foster a cultural competence or implement this food unit using high quality instruction when she said,

For me I think...I'd love to see a classroom teacher in the city working with kids

to look at how far do you have to go get fresh food compared to people that live in suburban areas? I guess this is culturally relevant based on your definition, more of an action project because students actually have to take some type of action that impacts their communities or their school. I can see a teacher saying, well lets think about, you know, if we started a school garden, how many people would we impact? And if we wanted to impact the broader community how might we do that? And you know we could talk about food deserts and that type of stuff. (Dr. Jackson)

Moreover, when talking about the possibility of a classroom teacher implementing a fresh food unit for students who live in the city, Dr. Jackson suggested that it would be a struggle to implement CRP because preservice teachers are not currently provided the necessary competencies to do so in her teacher education program. Specifically, she shared that she believed teaching in culturally relevant ways would “require” teachers to have a “different orientation” to implement CRP into science teaching, which she suggests may be too difficult for new or inexperienced teachers. However, Dr. Jackson indicated more experienced teachers may possess the necessary skills to adapt science content into a more culturally relevant approach. For example, Dr. Jackson said,

Yeah I think it also requires a different orientation on the part of the teacher and so as I think about new teachers, they can barely keep up with the things that we give them, but I would love to see experienced teachers, you know, start thinking about what that really means to connect with the students that they have and make it more personal and more relevant to their lives as opposed to, I’ve got to learn science because it’s on the test, but maybe because it can improve my life and the lives of those who live in my community. (Dr. Jackson)

It appeared that while providing the before-mentioned intervention between the two teaching frameworks did not help the participants to describe how CRP could be authentically implemented in their courses, eventually the participants were able to describe examples beyond CResP, as will be demonstrated by the data.

Beyond CResP. When probed further to distinguish CRP and CResP, many of the participants began to demonstrate an emerging or even better understanding of CRP

as compared to their first responses. They spoke about various past experiences or ideas they believed could be augmented into a lesson that embodied CRP's principles of having high expectations and building a student's cultural competence or critical consciousness. Much like the qualitative survey, the participants' did not use the terms high expectations, cultural competence, or critical consciousness, but their descriptions seemed to exemplify activities that would begin to promote these CRP principles as opposed to simply only fostering cultural awareness or appreciation. As such, these "near examples" represent teaching beliefs and practices that could be further developed into instruction that helps preservice teachers better understand CRP because it goes slightly beyond CResP. Thus, a move beyond CResP is exemplified as a step closer toward CRP wherein the participants have reported beliefs or practices that are characteristic of culturally relevant pedagogues. For example, Dr. Jackson seemed to articulate principles that were counterintuitive toward teaching that is culturally affirming, such as avoiding stereotypes, but could not firmly describe culturally relevant pedagogy. Perhaps most notably, Dr. Jackson began to question whether African American students may require a more "relevant" instructional "hook." For example, she shared,

Well, last year, I went to the XXXX Institute for science education faculty ... and part of one of the days we talked about culturally responsive curriculum and we were talking about what that meant. And what it ended up as was a big conversation about how people should use flocabulary to teach city kids because city kids were all interested in rap....which I found really disturbing at the end of it...its important to tap in to kids interests and backgrounds but I don't think necessarily think that all African American kids want to rap. And I find sometimes the stereotypes pervasive and hard to overcome. And that's why I said I try really hard to focus on what are the best practices for teaching science...how do we keep kids engaged? And...you know...How do we hook them...maybe that's the issue...maybe we need to hook African American students differently. But then when we get into the instruction, maybe we use the same strong

practices and maybe the questions we pose in inquiry should be closer to their life experiences...instead of just contrived and sort of esoteric... (Dr. Jackson)

However, after reflecting on the brief overview provided by the researcher regarding CRP and CResP, she began to brainstorm ways she could possibly transform a pollution activity she models for her elementary science methods class, which integrates the social studies curriculum to make it address a social inequity. First, Dr. Jackson showing her students how to conceptualize a cross-curriculum unit is a best practice in education; so this represents an example of a science teacher educator providing high quality instructional practices to preservice teachers. Secondly, Dr. Jackson made an effort to transform a pollution activity she does with her current preservice teachers to make it more culturally relevant by incorporating critical questions, which may spark students to think about inequitable practices.

So one of the things that I do with them is an activity called "Who Polluted the Potomac?" Have you heard of it? So you get an aquarium, a big bowl of water, and I take a bunch of film canisters, that have different labels...things like: trees and dirt and family picnicking, with little bits of trash, farmer and barnyard and there's like 16 or 18 different containers of stuff. And so I read a story about the history of the Potomac, this is one of the things that I love about this class because I can integrate science into social studies and it starts with Native Americans who fished and you know how they used the water and how the settlers came in and what they used. So I tell them we're going to read a story about the history of the Potomac and this lesson could be about any river, but this really focuses on the Potomac and the D.C. area and then it talks about how the river gets built up with pollutants. So, we slowly begin adding pollutants into a model of a watershed and into the water system... So maybe it's taking an activity like that and taking it a step further and talking about their neighborhoods and maybe we do something with maps to determine where are the landfills? Where do we choose to put them? Who are the people that are the loudest and most vocal against them? And do you want to live next to a garbage dump if they decide it's going to go in your neighborhood because the property values are low and there's land that's empty. What happens when things leach into the ground? And maybe that's where I'm thinking of your letter writing issue. Maybe that's where they write letters or they go home and they share what they learn with their parents and they try to spur people to action about something like that. I think that would work in some ways because everybody looks at pollution in their neighborhood... (Dr. Jackson)

Similarly, after initially only linking CRP to problem-based learning and environmental justice, Dr. Daly began to brainstorm about topics she felt could be suitable for CRP. Dr. Daly spoke about leading her students in a class project by extending an assignment with a book she already has implemented in her classes. She provided a specific example of fostering a debate about the marginalization of a black woman whose cells were stolen and illegally harvested for cancer research or a DNA debate about the origin of humankind. These kinds of activities should her preservice teachers emulate them in K-12 settings could potentially foster a sense of cultural competence or cultural identity if implemented properly.

If I had to think about other topics that may be suitable for culturally relevant pedagogy... Well, the Henrietta Lacks book is a really good topic because she was treated a certain way because of the time. But also a certain way because of her race and her economic level. Um...so maybe having a class project about should the Henrietta Lacks family be compensated for the use of her cells; you know her cells have gone all around the world multiple times and there are people who make a lot of money off of what they are able to culture from her cells. I think that could make for a really good debate. (Dr. Daly)

Further, Dr. Daly noted that she believed that any topic in science could be presented using CRP. Moreover, she suggested a DNA lesson could be used to show students how everyone descends from Africa. It could be suggested that if a science teacher conducted a classroom experience that sent the message to his or her K-12 students that all life came from Africa, this could foster a sense of pride in African American students who normally feel excluded or marginalized in classrooms (Atwater, Lance, Woodard, & Johnson, 2013). However, despite her enthusiasm about theoretically applying CRP to all science topics, she seemed to convey that she was not able to do so. For example, Dr.

Daly said,

Well, I imagine if I sit here long enough and thought, I could come up with a culturally relevant approach to just about every topic under the sun. I mean you can talk about DNA and um..., and how we've used DNA to show that everybody is descended from Africa. Because you know general citizens in the culture don't know enough about DNA... So I think there's one example...you can do that with all kinds of topics... with probably all areas of science. If you are creative enough, think long and hard enough, and you look at your resources.... I think it's possible. And honestly Janice, I don't do that well at it. I don't. Like I said I think I'm nibbling at the edges of it with problem based learning now, but um..., I don't do that well at it. (Dr. Daly)

Lastly, Ms. Alleyne attempted to demonstrate an understanding of CRP teaching principles in an impromptu unit on genetics, but this spontaneous example she provided did not truly represent CRP because it would only be based on the students' possible connection to the diseases as opposed to fostering cultural competence or a critical consciousness around the disease. Ladson-Billings (2000) suggests that culturally relevant pedagogues explicitly foster identity development within the context of the larger society, as well as show students how to confront oppressive structures in said society. Likewise, this genetics unit example could be further developed into a lesson that goes beyond CResP by incorporating these missing elements. However, the way Ms. Alleyne presented the genetics unit, it was more representative of a culturally responsive activity, where a teacher connects the curriculum to the students' culture, personal experience, or home life. For example, she said,

Okay, so when I'm thinking about genetics, one topic is sickle cell and diabetes. That's something that affects our community and I'm sure mostly when you teach African-American students, they know somebody with diabetes-- somebody with "sugar" and somebody with high blood pressure and maybe even that sickle cell trait. So, you know, that could be a lesson. For example, when you're teaching Punnett squares and you're looking at genotypes and phenotypic relationships, instead of showing different hair types, different skin colors, and different eyes, let me show you Punnett squares that show the inheritance of these chronic

diseases that affect our people. I think this is that what you're saying is culturally relevant pedagogy, right? (Ms. Alleyne)

However, when probed further, Ms. Alleyne seemed to make connections to her K-12 teaching experiences in which she suggested she thought she embraced culturally relevant teaching principles with her mostly black K-12 science students. She noted that she does not teach in culturally relevant ways with her post-secondary students, but realized CRP had the possibility to change collegiate and K-12 teaching and close the science achievement gap if ever given a reasonable chance in teacher preparation programs. Specifically, she provided some examples of her K-12 teaching that she believed could be used as best practices in science methods courses to help preservice teachers learn how to demonstrate CRP in K-12 teaching. For instance, Ms. Alleyne said,

I think I've done a project like that when I was a K-12 teacher. I love TV and there's a show I look at called, "Unsung." So, in my biology and engineering classes we did a project called, "Unsung Heroes," where we studied black and brown scientists who had been forgotten about in history. So, we did a mock court as a culminating evaluation. We sued the U.S. Department of Education for not requiring the curriculum to reflect the contributions by African American scientists and McGraw-Hill for not putting Ernest Just in the chapter about cell biology. My physics and engineering kids sued Bell Atlantic and General Electric because of what happened with Garrett Morgan. And so there would be a prosecutor, a defense attorney and they would have to go find their research to show why a certain person or institution should be included or if they weren't included, why they were excluded. (Ms. Alleyne)

Further, when talking about her mock court activities, Ms. Alleyne suggested teaching in culturally relevant ways had a significant value for her students. Specifically, she noted that those types of classroom experiences helped to foster a sense of higher order thinking and sense for sociopolitical action in her students because they were urged to face an uncomfortable reality that the contributions by black scientists were purposely being

diminished by institutions who devalued African Americans. For example, when talking about the mock trials, Ms. Alleyne said,

This type of activity made my students think from a whole different perspective. Then it stirs up anger: "Well you know if you found this out about Garrett Morgan, how many other people have been left out?" And then, you know, that starts that conversation. And we would do that for almost every unit. We couldn't do the court case because of the strict pacing guide, but we did some type of alternative assessment. (Ms. Alleyne)

More importantly, Ms. Alleyne goes on to say that preparing preservice teacher to teach in this sociopolitical way could positively transform science learning and close the white-black science achievement gap. She said,

I think teaching like this in higher ed programs would reshape perceptions by my preservice teachers when they go out into their field based experiences and when they go out into their first teaching jobs. It could change the way they can connect and relate to their students and it'll, you know, could close achievement gaps. (Ms. Alleyne)

Moreover, it seemed that as Ms. Alleyne reflected about her K-12 teaching she felt was culturally relevant, she began to speculate how she could connect what she did in the K-12 setting and apply it to the higher education setting. For instance, she brainstormed how she could possibly implement CRP in her post-secondary teaching and the kinds of possible questions she would use to guide her preservice teachers in a fictitious unit on soil or power plants.

You know, I think if I model culturally relevant pedagogy in my teaching, then when I go out into the classroom, that would be one of the "look-fors" on my observation sheet when I supervise. For example, I could be asking my students, how are you able to take learning about soil and relate it to your kids at such and such high school? And, you know maybe preservice teachers could talk about, how many of their students go in the backyard and you play in the dirt? Well, I suppose if you live in an urban area with mostly concrete, your dirt might be really, really dry. But if we were to go closer to the ocean or bay and those neighborhoods on the water, their soil may be different." And then, I could take it upon myself to go and get different soil samples and look at what different neighborhoods have different soils. So teachers could be asking their students,

what does this mean for where you live? Why isn't your soil like this soil? And they can try to grow their own gardens in their yard and be sustainable, but look, in your yard, we don't even have the type of soil we need to even have that. Those are things you need to think about. Another example, those neighborhoods close to a power plant are most likely poorer areas with people of color, but white people live across the other side of the tracks. You're getting all this pollution in the air. How's that affecting you and your family and the generations to come after you. These are things you don't even think about that the government can allow to happen to you because you're not active in the democratic process. (Ms. Alleyne)

Reflection about the struggle. Lastly, as was noted in Chapter 3, one of the purposes of this study was to spark reflection by the participants. Two of the participants demonstrated personal reflections about their teaching, which was demonstrated by a cognitive struggle to understand what CRP is and the institutional barriers that seem to prevent it from being implemented into their post-secondary teaching. These personal reflections often demonstrated how their participation in this study changed their thinking about teaching in culturally affirming ways or how they have begun to think about how they can change their teaching practices. Accordingly, evidence to support the robust theme that there is a struggle to understand and implement CRP into postsecondary teaching is found in reflective comments by some of the participants. The participants' reflective statements represented a cognitive struggle to understand how to implement CRP and a struggle to overcome institutional resistance for teaching in culturally affirmative ways.

Cognitive struggle to understand. Some of the participants' reflective comments represented a cognitive struggle to understand and implement CRP. As mentioned previously, the interview format of phase two afforded the researcher and the participants' room to expound on unclear statements and comments made from the

survey. So, during the interviews the participants were given room to clarify or change their statements if they felt their original comments did not accurately reflect their beliefs. Accordingly, participating in this research process caused some of the participants to engage in a cognitive struggle or personal reflection about their positions in society and also reconcile inaccurate perceptions or shortcomings they held about themselves or their teaching. For example, some of the participants struggled to differentiate between CResP and CRP, which would require the participants to go beyond what they currently advocate for in their courses. For example, when Dr. Jackson began to brainstorm ways to make science learning more “relevant” for black students, she demonstrated a struggle to understand how to transform her classroom activities that currently call for a general appreciation for otherness toward teaching that actually prepares her preservice teachers to engage black students in science, when she said,

I don’t know...I just don’t know the answer... you have given me a lot to think about as I am working on my syllabi for the fall. How do we hook them? (Dr. Jackson)

The researcher delicately confronted the conflict between what the participants identified on the qualitative survey and what they described during the first two interviews, such as indications on the qualitative survey, to statements such as “I teach students how to solve socio-political injustices within the content of the class,” which appeared to contradict the teaching practices described in the interviews by a few of the participants. For example, Ms. Alleyne indicated “yes” to the statements, “I teach students how to solve socio-political injustices within the content of the class” and “I facilitate opportunities for my students to learn how to confront racism in education with real world science projects and inquiry.” However, after carefully examining the article

she uses for a class discussion about the burden to act white by black students, the researcher could not confirm how this teaching artifact helped to teach her students how to solve sociopolitical injustices or confront racism with real world science projects. Therefore, at the end of the third interview when a level of rapport had been established and a reflective discussion about the articles had already taken place, the researcher reminded Ms. Alleyne of what she had indicated on the survey and could she describe how she accomplished this with the artifact she submitted? Accordingly, Ms. Alleyne responded,

Like now that I'm thinking about it and listening...and things I've learned here and articles you've sent...and our conversations...I'm really thinking that just having one day for our class discussion on the burden of acting white is not enough...how would that really impact you as a future educator...and you're just a freshman and you have three more years to go. So, now all of this is really making me think for not only my first semester course, but my second semester course as well. (Ms. Alleyne)

This previous statement by Ms. Alleyne suggested she had come to realize she initially reported an inaccurate perception about her teaching, but also realized the way in which she uses her artifact would not meaningfully impact a preservice teacher. In addition, early in the interview process Ms. Alleyne described herself as being very aware of the struggle African Americans have faced historically in the United States and in science education because of her first hand experience as a black person in America and STEM education. She even articulated best practices for culturally relevant instruction she implemented as a high school biology teacher; however, by the third interview she made comments that demonstrated she had personally reflected about her post-secondary practice. Ms. Alleyne noted that her participation in the research process caused her to reexamine what she reported on the survey and admitted she in fact does not engage in

the level of CRP in the higher education setting as she once presumed or reported.

Specifically, when asked to substantiate how she fostered CRP in her post-secondary classroom, she said,

Okay, now, I'm thinking and really honestly reflecting....I don't think I do anything to help my preservice teachers target their African American students...in a way that I should. Especially since we are in [a major urban area], so the majority of my students will teach students of color in [urban] schools. I think I do more with classroom management and science pedagogy...now that's really making me think and re-evaluate my approach for next semester.... Honestly, since I have been post secondary, I have never facilitated a critical consciousness in my students about societal injustices...which I'm thinking now..."Whoa I don't even do that now that I am on a college level the way I did when I taught at the high school level. (Ms. Alleyne)

Similarly, when the interview process was over, Ms. Alleyne confirmed on her summary form that it was not until after participating in this study that she changed her mind about the importance of preparing preservice teachers with the necessary skills to lessen the achievement gap among students of color and white students. Therefore, she confirmed that what she initially indicated on the qualitative survey was not entirely accurate, and she intended to incorporate explicit instruction about cultural identity, racial injustices, and the needs of African American students in her science methods courses. For example, on several areas of the summary form she reported,

I realized I haven't facilitated opportunities for my students to learn how to confront racism in education with real world science projects and inquiry on the university level but am trying to incorporate it as I move forward in my courses. (Ms. Alleyne)

After our last interview I used the scholarly articles that she shared with me to ignite discussions about cultural identity among my pre service teachers. (Ms. Alleyne)

After interviewing with Janice, I decided to discuss racial injustices in education in my university course. I used the articles she shared with me to plan a jigsaw about ways to meet the needs of minority students in STEM education. This was

important because national data shows how ethnic minorities' test scores fall behind many of their white counterparts. (Ms. Alleyne)

Dr. Jackson said that she engaged in personal reflection during the course of the study within the context of a racially charged current event, the murder of a black youth by a white police officer in Ferguson, Missouri, which she reported caused her to wrestle with ideas of white privilege. She wondered why she had not considered CRP or another culturally affirming way to engage her black students when she taught in the K-12 setting and what she could in the future to prepare her post-secondary students to engage their future K-12 students. Further, this caused her to search through her former teaching materials to identify possible areas where bias may have influenced her teaching.

Specifically, Dr. Jackson said,

In thinking about this study and the events at Ferguson had just happened, all of this has forced me to think about the role that I have in society, the privilege I have based on my birth and the way that I look and how that isn't an advantage for some people. I mean I just started thinking about all those things and I pulled up a file and started looking at papers and thinking what can I do better, what have I not done so well (sigh). (Dr. Jackson)

Dr. Jackson's statement suggested a struggle to personally reconcile her perception of her position in society and how that might have impacted her teaching. She reported that she thought deeply about the implications of a white police officer killing an unarmed black youth and the possible implications of her as a white K-12 teacher, teaching black children.

Institutional resistance. Some of the participants identified various institutional barriers to implementing more culturally affirming teaching practices. These barriers as suggested by the participants have been inherently created by leaders and policy makers within teacher education or by how teacher education programs are structured in general.

For example, Dr. Jackson demonstrated that she reflected on how difficult it was to understand and implement CRP because it was a philosophy that was not ordinarily adopted in her preparation program. In fact, Dr. Jackson suggested she realized she was not professionally prepared to make the necessary shift to transform her thinking or teaching practices to be more culturally relevant. Further, she shared she was not prepared to implement instruction on CRP with her preservice students because it would require a different “type of training,” of which she does not apply in her courses. She suggested CRP was a difficult framework to use and to teach others to use. Specifically, she said CRP is a “whole lot of work” and compared CRP to problem-based learning, a framework she suggested was also complicated.

I know just by looking at problem-based learning CRP is a whole lot of work and I think you have to be confident in the science and your pedagogy and your notions of what tools you have... to teach in general... to be able to do culturally relevant teaching. . [long pause]. I know I’m not there. So I would think we’d have to work really hard to get there; I’m not saying it wouldn’t be worth it, but I think it’s a very different type of training for teachers to think through that, it’s an additional piece and I think, [long pause] I know it would take me time to sort of wrap my head around that. (Dr. Jackson)

Similarly, Dr. Jackson appeared to suggest she is limited in using CRP because of the way higher education courses are structured. Accordingly, she reported she does not have the time to use CRP or teach students how to incorporate CRP into their K-12 teaching. Further, she suggested that CRP may be better suited for a diversity class as opposed to her science methods course. Her statements demonstrated Dr. Jackson’s struggle to understand that CRP is not meant to be isolated to one diversity course, but instead is meant to be embedded throughout a teacher preparation program (Ladson-Billings, 2000). For example, Dr. Jackson said,

There are things that I want to be more explicit about but I don't often know how to. If I were teaching a course like diversity education it.... it would be a better fit. I think when I do the draw scientist test I talk about kids who don't see themselves as scientists and why that is.. and talk about gender differences and talk about that middle school slide and what happens when kids lose interest in science and we talk about stereotypes and those role models. I mean in that context it works but in the broader context I have so little time to think about this. (Dr. Jackson)

Dr. Jackson suggested it would be easier to integrate CRP into a class that exclusively focused on diversity, which seems to demonstrate a struggle to understand CRP and how to implement it because Ladson-Billings (1995a, 2006) suggests that CRP is a framework that can be applied to any subject or content area. Ladson-Billings (2000) also suggests that embedding CRP across a teacher education program as opposed to only adding basic elements of multiculturalism may transform it into a more effective institution that actually prepares preservice teachers to more authentically engage African American students.

Ms. Alleyne also described her a struggle with institutional resistance on implementing CRP into her post-secondary teaching. Specifically, she reported that she believed she backed off from implementing CRP into her higher education teaching because when she tried to incorporate a personal story from her time when she worked with mostly black K-12 high school students, she was "reprimanded" for sharing such an "inappropriate" classroom account. Ms. Alleyne suggested that since that time, she has been somewhat intimidated to push the race issue within her mostly white university because at the very core, she did not think the leaders within her department or institution valued her input or subscribed to the ideals of diversity as they espoused. For example, Ms. Alleyne said,

I shared one experience and I got negative feedback from my supervisor...so I doubt I'll share my experiences again. And again, I think it depends on the University because I think if I were at a HBCU it would have been totally different than how it is here. (Ms. Alleyne)

Lake (2010) would suggest that Ms. Alleyne's reluctance to share personal stories may inhibit her students from building the competencies to later engage students of color in K-12 classrooms with personal stories because sharing and valuing personal experiences is a necessary part of building a collaborative trust in classrooms, which Ladson-Billings' (2000, 2006) also says is important for teachers who teach African American students. Additionally, no other participants shared any stories about getting administrative push back for implementing conversations about race or personal stories about real K-12 students.

When Ms. Alleyne described her personal story about her confrontation with one of her K-12 students, she reported she shared it to add a real perspective to teaching for her post-secondary students, who she felt could handle and appreciate a true anecdotal account about a hostile student using profanity because they might glean some value out of it if ever in a similar situation. She also suggested that she shared the story in an effort to help her preservice students foster an understanding about the culture of her K-12 students. Further, she described how she handled this very difficult situation with professionalism and compassion as opposed to allowing her emotions to dictate the outcome of an already volatile classroom situation. She described the personal story by saying,

My background has always been in urban schools with mostly black and brown children. So, I told my [preservice students] about how one of my K-12 students had cursed me out in front of my class and I shared the language he used. More importantly, I shared how I dealt with it...I said that I didn't go tit-for-tat with the student, I just told the student he had leave and I had to call the security officer

because the student was just belligerent. ...He was all in my face saying with his finger, you're this and this and that. And I just told my students that I stood my ground, I didn't disrespect him, I didn't curse back...I didn't fuss at him... You know I let him calm down and tried to diffuse it by trying to ignore the behavior until security arrived. But I shared that later when it was all over, I was ready to break down and hit the floor...because I just could not believe that a child spoke to me in that manner. (Ms. Alleyne)

Ms. Alleyne shared that she believed her teaching perspective from teaching mostly black students was not valued at her mostly white university, but she said she believed her perspective would be valued at a historically black college or university. In fact, she described her supervisor's response when she said,

My administrator was like, 'that was very unprofessional and I don't care what [that K-12 student] called you the [preservice teachers] don't need to hear stuff like that because that may not have been their experience in school and they may not have experiences like that in their future classrooms.' And the reprimand was just like so negative...as opposed to if I was at a HBCU, I am sure another professor would have said, 'You know what...now that happens, but that's the stuff you don't get to learn about in your textbook.' (Ms. Alleyne)

To conclude, two participants shared personal reflections that seemed to result in part from their participation in the study. Morrison, Robbins, and Rose (2008) say personal reflection about issues such as white privilege and bias is necessary for teacher educators to be able to foster the same in preservice teachers, which Ladson-Billings (2000) also says is critical in fostering non-racist teacher preparation programs. For this reason, sparking critical reflection was an important part of this study.

These participants discussed reflected on reasons for why they struggle to understand and implement CRP. First, they indicated a cognitive struggle to understand the framework, which was evidenced by reflective comments that demonstrated a realization that what they previously noted on the survey about teaching in a sociocultural

context was actually not entirely true. Secondly, they identified implementation barriers caused by institutional resistance. For example, the way teacher education courses are structured and a lack of institutional support were identified as barriers for not implementing CRP principles in their teaching.

While not every participant explicitly demonstrated reflection about how the study had transformed their thinking or their practices, the reflections that were noted directly contribute to the larger idea that science teacher educators' struggle to understand the CRP framework and how to implement into their post-secondary teaching.

Summary. The participants' in this study suggested they struggled to understand and implement teaching that exemplifies CRP. The participants initially reported they had never heard of CRP but were familiar with CResP. However, after being provided a short differentiation between CRP and CResP, the participants were better able to describe beliefs and practices that went beyond CResP. Consequently, most of the participants began to demonstrate an emerging understanding of CRP principles, but continued to share that they wrestled with how to provide instruction to their preservice teachers on how to implement CRP in K-12 classrooms. Therefore, it appeared the participants were able to describe CRP principles but articulated a conflict about how to model CRP in their science methods courses. Thus, the interview participants' comments suggested the structural theme that there is a struggle to understand and implement CRP in science education teaching.

On a final note, as a result of the participants' struggling to understand what CRP could like in science teaching or describing practices and activities that only foster awareness of otherness the researcher sent two journal articles at the end of the second

interview to encourage the interview participants' to later independently reflect on what culturally relevant science teaching could look like. The articles sent were "*A Case for Culturally Relevant Teaching in Science Education and Lessons Learned for Teacher Education* (Mensah, 2011) and *The Road to Culturally Relevant Science: Exploring How Teachers Navigate Change in Pedagogy* (Johnson, 2011).

In what follows is a discussion about the teaching practices and beliefs reported by the participants.

Conventional science teaching strategies and ideologies are preferred

Research question two was created to seek specific information about how science teacher educators were preparing the future teaching workforce to engage African American students in science classrooms.

Teaching practices/actions. Exploring the teaching practices and actions of science teacher educators seemed particularly important because the researcher wondered in light of the alarming white-black science achievement gap, which has continued to grow (Parsons, 2008) what was being done to address this gap? Thus, the researcher asked, in what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science? On the qualitative survey and during the interview it was reported by the four participants in phase two of the study that the white-black science achievement was both a growing problem and troubling because it perpetuates further inequities, such as a lack of African Americans going into STEM careers. However, when explicitly asked during the interviews which teaching practices were used to prepare preservice teachers to engage African American students in K-12 classrooms, the participants' overwhelmingly suggested they for the most part do not use

teaching practices tailored for the learning needs of black students, but use non-racist instructional strategies that engage all learners, such as science-for-all ideologies and inquiry-based teaching. On the other hand, they reported some isolated discussion activities or statements they use within the context of their science methods courses that highlighted African Americans or ideas of diversity in general.

Science-for-all practices. When talking about teaching practices, there was a propensity by the participants to suggest conventional science teaching strategies and ideologies, such as inquiry-teaching strategies were the best options to reach all students, including African American students in science because these strategies are a non-racist way to teach science. For example, the participants described modeling the constructivistic teaching practices that have dominated science education, such as hands-on experiments, like a “batteries and bulbs” inquiry activity, the use of pedagogical teaching strategies, such as modeling the learning cycle, and modeling the use of collaborative groups and creative discourse circles (AAAS, 1989, 1993; Christensen, 1995). For example, during an interview, Dr. Daly shared that the main theme that is threaded throughout her class and style of teaching is “continuous improvement,” which seems to compliment the class theme she reported on the qualitative survey “teaching science to all with a focus on developing skills that are effective with high needs students.” However, in line with the idea of continuous improvement, Dr. Daly and other participants described these ideologies and conventional teaching practices as ones that will help all students to improve science aptitudes to include African American students. Accordingly, when talking about teaching practices that would engage African American students Dr. Jackson said,

I find sometimes the stereotypes pervasive and hard to overcome. And that's why I said I try really hard to focus on what are the best practices for teaching science...how do we keep kids engaged? And...you know...How do we hook them...maybe that's the issue...maybe we need to hook African American students differently. But then when we get into the instruction, maybe we use the same strong practices and maybe the questions we pose in inquiry should be closer to their life experiences...(Dr. Jackson)

Modeling for all. When asked how to prepare teachers to engage African American students in K-12 science, the participants shared they model teaching practices they hope their students will eventually model in their K-12 classrooms to reach all ethnicities and cultures of students. The participants' suggested a propensity toward modeling inquiry teaching and constructivistic teaching strategies, such as the use of independent research, hands-on experiments, collaborative learning groups, and class discussions.

Each participant talks about modeling the learning cycle and they suggested that if their preservice teachers in K-12 classrooms emulated this strategy, it would help all students improve their science achievement. Specifically, when describing each of their preferred teaching methods, the participants' talked considerably about modeling the clinical and diagnostic method they use for teaching, such as demonstrating the Five E's (Engage, Explore, Explain, Elaborate, and Evaluate) of the learning cycle. For example, the participants' said they model it and use it because it will assist all learners in understanding science.

Okay, so every day when you come into our class, we use the five e-learners cycle in my classes. They learn this five e-learners cycle and then they learn others as they progress. I model real lessons using the five E's cycle... For example, I start by using technology, and my preservice students either have a Socratic classroom question to answer on their devices, they submit data and then we pull it up in class. So that's my engagement... (Ms. Alleyne)

I pretty much model what I want science to look like in the classroom. For example, I tell them that good classroom management comes from good instruction and that if they plan well and they can keep all kids engaged and they will have fewer problems in the classrooms. So, I do try to model that. (Dr. Jackson)

I model the learning cycle for them first using the traditional learning cycle, not the 5 E's, like with the batteries and bulbs experiment. And so we do the parts of the cycle and then after I've modeled it for them as if they're 4th graders we step back and we talk about it. What does that look like? And if is this your unit what does each day look like? How do you start that? And that's where we bring in the 5 E's and talk about the engage and evaluate piece of it. So that's pretty much every week, it's based like that. (Dr. Jackson)

If I'm teaching a course like methods in science...I want my students to do the experiment that they would have their students do in the classroom because I need them to see how it looks from a child's perspective from that, making sure that you do the lesson or the hands on activity. (Dr. Williams)

The day I teach them about the learning cycle, I require them to plan all their lessons using the learning cycle. So explore before explain. So, the day I teach the learning cycle, we do a model lesson together and it's an electricity lesson. I go through all the stages with them. Then, they do it, they do the lesson. So we do batteries and bulbs, can you light the bulbs with one wire? Then I model the explanation stage, and we do a little, here's how electricity works and talk with them about what the expansion could be. So I model that and they actually do it. They have batteries, bulbs, and wires; and the actually do the lesson. In fact, I try to do a little nature of science activity every class. For example, the first class we do an observation inference activity, where I ask them to observe a candle. But it's not really a candle. It's a piece of string cheese with an almond sliver stuck in the top of it. It looks like a candle...they thought it was a candle. They were sure it was a candle, so I blew out the almond and I ate it. Then we talked about how even your observations and inferences sometimes can be wrong. I don't do it as a gotcha, I do it as a lets think about the implications. Let's think about how you might use this with your students. (Dr. Daly)

Inquiry for all ideology preferred. Across participants, it appeared that the science teacher educators in this study favored and therefore either reported modeling or encouraging the use of the inquiry ideology, a standard science education philosophy because it provides access to science achievement to all learners (AAAS, 1989, 1993). Specifically, it appears that these science teacher educators subscribe to the idea that inquiry-based teaching is the preferred method to engaging all learners, including black

students as opposed to explicitly talking with their students about the particular needs of African American learners. For example, Dr. Daly reported that she does not explicitly talk about the contributions by black scientists within the context of her class, but instead expects her students to independently seek out information of scientists of color for themselves to include in their sample lesson plans. So, in doing so, she encourages her students to inquire about this information to be able to later incorporate it in their lesson plans without providing explicit information or direct instruction about these contributions, which seems to ironically contradict the importance of modeling.

Specifically, Dr. Daly said,

Well I don't directly discuss contributions by African American scientists, but they look up, research, and incorporate them into their units. I have a list of unrepresented scientists, which is probably forty percent African American and they come up with people like Mae Jamison and George Washington Carver is always popular. I don't think that I have in any of my planned lessons any references to any African American scientists. I let the unrepresented scientists assignment I use with my elementary and secondary students be my statement about incorporating those stories into their teaching.

In the same vein, Dr. Daly also suggested the inquiry method of teaching is a non-racist way of teaching as opposed to direct instruction. She said that she does not explicitly talk about the learning needs of African American students or how to confront the racist policies that affect African American students with her preservice teachers. Moreover, on the qualitative survey and in earlier interviews she reported she facilitated opportunities for her students to learn how to confront racism in education; however, when explicitly asked, "which racist policies in education do you talk about with your students?" she replied, "I don't understand what you're asking." Eventually, she went on to discuss that her students are not yet prepared to address complicated policy issues, but

asserted that she promoted inquiry teaching because direct instruction, whereby students only memorize science facts is a racist educational practice. For example, Dr. Daly said,

...what I talk with my students about because they are not really confident with dealing with policy issues yet...they are still thinking about what they are going to do in the classroom and what the cooperating teacher wants them to do...What I talk to them about is the direct instruction approach. Direct instruction is an approach that ultimately teaches students they are incapable of figuring things out on their own and that they are incapable of having any interesting ideas. So when you simply are preparing kids for a test and just rely on direct instruction in science ...those are racist policies. White and black teachers put those on students...when instruction is only about memorizing facts, the message that is sent to the students is that other people have to tell them what they need to know and they are not capable of figuring things out and critically thinking for themselves. (Dr. Daly)

Dr. Daly continued to advocate for inquiry teaching as opposed to lecture and note taking when she said,

I think best practices are to avoid the lecture and note taking approach to teaching because students need time to explore without being told what they are supposed to explore. For instance if you were exploring classification, and students are given sorts with pictures and descriptions, let them decide how things should be classified...let them behave as scientists. Then you teach what the current method of classification is. (Dr. Daly)

Additionally, Ms. Alleyne said that she does not largely focus on the learning needs of specific ethnicities, such as African Americans within the context of her science methods courses because teaching for the needs of specific ethnic groups was not highly regarded in her curriculum as compared to inquiry-based teaching. Furthermore, she shared that she only spent one isolated day on “diversity” and racial diversity was not particularly discussed. For example, Ms. Alleyne said,

Only one of the lessons was on diversity from my curriculum. The diversity piece was about educational diversity, so the handicapped, dyslexic, different things like that. But there was no...not one lesson that dealt with ethnic diversity, gender diversity or sexual diversity.

However, Ms. Alleyne reported that she modeled the inquiry teaching method to her preservice teachers because she believed the best way to prepare her students to teach science to all K-12 children is to train her students to allow students to explore and inquire about the world around them because that is how critical thinking is promoted.

To get you to be effective I teach inquiry based. Our whole thing in our program is trying out teaching...it is inquiry, 5 E's, hands on, no sitting and getting...no talking and chalking, and that's what I call it. We're hands-on. You let the kids explore. Let them do some critical thinking...so for example, we jump on tables, go outside, get our hands dirty, and dig up worms... (Ms. Alleyne)

A discussion about the inquiry ideology also dominated the interviews with Dr. Williams as opposed to teaching that is tailored specifically toward the needs of any particular group of students. When explicitly asked how Dr. Williams prepared his preservice students to engage African American students in the K-12 classroom,, Dr. Williams only offered a cursory mention of culture, but instead suggested that allowing kids to do science as opposed to only direction instruction is the best way to engage African American students and all students. For example, Dr. Williams suggested that an inquiry method of teaching where students are given the opportunity to explore with their hands and solve problems is the best way to prepare preservice teachers when he said,

I make sure I cover diversity, but one of the things I emphasize about especially in science education, the best way to teach science is to make sure its hands on. Make sure your students are doing more experiments and that you're not doing a lot of direct instruction. (Dr. Williams)

I'll give you an example...I would draw a picture of a piece of land, a body of water, and another piece of land. And then I would say to my students ok, how would we get from this point to this point... You know you have to be able to think about those types of things and design those types of things. I tell them that's where they should talk to their future students about the design process and

what engineers do. Getting students from non-traditional backgrounds in schools to really talk about these types of things in science and consider these things are the things that scientists do... (Dr. Williams)

When describing her use of inquiry teaching, Dr. Jackson suggested a favoring for hands-on and inquiry-based teaching. Moreover, she reported that inquiry teaching dominated her science methods courses because it is a best practice to encourage preservice teachers to get all children to ask questions.

So yeah, everything we do is hands-on. But I know it can't be all hands-on all the time, but I certainly think it can revolve around inquiry and questioning because I think it's really hard to ask good questions. So my students need to be thinking about "How do I ask good questions in science?" and "How do I get all kids to ask good questions?". (Dr. Jackson)

Hands-on inquiry experiences preferred. When teaching teachers to engage all learners, the participants appeared to favor inquiry-based approaches to teaching. Likewise, they also appeared to favor inquiry experiences that required students to use their hands and do something to solve a problem. Accordingly, often the terms hands-on and inquiry were used interchangeably, especially when talking about a popular batteries and bulbs hands-on inquiry experiment. Further, in talking about using inquiry experiences that were "hands-on," in general, the participants' did not describe specific experiences that helped their preservice teachers only engage African American students in science. Instead they described hands-on inquiry experiences that should prepare preservice teachers to engage all learners in K-12 science. For instance, three of the interview participants reported they use the light bulb experiment, whereby students are asked to illuminate a light bulb, only using copper wires and a nine-volt battery. Three of the participants conclude this experience exposed their students to what it feels like when

they do not know the answer, much the same way all struggling students may feel in a science classroom. For example, when explaining what many of the participants call the “batteries and bulb experiment,” Dr. Daly said:

It's usually a little bit of a challenge for everyone, so there's a sense of how exploration works because a good exploration really allows the students to explore, when they don't know the answer. (Dr. Daly)

And Dr. Jackson said,

I do the batteries and bulbs...so all the materials are on the table. I give everyone a battery, a wire, and a bulb and tell them their job is to make it light. And ten minutes later they're still trying to figure out how to make the bulb light and I get a lot of questions like, “Can I use more than one wire?” I don't know can you? You know so I try very hard to model that first engage and get them thinking about exploration...constant exploration. And so I will stop along the way and redirect for them to do a lot of exploration. They have a page where they take some notes and then we stop and I do concept development with them. And I ask them to share their observations and then I teach the science part of it. And so we do the parts of the cycle and then after I've modeled for them as if they're 4th graders we step back and we talk about it and we talk about where you think teachers might have difficulty? Where do you think students get stuck? How long could this go on?

And Ms. Alleyne said,

So I pull out a bag, and I'm like, ‘You have a battery. You have a wire. You have a light bulb. Don't touch it until I tell you. Put it on your tables and you're going to try to get this light bulb to light. You have ten minutes.’ So they'll have the lab sheet. So they just go for what they know for ten minutes and I walk around, and ask, ‘Is it working? Why isn't it working?’ So then, we bring them back together and I'll say, ‘So what happened?’

In summary, the participants' suggested hands-on inquiry teaching, like the batteries and bulbs inquiry activity was used to help their students relate to all of their prospective K-12 students who may be struggling to conceptualize a science related idea or solution. As a result of the participants describing general teaching practices they asserted were used to engage all students as opposed to exposing their preservice teachers to practices or ideologies that were crafted for the learning needs of black students, the

researcher sent a journal article at the end of the second interview to possibly encourage the interview participants to later independently reflect on the necessary concepts Ladson-Billings (2000) suggests are critical when preparing teachers to teach black children (Atwater et al. 2013a).

Racially influenced teaching activities. When asked how the participants' prepared their preservice teachers to engage African American students in K-12 science, the participants' reported many general science strategies, such as modeling inquiry-based teaching or hands-on activities they suggested would engage all learners. However, when probed further to provide more specific examples of teaching practices used to prepare preservice teachers to engage African American students, which is the basis for research question two, the interview participants' provided examples of culturally responsive activities that demonstrated the science-for-all philosophy. As such, the participants' seemed to report fostering a general sense of racial and/or cultural awareness in their students which appears commensurate with exposing students to ideas of otherness and difference, which Gorski (2009) says is proportionate to the benign ideas of multicultural teaching. For example, many of the interview participants reported leading group discussions using multicultural literature and sometimes engaging in racially motivated conversations that promoted a better understanding of all students. Secondly, the participants seemed to provide advice or recommendations on how to structure these multicultural conversations. However, it seemed the participants' did not appear to advocate for these strategies to be modeled by their preservice teachers in their future classrooms.

Group discussions. The interview participants' purported to use some teaching practices, such as the use of group discussions that they believed fostered a sense of racial and cultural awareness in their students, which marries well with the culturally responsive teaching framework because they said their aim was to expose their students to all types of otherness. For example, three of the participants reported fostering an awareness of racial injustice in education in their nearly all white preservice students, who they say appear completely oblivious to the injustices students of color face in public schools or in society at large. Specifically, Dr. Daly shared a practice that she described as a book study approach. Dr. Jackson and Ms. Alleyne reported using journal articles to expose their students to the inequity in education or the marginalization of African Americans in science, using culturally charged small group discussions. For example, Dr. Jackson reported sparking discussion about inequity with the preservice students in her teacher preparation program when she said,

Well, almost every week I share articles with them ... like today I just sent them a article from the Times that says, "US to Focus on Equity on Teacher Assignments." The Obama administration wants to see if there is a way to ensure that the most neediest kids don't get the most inexperienced teachers ...so part of it is me sharing information with them. (Dr. Jackson)

When probed further in how Dr. Jackson prepared her preservice science teachers to engage African American learners, Dr. Jackson shared a teaching practice she felt helped her students to reach all students regardless of race, gender, or culture. For example, she reported using a teaching practice with her science methods students in which she asks her students to draw what they believe a scientist looks like. She called it, "draw a scientist test." She noted that the students have in-depth conversations about their

drawings and this activity helps her students “to become aware that all scientists do not resemble Albert Einstein, a white man in a lab coat with goggles and crazy hair.” She also noted that usually all of her female students depict male scientists in their drawings and thus, she believed this awakening of race and gender bias in science helps to start a conversation about stereotypes in science. For example, she says,

...so the first week when we do nature of science we do the draw the scientist test and we analyze it...and then I have them stand up and show their pictures one by one. And then we analyze our own stereotypes about scientists. Eventually, I show them ‘draw a scientist’ pictures that I have from 3rd and 5th graders... and they get a hand full of pictures to analyze at their tables and they’re astonished that the pictures are mostly white, mostly male, almost all in chemistry garb. (Dr. Jackson)

Dr. Jackson’s ability to promote conversations in her science methods courses about otherness is an important homage toward building an awareness of multiculturalism and otherness, but Ladson-Billings (2000) suggests this is not sufficient to prepare teachers to teach African American students.

A culturally responsive exercise Dr. Daly shared in our interview, which was mentioned earlier on the qualitative survey was called the “culture bump,” which she said “epitomized culturally responsive teaching.” Although this teaching practice is not fully commensurate with culturally relevant pedagogy, it is an experience that promotes a prerequisite for cultural competence because she reported her mostly white preservice science teachers become aware of otherness within American schooling. Specifically, Dr. Daly reported the culture bump assignment was a multi-part process where students identified cultural experiences that made them uncomfortable. The cultural bump process included a class discussion for the explanations of the white-black achievement gap (Oats, 2009), a reflective writing piece of a culture bump during a field experience or

general life experience, and an oral presentation to the class to include a class discussion of each culture bump presented. Also, Dr. Daly indicated she encouraged self-reflection after this process by asking each student to write a final reflective summary about the entire experience with this assignment. Ladson-Billings (2000) would suggest the reflective essay and the discussion about the achievement gap within the culture bump assignment is critical to helping preservice teachers think about their own subjectivity and bias when they experience cultural otherness. In talking about the culture bump assignment, Dr. Daly said,

We devote one whole 3-hour class to cultural diversity, I talk about the wonderful research by Oats, and we do the culture bump at the end and the idea is introduced in essence by the discussions that has happened earlier... So they're going into their schools, they're experiencing their students and their schools but I tell them you've got time to be thoughtful about this assignment so what I want you to do is just think about how you're feeling and pick a time over the next 6 weeks when something makes you feel a little uncomfortable and you realize that it's because there's a difference in the way you think and the way others think. And I tell them it'd be great if you make the focus of this your placement because it's really a good idea for you to recognize those things that make you uncomfortable because there's a dissonance with your culture here and another culture there. And that's what a culture bump is, when you encounter a difference in another culture and your culture and it makes you feel a little uncomfortable. That's the bump... but it's the analysis of the bump that is part of the assignment... so they have to write up the assignment, describe what the bump is, go through that, but then they do a presentation to the class on the bump.

While the culture bump activity included autobiographical activities that promoted preservice teachers to reflect about one's cultural position in society, Dr. Daly reported that she did not foster training for her students in how to use this teaching practice to later facilitate cultural competence or critical consciousness with K-12 students, which Ladson-Billings (1995a, 2000, 2006) and Young (2010) say is paramount in teaching African American students. Specifically, Dr. Daly suggested that while the Culture

Bump assignment is so important to her students building an awareness of otherness, it is difficult for them to model this in their K-12 classrooms.

My students have historically been uncomfortable with that. When I say historically I mean consistently every semester. ... With the idea of using culture bumps in their own classrooms, using this kind of exercises with their own kids and I think it's because they're novice teachers and they really don't know how to handle difficult topics that came up as culture bumps and they don't yet have the experience of establishing a community of trust in a classroom and I have to admit that in my 18 years of public school teaching, there were a few classes that I would've done this with, and there were many classes I wouldn't have done this with. So that's something that I don't have any problem with and rejecting, because I kind of rejected that whole idea. (Dr. Daly)

Thus, it appeared the culture bump activity was simply an in-class activity to help Dr.

Daly's preservice teachers recognize general otherness as opposed to a strategy intended to later be used in the K-12 setting for African American students who may be experiencing what Ladson-Billings' (2000) calls unique "stumbling blocks," such as racist policies that lead to disenfranchisement of black children in the American education system.

Dr. Daly also reported she requires her students to read a book about a poor African American woman who was exploited by the science community in the name of cancer research in an effort to foster discussion about inequity in science. Dr. Daly said,

...I talk about *The Immortal Life of Henrietta Lacks* and if you don't know that book as a biology teacher, you need to read it. Henrietta Lacks was a real person... I didn't include this in my artifacts, but we do a book club on that. My secondary students read that book. They read the book and we have three discussions on the book... (Dr. Daly)

Likewise, after being repeatedly probed to offer some type of specific strategy Ms.

Alleyne uses to prepare her teachers with dispositions or competencies to engage African

American students in K-12 science, she shared that on the day she speaks to her preservice teachers about diversity in general, she uses of a journal article series to lead a discussion about racial otherness for her white preservice teachers. She reported she encourages a discussion about black and other students of color “acting white,” which Fordham and Ogbu (1986) say is a form of assimilation for African American students when she said,

My students read an article about the burden of acting black, and just so that it wasn't all black, I even found one about the burden about being Asian and Latin...so that's a discussion we have and its really interesting because 75 -80% of my students are white...so that's one activity, but one out of 16 weeks is just not enough...(Ms. Alleyne)

Dr. Williams also reported that he uses a diversity group discussion strategy, but says that the rationale is to make his mostly African American preservice students uncomfortable in an effort to prepare them for presenting in front of large groups, such as at major conferences, as opposed to preparing his students specifically to engage African American students. So, the students engage in a small group question and answer forums, where they dialogue about a particular book or empirical study related to some general form of diversity, which may or may not be related to race, gender, ability, or sexual orientation. He suggested he did this to help his students demonstrate proficiency in articulating a difficult scholarly message in front their peers. For example, Dr. Williams shared,

I put them in situations where they are uncomfortable, where they are in front of a group presenting and I also try and do that in my classroom. For example, I require them to read a book, like in my diversity class...they have to identify a book on diversity, and so I'm going to put them on a panel. I say you have five minutes to present your book and then expect questions from your classmates and me. And so I'm just trying to get them used to that scholarly environment where

they have to produce and sound credible and know what they're talking about. And that's basically one of my major sticklers in my class. (Dr. Williams)

At first glance, this activity appeared to be somewhat of an anomaly because it seemed the main goal of it was to expose Dr. Williams' students to characteristics of diverse populations so they could engage all learners; however, when probed further about this practice, Dr. Williams reported that because most of his students were already African American, they for the most part already understood the societal roadblocks black and other students of color will face in K-12 classrooms because they once were the black K-12 students sitting in the classroom. Therefore, Dr. Williams' said he ensures his students are prepared to address controversial issues, like topics surrounding diversity and professionalism under distress because he prepares his black students for the reality that they have to be better than the average white teacher. So, for example, he suggested he wants his preservice teachers to not only think like teachers, but to also think like researchers when he said,

They have to discuss a trend or the issue in science education, like the issue of minority students taking Advanced Placement science courses and they looked at the data across the nation and there was an alarming low number. And so based on the research you know, they had look at some empirical studies, they had to synthesize them, and then they had to give implications towards science education. So my students introduce the topic, tell what the expert said about the topic and then I ask them to synthesize the information and tell what are your suggestions to science education teachers. So, there's several trends and issues. And I tell my students you may want to look at that issue as a science teacher educator. How can we get more minority students taking AP Physics, Advanced Placement Chemistry and you know, attempting these exams? (Dr. Williams)

Fordham and Ogbu (1986) initially articulated the idea that blacks must work twice as hard in education to live up to the expectations of American schooling, which is already

dominated by a myriad of hegemonic influences that denigrate African American students. Thus, it appeared that Dr. Williams' was preparing his mostly black preservice teachers for this inequitable reality. Moreover, it appeared that he was almost modeling a sort of generational cultural competency. So, it appeared that Dr. Williams' preparing his students to think like educational researchers and attempt to solve provocative problems like the tracking of minorities into lower level science courses suggested he wanted his students to acquire skills beyond that of an average teacher. So in this way, it was as if he was demonstrating the very quality the preservice teachers ought to emulate with their future K-12 black students, which is black teachers must have the highest expectations for excellence for black students as a tool to compete with your white counterparts (Ladson-Billings, 2001).

Upon an even closer analysis, Dr. Williams' discussion activities aligned with both Ladson-Billings' (2000) and Fordham and Ogbu's (1986) ideas. Specifically, Dr. Williams suggested that he worked diligently to ensure that his students were the best and brightest. In fact, he went on to say that he used these group discussions to introduce his students to ideas within teacher education, to help his students conceptualize essential questions about science education, and begin to brainstorm how to solve the structural inequalities within science education. Accordingly, Ladson-Billings (2000) posits that including more highly qualified African American scholars in teacher education is one of many preferences toward building a more anti-racist institution of education for African American students in the US. Therefore, Dr. Williams' preparing his students to begin to analyze problems in science education, such as using empirical studies for trends in tracking students in science, may lead them to develop the dispositions for further

promotion into the professoriate, which Ladson-Billings' and others (Atwater, Butler, Freeman, & Parsons, 2013) recapitulate is one meaningful way to demonstrate that African American scholars are not only capable of intellectual thought, but also belong in institutions of higher learning.

General advice for teaching about the cultural other. Some of the group discussions the participants shared seemed to be characteristic of teaching preservice teachers about otherness. Moreover, the participants' shared advice about teaching preservice teachers to engage students who represented the culturally other. Specifically, Dr. Jackson and Dr. Daly seem to advocate for using multicultural literature in the context of overall preparation programs as evidence that they and the teacher preparation programs they represent foster an awareness of otherness in their students by embedding these conversations throughout the courses.

For example, in addition to her book study approach about Henrietta Lacks, Dr. Daly reported that the teacher preparation program she represented embedded general ideas of multiculturalism throughout the program using diverse literature to spark conversations about diverse cultures, as opposed to specifically focusing only on African Americans or collapsing all topics of diversity into one multicultural course. Dr. Daly advised she believed the idea of embedding conversations about multiculturalism throughout a preparation program were a best practice. Additionally, she reported it was as a result of the recommendation her overall program received from an external audit they conducted of their program. Specifically she said,

I know at [another nearby university] they have a separate multicultural course, but we decided not to do that here...we decided to weave it into all of our courses. And it became explicit in the courses. So, for example, the foundations professor uses the book, *Five Miles Away and A World Apart*, which is the book about J.R.

Tucker High School and Armstrong High School....it's a really dense read, but nonetheless a really good illustration of how integration got co-opted by the white legislative establishment. So, it really couldn't have the impact it could have had...and that's really interesting. And then our curriculum issues professor is doing African American literature and Hispanic gay literature...and he's talking about who these people are and telling about their stories. So, the student's are getting diverse perspectives ...the message they are getting from all the professors is this is an important topic and you need to think about it. Inequities in education and what you can do to implement culturally responsive pedagogy... (Dr. Daly)

Similarly, Dr. Jackson also advocated for multicultural conversations to be embedded throughout when she said,

Also, have you ever read, *Five Miles Away: A World Apart*? Its about one city and two schools and the story of educational opportunity in America...by James Ryan...its about...two schools after Brown vs. the Board of Education and the difference once white flight happened in the city. And what happened with these two schools...And another book that they read is Ruby Payne's book on poverty. And so we try to recommend other books they should read throughout the program. So what some teachers do is take the book study approach....they sign up and everyone reads... "*Why are all the Black Kids Sitting Together in the Cafeteria?*" (Dr. Jackson)

Ladson-Billings (2000) would suggest that this type of program-wide critique Dr. Daly reported is beneficial to creating anti-racist teacher preparation programs, but would also suggest the visceral next step to creating anti-racist programs would be to go beyond simply adding multicultural discussions within the courses.

Likewise, when probed even further, Ms. Alleyne reported that despite not spending a considerable amount of time on the learning needs of African American students, she did offer advice to her preservice teachers about all students of color and African Americans in particular in terms of classroom management. Her commentary appeared situated in her own lived experience as a black person. For example, she said,

So, I tell [my preservice teachers] with any minority students you have to really keep them engaged. But as far as classroom management, its okay to have African American students chime out...I call it pop-corning out...because that's a part of our culture...we go to church and we're like, "Say it, Go ahead on...Take your time..." We do this type of call and response in our churches and in our homes, and often times when teachers don't understand this experience, they look at calling out as a lack of management in the classroom. (Ms. Alleyne)

Ladson-Billings (2000) and Fordham and Ogbu (1986) suggest holding discussions of how black students may or may not distance themselves from their African American culture to conform to the middle class white culture of American schooling are the exact types of conversations teacher educators' should be having to prepare future teachers to teach African American students. However, Ladson-Billings' (2000) would suggest that these conversations must be on-going, systematic, and allow for self-reflection, so that preservice teachers can understand how "race and racism structure the everyday experiences of all Americans and negatively impact African American students and their ability to successfully negotiate schools and classrooms," which agrees with the critical race theory tenant that racism is normal in American culture (Ladson-Billings, 2000, p. 211).

When further probed what do you do prepare your students to engage African American students in K-12 science, Dr. Williams clarified that he provided instruction to his mostly African American students on a more salient point, how to address a student who may be marginalized in a science classrooms because of access. For example, he said,

I do talk about things like, access. You know, what do all students have accessible to them? And you know, one of the things I really emphasize with preservice teachers is being resourceful for students... You have a lot of students who seem not to have access to science, it doesn't matter what race, color, creed... And so providing resources for your [marginalized] students is important. And so I embed it throughout the entire course...I need them to understand what it means to you

know, address your lesson in terms of differentiating instruction for many types of diversity, such as linguistic differences, disabilities, race, and gender. (Dr. Williams)

Summary. The way the science teacher educators in this study reported they prepare their preservice teachers to engage African American students was by using the same practices they use that helps preservice teachers engage all students. Moreover, they reported they model the very practices they hoped their students would eventually emulate in their classrooms to engage all students. Specifically, they reported all students would be engaged in K-12 classrooms because they were preparing their preservice teachers using strong science pedagogy practices, such as modeling inquiry-based and hands-on teaching. However, when probed further to provide evidence they teach in culturally affirming ways as was suggested from the qualitative survey, the participants' described conventional activities that reflected an interest in preparing preservice teachers to address cultural difference and awareness. For example, the culture bump activity, the draw a scientist activity, and reading activities seemed to foster a sociocultural awareness and create dialogue about many types of diversity. Thus, the statements that suggested a propensity to use constructivistic teaching strategies that were aimed at preparing preservice teachers to engage all students in science worked to construct the theme, modeling conventional science teaching strategies and ideologies are preferred for preparing preservice teachers to engage all learners as opposed to identifying specific learning needs of African American students.

What follows is an analysis of the beliefs and experiences related to race reported by the participants that may have impacted their teaching practices.

Experiences and Beliefs Related to Race

Wallace and Brand (2012) assert that American racism was built on and is perpetuated by the invisible myth of black inferiority; moreover, the white-black achievement gaps, chronic school failures, the lack of black students going into STEM careers, and other inequities are evidence of racism's effects in the educational system. These hegemonic reverberations of racism, to which Wallace and Brand allude, also appear to be concerns for the science teacher educators in this part of the study.

Research question three asked, how do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices? Therefore, what follows will show how the contextual themes early experiences and beliefs in the manifestations of racism build the idea that racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.

First, it is important to note, the participants were selected for interviews because they emerged from the qualitative survey in part one of the study as self-proclaimed exemplars for cultural teaching. Consequently, exploring the background experiences and beliefs of the interview participants was critical in understanding how these science teacher educators' situate constructions of race and how those ideas may have influenced their thoughts about how to teach. Accordingly, each of the participants shared a unique lived experience that they say has impacted their epistemological sense of society.

However, despite the uniqueness of their stories, similarities across all four participants emerged. So, secondly, a discussion of how the participants' experiences and beliefs related to race may have impacted their teaching practices is analyzed, and the data revealed while the early formative experiences described by the participants' were complicated, subjective, and diverse in nature, these experiences appeared to influence the teaching practices they reported. Therefore, in what follows is the background information participants shared, which provided a necessary context for their beliefs and experiences. Thus, an analysis of these beliefs and experiences will be linked to previously mentioned teaching practices that may have emerged from RQ. 2.

It must be noted that the anecdotal descriptions of the participants' background experiences are lengthy, but this rich information is pivotal in later understanding how these experiences have impacted their thinking and pedagogy. Moreover, it is necessary to caution readers that the participants willingly shared very personal and sometimes alarming stories, which was possible by fostering a safe and trusting interview atmosphere. So, while these stories are captivating because they vividly illustrate four different lenses or perspectives of often the same idea or event, it is necessary to note that the researcher truly appreciated the candor, honesty, and commitment to the process that the participants' held. Accordingly, at times some of their descriptions are purposely extensive to allow the participants' stories to unfold with minimal editorializing by the researcher.

Experiences related to race. It is important to understand which early experiences the participants' say have shaped the way they think about race and racism, which may have also influenced the way they think about teaching. In this study, two of

the interview participants were white and two were black, and three of the four experienced the Civil Rights movement first hand. All of the participants' shared experiences regarding their childhood, upbringing, family dynamics, the struggle of segregation and integration, and how these experiences have impacted them. While the participants came from two different ethnic backgrounds, they described much of the same concerns from different perspectives and societal positions. Thus, it appeared the participants' racial beliefs were socially constructed because these beliefs emerged from racially charged experiences the participants' reported. Specifically, they spoke about past experiences from the perspective of both early childhood and young adulthood, which provided a primary foundation for their beliefs related to race.

Early experiences. Dr. Daly spoke about many early experiences with her racist father, her experiences with school integration, and within various social situations while growing up that helped to shape her present day beliefs about racial differences and inequity.

So, I'm a [Southern] girl. Born in early childhood on a tobacco farm outside of a [small southern town]. I was in [a large southern state] when the lunchroom sit-ins occurred. And my brother characterizes my father as a sheet-wearing racist. Uh, I don't know why I came this way, but I've always thought the sit-ins were very reasonable... Those young people had a right to eat at the lunch counter. I told my dad so at the kitchen table while we were talking about the evening news. And I remember specifically... I had my hair in curlers and I remember that he hit me so hard that he knocked the curlers out of my hair... I think I came from the womb with a difference sense of empathy than apparently my father had. And a lot of the other people in my family. Um, I've had African American friends all of my life. I remember I went to school in [large southern state] and it just happened that my family moved to [a more northern state where integration was already in place] the year that integration was mandated for schools [in the large southern state I came from]. So I never went through a time period in a school when folks were adjusting and shifting from the pains of integration because [northern] schools had been integrated for years. So I went from a school system that was segregated to a school system that was integrated... and painlessly so. I was on the basketball team with African American girls and you know we were having a

great time. I had a lot of friends that were African American in school and it was like okay, this is what we're doing. Um, my family didn't have a problem with that, they just didn't want me marrying anybody that was not my color. So, in my background I have a sense of the dichotomies of approaches to understanding the other; to seeing persons that appear to be different as persons who really aren't that different... As persons that are human beings and have the same aspirations, hopes, dream, likes, loves, hates, that kind of thing. I am not going to say that I don't have racist hints in me because I think you can't escape culture. You know that's part of where I came from and my best girlfriend is Trinidadian and [highly educated]. But even with her I've found myself sometimes thinking well she's not as capable and I realize it's a vestige of the culture of my past. And so I am not like Pula Dean where I say, [joking] with tears running down my cheeks, I am not a racist. You know I probably do have things in me... I know that things have come up where I have thought well... they're different and they're "not as good as" and I have tried to be very reflective of that and I say to myself you know you're reacting to, responding to what your culture taught you. It's not what's true. ... (Dr. Daly)

Specifically, in the previous statement, Dr. Daly reported multiple points about her background that suggested that while she believed in equity, her racist upbringing may still impact her beliefs. Specifically, she reported that despite coming from a southern state that embraced segregation, she "painlessly" attended integrated schools, socialized with black people growing up, and currently has a close black friend, she admitted the possibility that she may still harbor racist ideologies. Next, Dr. Daly described in more detail her upbringing and the culture within her family, which was led by her father, who she said taught her that black people were inferior. She said she was encouraged to believe this about all black people. However, based on her early childhood experiences with a black friend, she reported she realized the qualities she was being taught about black people may not be true.

My father made me do things like look up the dictionary definition of n-i-g-g-e-r, so that I would know that it meant, diminished, stingy... He made me read the definition in the dictionary because I told him, 'that's not a good word and that's not how to characterize people.' He said, 'oh yes it is' and so those are things I was kind of told as a child [long pause]. When we watched the evening news,

again my father would make comments about people on television. He would comment on the facial features of African Americans, kind of like the same comment that got Howard Cosell fired, if you know what that was. I am sure there were other things. But I had a playmate and I don't remember much about her, but I think it was her and her brother. They were tenant farmers living on the farm next door from the farm that we had. And we played with them all of the time. We'd go down to their house and play with them, but they were not allowed to come up to our house and play. They were black kids. And we played, you know we were kids...we played. And I think that may have had a shaping influence on me because it was pretty clear they were just kids. They weren't less than or any of those qualities my father had tried to convince me of. They were kids. And I think their mom was very kind. I remember that. And I don't remember much more than that. I do remember that the house they lived in had dirt floors and it was not as nearly as nice as our house. And I won't tell you I remember thinking why do they have this house and we have that house. I just remember that it just seemed normal. And I remember that we were just playmates and I think there might have been an incident where I was told to cut back on playing with them. It is awful tempting to demonize my father. So I want to hesitate with that. (Dr. Daly)

So, thus far, Dr. Daly has reported about her early experiences to include socializing with two black children on a nearby farm, which she said influenced her to reject the racist ideologies her father attempted to indoctrinate her with. Consequently, Dr. Daly later suggested it was her past experiences that fostered a "sense of inequity," which influenced her to go into higher education, focus on equity research, and shaped her ideas about African Americans in schooling and science education, in particular.

So I have tried to be very honest with myself about those kinds of things. And one of the things that drew me into higher education was a sense of inequity in science education. So one of the things that I brought to higher ed was a sense of what can I do to help my teachers... the preservice teachers who will be practicing teachers... how do I help them learn how to and believe that, everybody can do science. Well, by the time I came into higher ed, I was on a path of equity research and it was what my dissertation was on. Also on this idea that everybody could do science... Not only believing it, but thinking it...that it was a God given right to have science experiences that open doors... Understanding about yourself and your ability to think as well as what science is, everybody has that right to have those kinds of experiences. And the literature on African Americans...the connection to poverty, the connection to low achievement... the connection to a lack of self esteem and all that goes on generally with African American kids.

Statistics show it's a trend. Since 1996 since I got my doctorate, those statistics haven't changed. You know there's a middle class, a growing middle class, African American middle class, which I think is wonderful, but we're still leaving so many African American kids behind. So when I started teaching science methods, I have always incorporated some things about culture and race and gender into my instruction. (Dr. Daly)

Dr. Williams shared the least about his early life experiences related to race, but he reported how his conservative upbringing in an all black neighborhood and a social consciousness within his immediate family shaped his appreciation for education and his concept of his social position in society. For example, Dr. Williams said,

I grew up in [in a large southern state], and I grew up in a predominately black neighborhood. My educational experience from elementary to middle to high school... even undergraduate was predominantly black schools. I grew up in a single parent home. My mom attended college, attended a small school in [the same southern state in which we lived] so she really emphasized education. I would say I grew up in a very conservative household but with the notion of embracing diversity. And I wouldn't necessarily say it was a very rough area I grew up in, but it was tough in terms of the type of people I hung out with. I was educated by the teachers who did the sit-ins and civil rights demonstrations. And my parents were apart of that generation that did the sit-ins and demonstrations. So they were apart of the Jim Crow era they were they were aware of that. And they didn't hide that from us...they were very adamant about it. They would discuss you know these were some of the struggles so as a result of that, this is what you can do now and make sure you don't forget that. So when I was attending school, if I ever wanted to give up or something, I just had to remember that there are some people who struggled and died to get me where I am now. And so that was always an emphasis. Religion was very big in my household my mom was very adamant about us attending church, putting God first, and prayer. Also, the black struggle was really talked about in my home. My father was very big into African art and African studies. So my family really emphasized a lot of what took place in the 60's during the civil rights movement. And also that transcended over in education. I had a lot of teachers who also were a part of the civil rights movement. So in essence there were two educations we would receive. For example, a traditional education, which is the curriculum of K-12 but also the hidden education as I would call it. Like some of the do's and don'ts of an African American male that my family would teach me. So, some of the things I learned you don't do are like ride around with loud music to bring attention to yourself, watch how you dress out in public, always be mannerable at all times, respect authority, but make sure you also demand respect as well, be mindful of your surroundings, and be careful of the company you keep. (Dr. Williams)

In Dr. Williams' description of his upbringing, he noted that his family and teachers who had participated in the Civil Rights movement influenced his understanding of the role racial injustices have played in society. He also reported that his mother taught him by her actions that education was a vehicle for social mobility. As a result of this, he seemed to suggest that in addition to the "traditional" K-12 education he received, he was also taught some of the unwritten rules of black culture, such as persistently working hard in school and in society to honor those who came before, sacrificed, and died to make it possible for him and other black children to get an education.

In describing her early experiences, Dr. Jackson shared that these experiences shaped her regarding her passion for science as well as her outlook on otherness. She reported she grew up in a rural area with very little diversity and had strong science experiences at home, but she reported she did not enjoy school science. Dr. Jackson also talked about how early experiences with her family and in school shaped her ideas about race. For example,

I was adopted and born in 1965 and the year I was born my father started teaching middle school science...So, my father was a science teacher, and my mother was a stay at home mom... So, I grew up in [the western part of a northern state], in a rural area. There were only 5 houses on my street and I grew up on a big farm. I grew up in a time when after breakfast, my mother would say, "Okay go outside and play, I'll see you at lunch time." So, I spent a lot of time outside on a farm, in the woods, in the fields. There were no kids where I lived, my age, at all. So, I spent a lot of time outside, exploring and picking up things, wading in the creeks and doing that kind of stuff. So, I was a nature girl pretty early on and when my dad came home from work, I remember I would grade his papers with his red pencil and he used to take me to Ward Scientific, which was in [a northern city], where I grew up. They had a rock pile, so when they had specimens that weren't good enough to sell, he would take me to the rock pile on the weekend and we would sift through it and look for specimens and I had a rock collection. We would do science experiments in the basement, but I did not have strong science experiences in school growing up, even though I took all of the science courses I

could possibly take. They were all lecture and taught from the textbook....I liked science but I didn't like school science. I can remember my mother being very surprised, there were three black kids in my high school. Um, one who was on the soccer team with me and who I got to be good friends with, but I was never allowed to go to her house, even when I was invited. One who I spent a lot of time with in class, who actually died of sickle cell anemia the night before graduation, and one who was a young man who played soccer and basketball, but I was not in any of the same academic classes with him. (Dr. Jackson)

In Dr. Jackson's response about her upbringing, she reported that she was heavily influenced by science very early on from her father. However, she rejected school science because she said her mostly white science classes were dominated by lectures. She also reported her mother was surprised to learn she had three black students in her school and she was not allowed to visit the home of anyone who was black, which suggested that she probably did not experience much diversity in her K-12 schooling career. Interestingly, Dr. Jackson went on to share that when she went to college she was faced with a situation where she experienced harsh treatment for looking and being different, which she suggested introduced her to the concept of otherness or not belonging to a group. For example, Dr. Jackson said,

So, when I went to [a small mostly white university], my roommate was Puerto Rican. And I went home with her one weekend in the winter...she lived in Brooklyn. So, her family was lovely and we had a really nice weekend. And I remember on Saturday morning, we got up and went out early just to walk and get something to eat. I remember I got pelted with snowballs because I was a white girl in their neighborhood. And I can remember that Sonya turned around and started yelling in Spanish at the boys who were throwing the snow balls...and I don't speak a lick of Spanish...I just was really surprised because I didn't realize at the time I looked any different from everybody else, but I guess I did...Because of this I have more empathy for those who stand out in a group in any way from others. And because of that I feel I gravitate to those who are different because I don't want them to be or feel alone or feel they are standing out in a group...if that makes sense? (Dr. Jackson)

As a result of this experience where Dr. Jackson reported being singled out for being different, Dr. Jackson indicated that she makes it a point to ensure that everyone feels included in her classes because she remembers what it felt like to be what she called, “the only one.”

Lastly, much like Dr. Williams, Ms. Alleyne, shared early experiences that she contested shaped her beliefs and teaching practices. For example, Ms. Alleyne reported that she was raised in all black neighborhoods and attended mostly black schools from K-16. Ms. Alleyne shared by far the most detailed recollection of her upbringing and how social constructions of race impacted her and her family. For example, she said,

So, I grew up in a really low-income black neighborhood, not public housing though. But early on, I was the kid who had a mom and a dad. And, you know, my mom was even saying this week, "You know everybody used to come over to our house because you had all the toys and all of the clothes." So, I was just like "that girl" in the neighborhood. And so now when I think back to all my friends that I grew up with in that neighborhood...I can't think of anyone that I'm connected with now in my adult life because they either got pregnant in high school or...when I went to high school I lost contact with my neighborhood friends...because you had to apply to go to [this elite all-black magnet high school], and if you didn't get in or keep your grades up, you got sent back to your zoned school. So, the friends that I had in my neighborhood, they didn't come to [the elite black high school I attended]. They went to the zoned school because they didn't have the academics to apply and to come to the school. So then, when I went to [this high school], my whole circle of friends changed and it was no longer neighborhood friends, you know, I would speak in passing, not to be rude, but I had my whole new [high school] family. I had very close-knit parents and my mom, early on, instilled the value of education. However, when I got older, my parents divorced and times got a little hard but my mom continued to instill the power of an education. So I went on to graduate at the top of my high school class. I received full scholarships to various universities. (Ms. Alleyne)

In this previous description, Ms. Alleyne reported that her parents instilled the value of education, which she suggested is why she took great pride in and graduated from an elite all black magnet school. However, as a result of attending this school, she suggested she

was forced to separate herself from the children in her neighborhood, which she also suggested was the determining factor of her later academic success. For example, she seemed to imply that her neighborhood school in which her neighborhood friends attended was not a quality school and interestingly, many of her friends who attended this school did not experience academic success.

Next, Ms. Alleyne suggested it was because of her family's belief in education and sociopolitical influence that she attended a black university, which is similar to what Dr. Williams reported when he spoke about his family's influence on him.

Also, I have a brother; he's Muslim. So, you know, black Muslims are very racially conscious. So, I grew up in a family that were very active in politics, they were educated and they all went to HBCUs. So, I grew up in social consciousness. I can remember in high school, wearing like the red, black and green beads, and the medallions, and, like, the dashikis and all that.. Well, because of my family and our background, I only applied to HBCUs - Historically Black Colleges and Universities. I attended [an HBCU in a mid-Atlantic state], and I had aspirations of becoming a doctor like most biology majors do. Education was always in the forefront of my upbringing as well as just being proud of who I was, despite knowing how society would look at me. My mom always told me, even in elementary school, "You have already started this world with two strikes against you-- you're black and you're a female." Now that I look back, it was three strikes because we were poor too but, you know, sometimes you don't know what you don't know. So, three strikes, and she just always told me, "You always have to be better. So if a white person does ten things, you need to do fifteen things. You just always have to strive to be better." (Ms. Alleyne)

In addition, Ms. Alleyne said that her mother instilled a similar ideology in her that Dr. Williams previously mentioned in his description of his upbringing, which Fordham and Ogbu (1986) suggest is this idea that if you are black, one has to be better than average to be able to compete with one's average white counterparts. However, Ms. Alleyne pointed out that she had double limitations placed on her by society because she was

black and female, but the academic and social preparation she received from her schooling and her family would later prepare her to compete with her white counterparts when she finally attended an all white university.

I think, racially...when I think back, I was really sheltered. My elementary school was predominantly black. My middle school was kind of mixed. High school...as I said, I went to an all black high school in [a small city in a mid-Atlantic state]. My grandmother had graduated from there...my mom, my dad, all of their siblings have graduated from there. So, I think my racial identity really came from my environment when I was a student at [my high school]. Because at [this] high school, we were the black school during segregation. You could walk the halls and see all of your parents and grandparents on the walls in class pictures. So, it was just like you had pride. So, you couldn't let those before you be disappointed. We all went to the same churches. We lived in the same neighborhood and we really uplifted each other. We just had the mindset, you have to be the best. Teachers didn't allow us to be anything less than the best. All of my teachers were African-American, my classmates were African-American and we were just always told, "When people see you guys, they don't think that you're going to speak the way that you speak or your grades are going to be the way that they are. For example, I played the violin, and folks would say in shock, "You're a violinist?" My teachers would tell us, the world is going to think you're only supposed to run a ball or beat a drum in the band. But the teachers at [my high school] just told us that we were just so much more than that. I think that was like a culminating experience. I had it at home, but then when I went to [my high school] it just codified everything that I had learned from my family. And, you know, I'm indebted to that school...But having attended that school, I think it exposed us to the real world. It told us, you know, just because of what you look like, what neighborhoods you grow up in, it doesn't negate the value that you have to society or where you can't go. So, later, going to a HBCU was a deliberate choice. I was a National Merit Scholar, so I would receive letters from prestigious predominantly white schools, such as Tech, Emory and Carnegie Mellon. And from UVA, I can remember getting many letters and calls but I just did not want to go there because of just the background I had at [my high school], which is ironic because I eventually would go on to graduate from a PWI because life happened. That was a big culture shock and it created some self-doubt when I left Norfolk State because when I went from a class of 20 and everybody was black and then go into a class size of 200 and there are only two blacks...I'm thinking, "God, can I keep up with them?" or "They're smarter than me. They have all of this...these resources or equipment and we didn't have any of this at Norfolk State." Then you start to, I guess, devalue your own self-efficacy, like you just think, "Maybe I really can't compete." Then, you know, once I took a

couple of quizzes and tests, and really listened, I realized, "Well, you know what? They're not even as smart as I thought they were...or as my perception was."

As was seen in the previous comment, when Ms. Alleyne continued to describe her background experiences, she reflected again on her time in an all black magnet school, which she implied helped to prepare her for the rigors of post-secondary study. She pointed to the segregationist history of the school, the generational pride of the students at the school, and again she highlighted that her all black teachers, family members, and neighbors instilled a sort of accountability in the students at her school. Specifically she spoke about her all black teachers having the highest expectations of her and the students who attended her high school, which Ladson-Billings (1995a, 2000, 2006) would agree is critical for African American students.

Beliefs related to race. In addition to describing personal experiences, the participants also shared many personal beliefs about race and racism by sharing anecdotal stories and personal opinions about several manifestations of racism. The participants' stories, which highlighted everyday examples of how racism infiltrates and permeates society, exemplified the critical race theory principle that suggests racism is normal and that ideas of race are subjective, which was one of the major assumptions undergirding this study (Delgado & Stefancic, 2012). For example, they reported beliefs that explained the white-black science achievement gap, colorblindness, and tolerance for racial differences. They were also asked how they would respond to a scenario where one of their students was accused of being racist, which helped to illicit their beliefs about how to address possibly racist teachers. Lastly, to show how these reported beliefs related to race may have impacted their teaching practices, which is the basis for RQ 3,

each belief is associated back to various teaching practices as mentioned by the participants. It should be noted that since RQ 3 focuses on the ways race has impacted the practices of these participants' the participants' words were used to justify the impact; consequently, descriptions of the actual practices were restricted.

It appeared that the participants' beliefs related to race influenced or impacted some of their teaching practices. For example, they shared their beliefs related to manifestations of the racism in education, such as the white-black science achievement gap, color-blindness, tolerance, and racist teachers. Additionally, they shared how these beliefs may have influenced them to implement various teaching practices and ideologies into their science methods courses.

Science Achievement Gap. First, the belief about the disparity between white and black science achievement, appeared to manifest similarly across the participants. Each shared their thoughts about why it existed, how it could be lessened, and described factors they believed deepen the gap, such as teachers not understanding some of the possible instructional needs of black children, poor science instruction in elementary and low performing schools, lack of black role models in science, the role of universities, and access to supplementary science experiences outside of the classroom. For example, Dr. Daly shared that she believes that the abstract nature of science, economic impoverishment, and the lack of black role models in science has greatly influenced the science achievement gap between black and white students, which she reported motivated her to incorporate under-represented scientists in one of her students' lesson plan assignments.

I think Oat's explanations for the white-black achievement gap is connected to the white black science achievement gap. Oats does talk about those factors that I

think really contribute to it. What comes to mind for me is what can we do about it. I don't have any doubt that it exists. I think the science gap is probably related to economic disadvantage, which in turn is related to an intellectual impoverishment within the family. Science is so conceptually complex, and so if your family members who don't have the where-with-all or background to provide rich experiences to encourage kids in science, it just doesn't happen. And everybody can do math just a little bit. Social studies is accessible in terms of, its pretty much reading history and maybe figuring out what it means. However, science is so conceptually difficult. For example, describing the reasons for the seasons and phases of the moon...those things are conceptually difficult and often times the only place that black kids can get science is in schools, and elementary teachers don't do a great job of teaching science. So what the teachers can't provide, the parents can't provide, and there's not a lot of known role models even though there are a lot of black role models in science. That's a reason why I do another assignment where my students have to incorporate an underrepresented scientist into their unit. They look up, write, and use that underrepresented scientist's story in their unit and so they have to plan how they're going to tell their students or have their students learn about the scientist. I don't think there's enough stories where students see themselves. They can say oh that person is like me, they're a scientist, and I can be a scientist too. So I don't think there's enough of that going on but I think at the core the issue is impoverishment and the schools don't do a good job. But in the rare suburb and in upper class schools where teachers that don't do a good job in teaching science, parents are able to supplement. For example, these parents are generally well-educated, they take their children to museums, they watch the discovery channel, talk about it together, that kind of thing and I think it's a vicious system that does not support a student's achievement.... (Dr. Daly)

Similar to Dr. Daly, Dr. Williams noted the science achievement gap existed because there is little to no early attainment of interest during the formative years within the context of the black family or in elementary schools. Dr. Williams contended that this too was his experience.

I think it's an issue of early attainment. A lot of African American students are not offered the resources to like science, such as science camps. Opportunities to you know, do science things when they're smaller. And so when you look at that early attainment...its just the resources that white students are provided, the lack of having parents and other family members interested in the science field. I'll give you my personal testament. There was no one in my family affiliated with science until my cousin graduated with a degree in mechanical engineering. So that was the first relative that I had in a STEM field. And so, although I grew up appreciating education, I gravitated more towards math. Like I said, when I went to college, I didn't major in a science but I majored in English and minored in biology because while I did somewhat enjoy science and mathematics I think not

having early exposure, you know being affiliated with individuals in the field at an early age, affected me. (Dr. Daly)

Additionally, Dr. Williams shared that as a result of the white-black achievement gap, teachers need to better understand the learning needs of black children and the dynamics of the black family. Accordingly, he suggested teacher education programs must become more competent in preparing preservice teachers to address these diversity issues, and as a result of this belief he reported that he incorporates instructional modifications to help his teachers change the science achievement gap narrative, such as highlighting the contributions of black scientists in early elementary grades, so that black students can perhaps visualize themselves in those STEM roles. For example, Dr. Williams said,

Also, I know one of the biggest assumptions a lot of white preservice teachers make of black students is that they are all are poor and that they all come from impoverished backgrounds and that's not the case. You really have to emphasize in any preservice teacher program that there's a need for diversity training and understanding diversity, whether you're black or white. Now when you have a situation where you have white students who have never been around you know black individuals and they have to teach black students, I think it's important that they understand the various culture, some of the you know the understandings of, for lack of a better word, you know you just have to know people and you just have to understand the family structure and I think that was probably the biggest misunderstanding a lot of, when I was a K-12 teacher, a lot of white teachers were misunderstanding the black family structure...So, what I do is I make sure my preservice teachers emphasize and highlight in their instruction, especially at the elementary, African American scientists. So, I encourage my students to highlight those scientists of color who have been successful in the STEM field. So, often times when students see that someone like them is doing science, then their more apt to explore how they can do science...You have to do that as early as elementary school. (Dr. Williams)

Dr. Jackson shared a triangulated belief about the existence of the white-black achievement gap. First, she contended this disparity in science achievement was a result of students in low performing schools, which are most often schools with high black and Hispanic student populations, who do not have access to equitable resources in K-12

settings, such as not having quality teachers and science supplies. Secondly, she indicated these students do not have access to high quality instruction, such as hands-on inquiry experiences and encouragement into advanced STEM courses or career fields. Lastly, she indicated that colleges and universities that “weed” out prospective STEM students if they do not possess all of the prerequisite dispositions for higher education study, also influenced the white-black science achievement gap. Dr. Jackson said,

I think part of it goes back to how students are taught and ultimately the goal of instruction. I think that too many students are taught to pass the test, and they're not taught about the beauty of science or the joy in understanding something that is hard or exploring and coming up with an answer on their own. I think that we don't always give the neediest students the best teachers, and I think often times they don't have the best experiences with science and I think that's one thing. Also, I've been at a lot of schools that just don't have the resources to do hands-on science... everything is taught from a textbook or united streaming ... that's all they get ... so I think part of it is instruction and the quality of instruction their getting and the lack of encouragement to continue with science. I also think tracking is a huge problem. If we want students to go into science we have to put them all on the track to go to college... we just do... we need to encourage them to do science and math classes, but instead I think we take the easy way out and we put a lot of students in the “lets just get a standard diploma and you don't have to do all those hard courses.” So, I think that's part of it. Ok, I also think part of the problem is not just K-12, but it's the colleges... I think the way students who come to college who might be interested in science... the introductory science courses are all weed out courses... so I think we don't do enough to help students who don't know how to study regardless of where they come from or what kind of schools they went through ... I don't think we do enough ... I think the mentality in the sciences is to always weed people out, and we tend to weed out certain kinds of folks. I don't think that's right, but I don't know how you get past that mentality in the sciences. I think the college folks are in particular need to be much more encouraging of under represented students and embrace them and find ways to help them through the early courses because I know most of them early courses you have to get through them to get to the good stuff and I don't think they ever get to the good stuff. (Dr. Jackson)

Thus, she said “tracking is a huge problem,” which she believed prevented black students from participating in advanced or rigorous science courses because they are funneled into lower level science courses. Ladson-Billings (2000) would propose that many black

students are tracked into lower level science courses, which ultimately limits their participation in college because some K-12 teachers do not have high expectations for these African American students. Interestingly enough, Dr. Jackson also described an additional factor that all of the other participants mentioned, the lack of black role models in science curriculum. However, the genesis of her belief that contributions by scientists of color are largely ignored in science education and the science community in general materialized in somewhat of a different way as compared to the other participants.

Specifically, Dr. Jackson said,

My advisor for my master's thesis was African American, and he had a strong interest in the history and philosophy of science. So, I wrote two chapters in a book he published about black scientists and inventors...and when he asked me to write a chapter I thought, oh, this was going to be a piece of cake...well I hadn't even heard of the people he assigned me to write about...never...never...never heard of them. The book was called...So I wrote a chapter on Charles Turner, who is an entomologist and one on Elijah McCoy. But if you ask any of my students about black scientists, the only person they ever hear about is George Washington Carver....they never hear of Lewis Latimer, Daniel Williams, Granville Woods ...or even Shirley Jackson. So, I feel like it is important for kids to hear about people who made important discoveries ...and that they are not all white and they are not all men. So, I do model lessons in class...I pick diverse people specifically so we can talk about how teachers should talk about them and their struggles and their contributions... It's funny because I taught this summer and at the end of it I had students who said, "You know you read an awful lot of black books." I kind of looked at them and said, "really!?" And I said that was intentional because it is really easy for you to find resources on George Washington Carver...but if I want kids to learn about Lewis Latimer...who is really important...because we spend a lot of time on Edison, but we should be talking about Latimer ...and where Edison would never have been without him and his work. There just aren't kids books on these other people. So, I think it is important that if you are teaching African American kids that you make sure they see themselves reflected in the curriculum. And um...its relatively easy to do in science if you take the time to think about it, but you have to address science and the history of science. So for example, Bill Nye, as smart and as interesting as he is, he is not the only role model for who a scientist is and what a scientist should be. And I think the job of the teacher is to show kids that every person that works hard can be a scientist and to do that you have to show them a lot of different examples. So, when I'm thinking about how I should teach in my science methods courses, I think back about the kids in my classes when I taught

in [K-12]...my fifth, sixth and seventh graders, who when you'd ask them what they wanted to be when they grew up, nobody ever said a scientist. Would that have been the same if I'd been in a class with mostly white students? I don't know. I think it's really important we know that we have a huge shortage of minorities in the sciences and stem fields in general. I think it plays a role in the science achievement gap and the shortage of African Americans pursuing careers in STEM because I think we have to encourage kids to think about science as a viable option for them as a career and they should understand it's impact on them. So, it starts with showing kids role models. (Dr. Jackson)

Dr. Jackson shared her beliefs about how the lack of black role models in science

impacted the white-black achievement gap and the lack of blacks in STEM careers.

Therefore, it is possible to also suggest that this idea of changing the way students think about scientists, which was shaped by the influence from her college advisor and her research about black scientists, may have later motivated her to use what she previously described as the "draw a scientist" activity, where students are confronted with the stereotypes of what a scientist looks like.

Colorblindness. A second belief the participants shared was related to colorblindness, which many of them said contributed to a false idea of tolerance. The idea of colorblindness first surfaced on the qualitative survey, and while many of the interview participants' rejected it, they shared somewhat varied or unclear responses. However, during the interviews, the participants more thoroughly expounded on their beliefs. For example, Dr. Daly shared colorblindness was a myth and her rejection of colorblindness has not changed since what she noted on the survey. She shared that colorblindness negates what is special and unique in each person. In addition, within the context of the interview, she seemed to denounce the idea of "tolerance" as a goal, wherein she initially supported it on the survey. Thus, it appears Dr. Daly more

comprehensively explained that educators and people in general should go beyond tolerance. For example, she said,

I think colorblindness doesn't exist. I said in my survey it doesn't exist also...Two reasons...first the biases that everyone brings is from their own cultures...everybody's got them...everyone. So, it comes from otherness....you trust things that are similar and distrust things that are different. Every human being needs to work on that. But secondly, there is a lack of appreciation for who people are if you insist that you are colorblind. You are ignoring the special-ness of each human being...whatever their color. You're special for who you are and your skin color is a part of that...I'm special for who I am and my skin color is a part of that too. But to say, "Oh, I'm colorblind..." that says I'm not going to pay attention to that part of you that is special...that's part of your special-ness. So, I think better understanding the false sense colorblindness and tolerance within diversity training has to be worked on...it's not just "I don't want to be biased" but we need to also start to think, "hey, this is really cool...its really cool to have all these differences in ideas and differences in the way people look and act and what they like. It's neat and cool and rich. And that's why I don't want to be colorblind. And I'm not trying to be colorblind, and I don't think I'm colorblind. (Dr. Daly)

Next, Dr. Jackson described her belief regarding colorblindness, but during the interview indicated she could not remember what she said on the survey. On the survey she indicated that she did not subscribe to idea of colorblindness, and her responses during the interview seemed to compliment her earlier reported beliefs. What interesting however, is that when asked to describe her own ethnicity, she was the only participant who indicated that she did not think she had one. Moreover, much like Dr. Daly, Dr. Jackson situated her beliefs about colorblindness with tolerance, which she curiously supported on the survey yes-no questions. So, now given more room and space to expound on her beliefs, Dr. Jackson more clearly shared her thoughts on colorblindness and tolerance, which she said influences her use of candid class and individual discussions about fostering acceptance in classrooms.

I don't think teachers can be color blind I think that they have to work hard to make sure that everyone is treated fairly and equitably. But to do that you have to recognize that kids are different and they may not all be treated the same. And I hate the word tolerance because in part it means that we have to just put up with things...and we are just accepting the status quo ...I don't think we should be teaching tolerance...we should be teaching acceptance. I guess I literally always think about teaching tolerance.org, out of the Southern Poverty Law Center...and I appreciate what they are trying to do but I think they misspoke the word, tolerance, when it should be, "acceptance." We are a very diverse group of people... We have to respect others...we have to accept others, whether we agree with them or not. I sort of see tolerance as a sneering. Its like saying, 'okay you can work with us, but I really don't want you to.' So, I really don't like the words, "tolerant or colorblind (Dr. Jackson)

Next, Dr. Williams revealed a belief contrary to the other participants. During the interviews, Dr. Thomas seemed to support his beliefs from the qualitative survey, in which he reported, "Yes" to the statements about colorblindness and tolerance. So, in the event Dr. Williams misinterpreted the ideas of colorblindness and tolerance as the gold standard, which Nieto (2010) says often happens, he was given the opportunity to clarify his position. However, during the interview he reported that he continued to embrace a "colorblind" approach. Peculiarly this curious colorblind position seems counterintuitive to his position about the best approaches to training teachers. Thus, it appeared that his explanation for colorblindness is possibly a misinterpretation of the term because his reported beliefs and experiences related to race, such as his beliefs about the white-black achievement gap and how teacher education programs ought to prepare preservice teachers to address diversity in K-12 classrooms appear to be diametrically opposed to the idea of colorblindness. For example, Dr. Williams said,

As I mentioned, when I train students, I tell them you have to put these blinders on and when any student walks through your door your end goal in mind should be student achievement. Your approach to education should be a colorblind approach and it should be to the point where race, color, creed, none of that matters. You're there to teach and you're there to make the educational

experience better for that student. I've always been that way and I'll always teach that way. You have to approach education that way. (Dr. Williams)

The world is not all white and the world is not all black and more than likely a white teacher is going to come across black students and a black teacher is going to come across white students and you know black on black, white on white but at the same time you have to address diversity training and how to you know address the needs of a specific children. I know one of the biggest assumptions a lot of white preservice teachers make of black students is that they all are poor and that they all come from impoverished backgrounds and that's not the case. And so you know in training teachers, any teacher, it's important that they understand, that they pay attention to student backgrounds, especially at the elementary level. They look at student cumulative folders, they meet with parents, they get a sense of the parents, in terms of their position on the importance of education. And from that, you address them with those issues but I think it doesn't matter what color you are, you really have to emphasize in any preservice teacher program that there's a need for diversity training and understanding diversity, whether you're black or white. (Dr. Williams)

So, the first statement seemed to embrace colorblindness and suggest skin color does not matter, but the second statement appeared to reject the idea of teachers ignoring the color of his or her students. These two contradictory quotes about colorblindness give the impression that on one hand Dr. Williams is not familiar with Nieto's (1994) ideas of tolerance and colorblindness, but on the other hand, his earlier explanations for how preservice teachers must be trained to recognize the learning and cultural needs of African American students, whereby white teachers do not assume all black children come from poverty suggested that Dr. Williams did not subscribe to the Nieto's monocultural philosophy of schooling and education.

Lastly, Ms. Alleyne substantiated her claim from the survey that she is adamantly against the idea of colorblindness, which seemed to correspond with her description of her sociopolitical upbringing and awareness of her "blackness." Interestingly, her response about colorblindness during the interview appeared to be about making her

white students more comfortable with her blackness, so that she could deposit a sociocultural awareness of black students and other students of color. So, she realized that to connect with her students, who were drastically different from her, she had to forge relationships with them, which Ladson-Billings (1995a) suggests is just good teaching. For example, Ms. Alleyne said,

I said, "No, I am not colorblind" on the survey because of where I work. I mean, we have diversity at my university but not a whole lot. So, the majority of my students are white. I think that if I would've come to my university with my extreme sociopolitical mindset from my past, like everything has to be pro-black, pro-black, pro-black, I would not have connected with my students. As I've been saying, as an educator, relationships are just everything to me. So, I had to find a way to connect with my white students because that's the majority of who I teach. On the other hand, there was an article that I read in graduate school called, "The Burden of Acting White" by Ogbu. So, I incorporated that article last year into my classroom to expose my white preservice students to some of the things they may see with black students when they go into middle and high schools. But in doing that, I wanted my students to see all colors, and I don't want my students to think, "Oh this lady only sees her own color, which I know would make them feel uncomfortable. So, I included other articles, like "The Burden of Not Acting White or Black" from the Asian and Latin perspectives. I hope it opened up their eyes. That was the goal of that lesson. (Ms. Alleyne)

When Ms. Alleyne spoke about colorblindness and her use of the acting white article series, she provided an example of how she exposes her students to the social constraints black students face in America and strategies, such as code switching that African American students may use to experience academic or other successes in society. She reported that white and black teachers must see everything about all students, including their color to make a connection with them.

...My favorite poem that I share with my students is by Paul Laurence Dunbar, "We Wear The Mask." It reads, "We wear the mask that grins and lies, it hides our cheeks and shades our eyes..." So, we read that and they're like, "Ooh that's nice," but I share with them that they are not thinking about the poem like I as a black person is thinking about it." So, using this poem, I teach them how some

black folks code switch, and for some reason they think that's hilarious. And I said, "We literally have to wear masks in the real world." A black person goes home and you act this way, but when you're in the real world, you have to turn on a whole different personae. When you're educating students who don't look like you, you have got to find a way to connect with them...you've got to find something to make a connection. And I tell my preservice students it's going take you to be a proponent for your kids and you have to take the initiative because it's not going to be your SOL objective that gets their attention. It won't be in your textbooks. It won't be in any of your professional development. But if you're true about teaching children, not black, not white, not purple, not green, but children, you're going to find something about each one of those babies in your class to make a connection with them to get them to the next level. So, seeing color goes both ways. That's for everybody. Because hey, you may be black and you might teach at an all white school and then it's flipped. Or you might go to Texas and now your student population is Mexican or something. You know, so that goes for everybody, not just black. (Ms. Alleyne)

Confronting racism. The last belief that the participants' shared dealt with racism and how they would handle a fictitious scenario. The scenario was about one of the participants' preservice teachers returning to seek advice about a K-12 student in their class calling him or her racist. Each participant was read the exact same scenario, verbatim. The behavioral scenario, which was intended to elicit information about the participants' beliefs about racism and how to deal with it in schools, yielded interesting results. Specifically, two of the responses appear to be completely divergent, almost to the point as though the participants were sitting in the same room and saying the exact opposite of the other. Also, when confronted with this scenario, Dr. Jackson and Dr. Daly both shared that this scenario had indeed happened to them before; however, Dr. Williams and Ms. Alleyne did not indicate this has happened before. Interestingly though,, Dr. Jackson and Dr. Daly, had two very different perspectives on when their students have been called a racist in a K-12 classroom.

First, Dr. Daly suggested that K-12 students of color might call her students racist because the K-12 students are resisting or challenging the preservice teacher's authority. It appears that Dr. Daly somewhat denied the likelihood that the racist accusation could have been substantiated. So, in reaction to the racist scenario, Dr. Daly said,

We actually talk about that in my methods classes. Because it's probably going to happen. It has happened. It happens because it's a strategy...white teachers are an easy target for black kids and race is an easy focus. Usually every teacher at some point has to exert authority and kids are going to see how far they can push a teacher. They just do that. So, one day you can have a great relationship with them and then the next day their hormones fly in a different direction. So it's, it's going to happen, now I'm not saying it happens with every teacher, there are some teachers that have a neutralizing kind of personality. But I've had it happen enough with my students in their field experiences that we talk about it in our methods class. And it's a cultural bump experience. And that's how we deal with it. I mean it may not come out in the assignment but it, it's an experience where they tell us what happened and I say to the class, what do you think she should do? What's going on? And usually we get some of the story, you know what was going on in class when this happened? What did you say? What could you say? And the students themselves generate solutions. There's no simple solution. It's contextual and it comes from what went on in the class. But sometimes it's just a matter of the teacher taking the student aside and assuring the student that they care about them, they want the best for them, that they value them and they want them to succeed in their class...So its usually a behavior thing, where they, you know the students are talking or something and the teachers says you need to stop talking and get to work. And then the students attacks the teacher with a racist accusation. Its, a way to criticize the teacher back. The response from the teacher should be... you know, I do this for you. I want you to have a choice in life. I want you to use your education so that you can have choice. And we talk through some of those things that you could say to kids...that's really not about you trying to assert authority just for the sake of authority. It's not about you wanting to control them just to control them. It's about wanting what's best for them. So that's one of the things that usually comes out of the student conversation. I try not to give students [pat] answers for difficult questions because they're usually really fallacious shaky answers if I do that.

(Dr. Daly)

Dr. Daly's intriguing response to the racist scenario seemed to contradict her own personal experience she shared when she made a racially insensitive remark to one of her students that could have resulted in her own K-12 students calling her a racist.

Furthermore, she previously admitted that she may hold “inadvertent” residue from her past, such as her racist upbringing to which she said she can not fully escape. So it seemed unclear as to why Dr. Daly would only offer this alternative explanation to the scenario without at least discussing how she would handle the possibility of her preservice students being racist, when she herself admitted to it when she said,

I was substitute teaching in Louisa County, and I remember one of the students in the back of the class had her head down and she was sleeping. So, I said something really unfortunate. And I remember really apologizing to her for it. She sat up and she didn't understand what was going on. She was completely lost and was not able to do the assignment and I said something about the shine on her face because she'd been sleeping and had gotten that little sheen on her face from sleeping and after I made the comment, I had realized that it was inadvertently a reference to her skin color. She took offense and other persons in the class took offense. And I immediately knew, oh my goodness I have said something stupid. And I apologized to her right then, but what it said to me was, remember I said, I still got some racist in me and I know I do, that I carry things with me that I can't escape and I know that I need to recognize them and figure out what I am going to do with them. But that was an introduction for me of the persona that I needed to have in the classroom. So the persona that I took on was that everybody has good intentions, everybody has capabilities and I am going to look at you expecting you to do good and want to do work and if you do otherwise I will address that but I am going to have high expectations and not assume that somebody has a negative quality to them. In a classroom you say things because you feel like you need to control behavior. And I am not sure that even today I would be absolutely, spotlessly non-racist. I am not sure that something wouldn't come out. I have this childhood where it was N-word this and N-word that. It's just really hard to completely forget all of that. (Dr. Daly)

On the hand, Dr. Jackson indicated that she felt no student would blatantly accuse a teacher of being racist if there was not some underlying reason. So, in reaction to the racist scenario, Dr. Jackson reported she would use a direct line of questioning that may help a preservice teacher critique his or her actions. For example, Dr. Jackson said,

Well this has happened before in the last couple of years. I would say maybe two or three times. It's always with my students who are in the middle or high

schools...it's never happened in the elementary school. And the first thing I say is, "are you?" And they say, "no." And I say, "Well, everybody is so you have to get past that." And then I ask them, "What happened that would make them say that? So, they share the circumstances of the incident. And I try to deconstruct from the perspective of the students and then I always ask them, "What are you doing in class and who are you calling on and where are the students sitting?" And sometimes I sort of have them map out the classroom and talk about those kinds of things. I ask, "Are you ignoring certain students; are you treating groups of students differently?" But I think its really important to try understand where the comment from the student comes from because I don't think a student would just say that without reason and I think we have to try understand and value the perspective of others even if we don't agree because that's the way they're perceiving things ... so we have to recognize that they're feeling whatever it is...and we have to figure that out in some way. I think that even that if a student was spouting off at a teacher...that underneath all that bravado...I have to believe in my heart that if someone makes that claim...it means that something has happened...for example, a teacher may have turned a blind eye to something...the teacher has favored a group of students over another...or treated a particular student or group of students badly...even if the teacher doesn't recognize it. I honestly don't think a student would just throw that out there. If they did, there was grain of truth to it, somewhere. (Dr. Jackson)

So, when Dr. Jackson's response is compared to Dr. Daly's response to the racist scenario, it appeared that the two responses were very different because on one side, it seemed Dr. Daly offered an alternative explanation for the racist accusation without considering the possibility that racism was a factor; and on the other hand, Dr. Jackson appeared to address the possibility of the accusation by directly asking, "Well are you?" The direct questions Dr. Jackson suggested she would or has used in the past to help her preservice teacher deconstruct a racist accusation seemed to illustrate what Oats (2009) says are factors teachers' ought to consider when delivering instruction. For example, Oats suggests that it is the biased treatment African American students' face in schools and classrooms that deteriorate the quality of their education and deepen the white-black achievement gap. Thus, Dr. Jackson reported she would help a teacher critique some of their instructional practices that could unknowingly appear biased to someone, such as

only calling on certain students, “mapping” out the seating arrangement of the classroom, or the perception of “treating groups” of kids differently. In addition to Dr. Jackson’s explanation of how she would address a potentially racist teacher, she also demonstrated reflection about her beliefs about racism. Consequently, Dr. Jackson reported that as a result of the interview process, which may suggest that her involvement in the study made somewhat of an impact on her thinking, Dr. Jackson sent an email indicating she had rethought her ideas about racism. For example, Dr. Jackson said,

I was up most of the night thinking about our conversation. I just wanted to extend my thanks to you for your time and for including me in your study. When I was walking home I thought about the definition for racism I gave you and realized that I think racism is more than just actions, but also it is a thought. (Dr. Jackson)

Dr. Jackson also indicated that the study allowed her to take the time to conduct self-examinations, which Ladson-Billings (2000, 2006) suggests educators should do on a regular basis to examine personal bias and strengthen our sociocultural awareness of our impact on society. For example, Dr. Jackson reported,

... I’m kind of sad it’s over...its been so nice talking with you over all these different times and months...its been a good self-examination...I don’t often get asked to think about my own practice anymore....beyond what I force myself to do...so its good to have to think differently ...I’m appreciative of the opportunity...so thank you! (Dr. Jackson)

Next, Ms. Alleyne and Dr. Williams shared their beliefs about racism and the scenario and their comments seemed to reflect earlier comments made about black students. Interestingly, Dr. Williams provided two responses in terms of an administrator’s point of view on two separate occasions. The researcher was unsure how to interpret his first response, so it was asked a second time during another interview

session to hopefully more clearly and accurately capture his perspective. The first time he was presented the racist scenario, Dr. Williams reported,

First thing I would say, that's a sensitive topic so I would say, make sure you go back to your principal and inform your principal that your students have been saying this. Because, one of the things you need to anticipate is that these students are probably going home telling their parents this, and so now you may have parents coming in and so going to the principal...well that's protecting the principal so he or she is not blindsided. Also, be willing to talk to the students. Ask them why are you saying that? What is it about me that's making you say that? And then from that you probably want to start dispelling some things. (Dr. Williams)

The second time Dr. Williams was presented the racist scenario, he responded again from an administrators' perspective, but this time suggested he would ask meaningful questions to help his student understand his or her biases. Furthermore, he situated his answer within the context of his definition of racism, which appeared to provide the researcher a better understanding of his beliefs regarding racism in schools. Specifically, Dr. Williams said,

First I'll ask for the facts. You know, what and how did the students say it? I'll probably have to get in administrative mode. You know, what exactly did the students say and I would ask them to write a statement. What led up to that? Just to have on file you know, but also- and I would ask you know, him or her, what do you think led up to that and I would also ask- tell me about the experiences in your class. What are you exposing students to? Because more than likely, if I was an administrator, I would definitely interview the students just to see you know, what's going on? What would cause the student to make such an impactful statement...to call somebody a racist? But I'll ask definitely why do you think the students said that? What was it that led up to that very point? Okay. What did you say? And so, once finding that out, I'll say well, you have to understand that you know, many of your students probably have never you know, been in contact with a white person and you have to be mindful of how you approach your students and so... and you know, you can't assume that every child, two things you can't assume- you can't always assume, like I said before that, all black students come from impoverished backgrounds so you can't say things like negative, derogative things because some students aren't exposed to that. (Dr. Williams)

Dr. William's second response to the scenario appeared to be more commensurate with his beliefs about racism, in which he said,

Typically growing up when I heard the term racist it dealt more with a power structure. It seemed that those who were racist were in a position of power, so they would hinder others races. Those with no power don't have the capability to be racist because they lack a certain level of influence. So, race still matters you know, we still live in a society that's probably more racist than ever. I hate to bring in politics but you know with the current president, man it's pretty evident that we live in a racist society. And so, being aware of that, and I tell my students you never know where you're going to be teaching. You may come across that in so many different contexts. It's your job, despite where this child is coming from, to teach. And if you approach it that way and you'll be fine. Because racism is taught. It's not something that is genetic. It's taught, that just my opinion. And so in education, I think embracing different cultures and races is definitely important. (Dr. Williams)

Unlike Dr. Jackson's reaction to the scenario where she was preparing her students to face the possibility they were racist, Dr. Williams seemed to be preparing his mostly black students for facing the realities of racism within the larger institution of education, which Ladson-Billings (2000) says often prevents many African Americans from entering the teaching profession and teacher education.

Much like Dr. Williams and Dr. Jackson, Ms. Alleyne approached the scenario by engaging in a series of reflective questions to help the preservice teacher understand perhaps what could have happened to cause a student to accuse him or her of being racist. However, she also used herself as an example to show that black teachers are not immune from this experience. Furthermore, Ms. Alleyne's response to the scenario aligns directly with the beliefs she shared about racism and talking about race in the classroom.

I would tell them to step back and take a self-reflection and say to your self why did this student call you a racist? Can you think of any instances that may have been misconstrued by your students as being racist.... Or could have offended your student. And you may have said something and you honestly had no malice intended....but someone else, maybe a person of color may have been offended. So, first I would ask the teacher to do a self-reflection. Can you really think of a situation that you may have come across as racist. Because sometimes people really don't know what they don't know and then um with that student...I wouldn't dare do it...I wouldn't have the teacher meet with their student one on one, but maybe I would suggest that the teacher seek out a department chair or

assistant principal or someone else that may have observed them, who can give them open and honest feedback. And honestly ask the tough questions...so for example, I had a black student tell me when I was teaching high school that I was a racist. So I took the comment seriously and went to a black colleague and asked, "Do you see that in me? Honestly from colleague to colleague, from professional to professional, do you honestly see that in me?" So, hopefully that teacher will go to someone who is capable of giving objective and accurate feedback. But first I would tell that new teacher to do some self-reflection. (Ms. Alleyne)

Ms. Alleyne's beliefs about racism in schools appeared to impact the conversations she reported in her science methods courses. Admittedly, her explanation about the academic and social characteristics of white and black students rests on the subjective perspective she gained working with mostly black students in a K-12 setting. For example, Ms. Alleyne said,

And so, we have the conversation about race and I always tell my preservice teachers - and this isn't research, this is just based on me and my experiences. I tell them white kids work for grades; black kids work for relationships. If you can remember that when you go into that classroom, that's going to help you. White students, I've learned, they could care less if they think you as the teacher like them. They know they are expected to get the grade. They could like you, hate you, you would never know. Some of them are indifferent. They do their work to get their grade to pass the class and move on to the next class. Black kids, on the other hand, could be as smart as Einstein or George Washington Carver, but if I pissed them off one day, I mean, you can just say anything to set them off, and they will tell you, "Well I'm not doing your work today" or "Whatever I'm not turning this in" and they shut down. But they didn't realize they were not hurting me; instead they were hurting themselves. Kids who may not perform as well as others, when they love you and they know you love them, it's like, they just try their best to do whatever to please you. You know, these are the kids that don't do homework for Ms. Jones' class down the hall, but they come to my class and excited to do their homework. Yeah, because we have that relationship. When it's positive, African-American kids - and not all, but a lot of them in my experiences - when they know you genuinely care about them and their futures, they do whatever they can to rise to your expectations of them which they may not get in another classes or even at home. You know, we put racism into like that big category and it oftentimes isn't that. So you can't be pissed off or hate people who are racist. I just believe people are racist because they don't know what they don't know. Sometimes they just don't care to know. Or if you look in the media and all

you see is buffoonery and all these reality shows where people are acting like minstrels and that's your perception because that's all you know, then that's all you know and that's how you perceive a certain class or a certain race of people. And that doesn't take away from you, or your character, or your morals but if those are your experiences, oftentimes racism sometimes only builds upon our past experiences and our perceptions. (Ms. Alleyne)

Summary. The participants' reported early racially-laced experiences that impacted the participants' beliefs about race. Secondly, their reported beliefs regarding the white-black science achievement gap, colorblindness, tolerance, and racist teachers, appeared commensurate with what Oats (2009) suggests about the white-black achievement gap in general. Specifically, Oats asserts that what happens to children when they get to school as opposed to the intellectual or cultural capital they may or may not bring to school plays a larger role in the white-black achievement gap. Accordingly, Oats says inequitable treatment from schooling experiences for black students', such as having poorly trained and biased teachers, inadequate classroom resources, and a culture that expects failure, is more of a explanation for the white-black achievement gap as opposed to other factors, such as parental involvement. However, while the participants' openly shared what Oats (2009) would assert are legitimate reasons for the white-black science achievement gap, based on the comments during the interviews, the participants' only suggested activities that advanced an awareness of racial otherness. However, no one suggested any specific instructional interventions with which to lessen the white-black science achievement gap, which may suggest that while race matters in science achievement, there is no clear path to move from theory into improved practices. Furthermore, these previously described early experiences related to race and beliefs in

the manifestations of racism work builds the structural theme that racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.

Summary of Part 2

The analysis of part two of the study included an inductive examination of 12 semi-structured interviews. The major structural themes concluded from the interviews were

- There is a struggle to understand and implement CRP in science teaching,
- Modeling conventional science teaching strategies and ideologies are preferred for preservice teachers to engage all learners as opposed to identifying specific learning needs of African American students, and
- Racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.

To conclude, Chapter 4 reported the qualitative findings of part one and part two of the study, using Moustakas' (1994) strategy for phenomenological data analysis. Each research question was explored in both parts of the study. Moreover, the findings were synthesized using Ladson-Billings' (2000) ideas of CRP, characteristics necessary for teaching African American students, and ideas about race. The analysis revealed both three structural themes for the qualitative survey and three structural themes for the interviews. In the following chapter, the findings will be discussed and implications for science education for various stakeholders will also be discussed. Finally, recommendations for future research are presented.

CHAPTER 5

DISCUSSION

This chapter concludes this investigation. What follows is a general overview of the study, which includes a discussion of the research problem, the purpose, the

methodology, and the overall findings. Next a detailed discussion of the findings noted from Chapter 4 are examined using, Delpit's (1988) and others' (Delgado & Stefaniec, 2012; Fordham & Ogbu, 1986; Ladson-Billings, 2000; Mutegi, 2011, 2013) critical interpretations about how to engage black and other children of color. Following the discussion of the findings, further significance and implications of the study for K-12 teachers, teacher educators, and policy makers are explored for teacher education with an emphasis on science teacher education. Implications for educational researchers are addressed within the context of directions for future study. Finally, the chapter concludes with an examination of the study's limitations and a final statement by the researcher.

Overview of the Study

The science education community reports teaching in culturally affirming ways is an important part in addressing the K-12 science achievement gap between African American students and their Caucasian/European American counterparts (American Association for the Advancement of Science, 1989, 1993; Lee & Buxton, 2010, 2013; National Science Teachers Association, 2013; Rodriguez, 1998;). However, it remains unknown *how* science teacher educators, many of whom reflect the dominant culture, achieve this (Milner, 2010). Therefore, a phenomenological single exploratory case study design (Yin, 2009) using a critical theory perspective (Kincheloe & McLaren, 1994) was used to examine the beliefs and practices of science teacher educators in an effort to learn how they prepare future K-12 science teachers to engage African American students in science, who Mutegi (2011) and others (Johnson, 2011; Wallace and Brand, 2012) say are the most marginalized or oppressed by science and in science education.

Given that the science education community reports teaching in culturally affirming ways is an important part in addressing the K-12 science achievement gap, the purpose of this study was to examine the beliefs and practices of science teacher educators in an effort to learn how they prepare future K-12 science teachers to engage African American students in science. Therefore, the research questions that guided this inquiry into the lived experiences of science teacher educators were:

1. In what ways do science teacher educators describe CRP principles?
2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science?
3. How do science teacher educators describe their personal experiences related to race that have impacted their teaching beliefs and practices.

To answer these research questions, the researcher used a qualitative design to more thoroughly examine science teacher educators' beliefs, experiences, and teaching practices in a mid-Atlantic state within the United States of America. This area of the country was selected because this state represented the various geographic, cultural, and racial demographics that is also represented across the nation. A single exploratory case study was the chosen method for this investigation because to the researcher's knowledge there have not been many studies related to teacher educators in science. Yin (2009) says one of the rationales for a single case design is when the objective of the study is to "capture the circumstances and conditions of an everyday or commonplace situation" (p. 48). Therefore, since the objective of this current study was to examine the experiences that shaped science teacher educators' beliefs and teaching practices, the single case study design was appropriate. In addition, Yin (2009) suggests the single case study

design is also appropriate when “the investigator has an opportunity to observe and analyze a phenomenon previously inaccessible” (p. 48). Therefore, because science teacher educators’ beliefs and teaching practices have been virtually absent in the literature, conducting an exploratory single case study design was the best methodological approach to discovering information about this community of educators. Figure 1 described the integration of the theoretical and methodological framework.

Figure 1. Theoretical and Methodological Framework

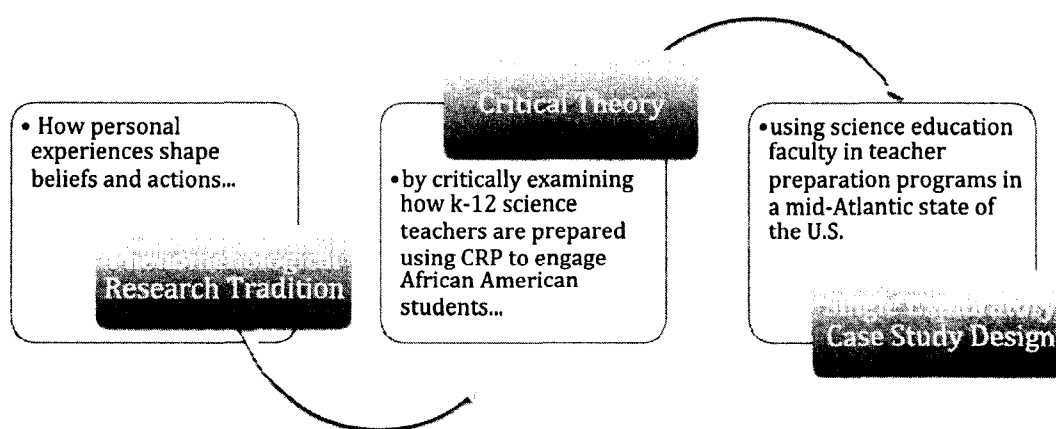


Figure 1. Shows how the research tradition informed the theoretical perspective and design framework.

Overview of the methodology and findings. The investigation contained two parts. In the first part, 56 science teacher educators from a mid-Atlantic region of the US were invited to respond to a short on-line qualitative survey. Subsequently, 11 science teacher educators’ completed the survey. The survey contained a demographic protocol, 11 open-ended questions about teaching, beliefs, and experiences, as well as seven yes-or-no questions about teaching in culturally affirming ways. This survey was used to gain access to the participant pool, to preliminarily examine the beliefs, experiences, and teaching practices, and to ascertain possible candidates for part two of the study. To be

selected for part two of the study, the survey respondents had to self-identify as either white or black on the demographic protocol and demonstrate an affinity toward teaching in culturally affirming ways. To meet the commitment toward teaching in culturally affirming ways requirement, the respondents had to earn a score between five and seven on various yes-or-no questions from the survey. There were seven yes-no questions and they were constructed using Nieto's (1994) ideas of multiculturalism. Consequently, four respondents met the requirements to be funneled into part two of the study.

In part two of the investigation, the four selected from part one, participated in three separate interviews each. The first interview addressed their background experiences and some initial beliefs related to race. In the second interview, the participants' discussed their overall teaching practices and knowledge about culturally relevant teaching. During interview two the participants demonstrated an unclear understanding of CRP and how it could be implemented into science teaching; therefore, after they communicated their misunderstanding about CRP, the researcher attempted to remedy this misunderstanding in an effort to highlight the use of CRP as a possible strategy to lessen the white-black science achievement gap. As a result, the researcher provided a short clarification about the difference between CRP and CResp and sent three electronic articles that focused on culturally relevant science teaching (Johnson, 2011; Mensah, 2011) and best practices for teaching African American students in general (Ladson-Billings, 2000). Finally, the third interview explicitly addressed the participants' beliefs and experiences related to race. After the third interview, a copy of each transcribed interview and an electronic summary form was sent to each participant to

give the participants an opportunity to clarify or change any statements they made. Only one summary form was received within the time frame of the study.

The coding scheme from the open ended qualitative survey and the three-part interviews were coded inductively and deductively using Moustakas' (1994) modification of van Kaam's (1959, 1966) phenomenological data analysis strategy. These processes allowed for data to naturally emerge and also to be classified according to the CRP framework (Ladson-Billings, 1995a, 2000; Johnson, 2011). This was important because very little is known about science teacher educators' personal perceptions of race, teaching beliefs, and teaching practices in terms of preparing preservice teachers to engage African American students in K-12 settings. The final themes for part one of the study were:

- CRP is an emerging skill used by science teacher educators and is not fully incorporated in science teacher education because CRP is largely misunderstood as CResP;
- Science teacher educators subscribe to conventional science teaching practices and beliefs to prepare PST to engage all learners; and
- There is a call to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.

And the final themes for part two were:

- There is a struggle to understand and implement CRP in science education teaching;
- Modeling conventional science teaching strategies and ideologies are preferred for preservice teachers to engage all learners as opposed to identifying specific learning needs of African American students; and
- Racially charged formative experiences engineer subjective ideas of race, racism, and teaching practices.

Discussion of Findings

In the following section, the findings are discussed in an effort to explore what was learned and how these discoveries are important to many science education stakeholders. In doing so, Delpit's (1988) and others' (Delgado & Stefaniec, 2012; Fordham & Ogbu, 1986; Ladson-Billings, 2000; Mutegi, 2011, 2013) ideas are used to expand the understanding of culturally relevant pedagogy, or CRP, in science and to illustrate what the findings mean for science education stakeholders and teacher educators in general, so that public schools can deliver content using strategies appropriate not only for all children, but African American children in particular.

In 1988, Lisa Delpit explored the intransigence of power and its insidious impact on children of color in *The Silenced Dialogue: Power and Pedagogy in Educating Other People's Children*, which emphasizes the idea that black students and other poor children of color are marginalized in public schools. She explains white educational leaders, members of the "culture of power," often do not realize their level of influence, and in doing so, silence the voices of their diverse colleagues and other educational stakeholders of color. Further, Delpit offers candid guidance about how to engage black children in

American classrooms. Similarly, the purpose of this current study was to critically explore how science teacher educators' prepared their preservice teachers to later engage African American K-12 students in science. Thus, the findings of this study are discussed by recasting Delpit's ideologies about the culture of power to make the case for CRP (Ladson-Billings, 1995a, 2000) in teacher education and science teacher education (Johnson, 2011; Mensah, 2011, 2013; Mutegi, 2011) in particular. To further illustrate this, implications for teacher educators, policy makers, K-12 teachers, and educational researchers are provided.

Research Question 1. In part one and part two of the study, the researcher addressed what the participants knew about culturally relevant pedagogy (CRP) principles and if or how they applied these principles in their science methods courses. The first research question asked, in what ways do science teacher educators describe CRP principles? It was found that every participant in the study (whether in phase one or phase two) did not report a clear understanding of the CRP framework (Ladson-Billings, 1995a, 2000) and most often described teaching ideologies and classroom examples that reflected culturally responsive pedagogy (CResP) (Gay, 2000, 2010). Specifically, the theme that emerged from the survey was CRP is an emerging skill used by science teacher educators and is not fully incorporated in preparing preservice teachers to teach science. Correspondingly, the theme for part two very similarly suggested that science teacher educators struggled to understand and implement CRP in science education teaching. The survey respondents and interview participants reported beliefs and teaching practices that appeared to be prerequisite dispositions and activities toward high academic expectations, cultural competence, and critical consciousness—the three

principles of CRP. These prerequisite dispositions and activities were more reflective of statements representing high quality instructional practices, cultural awareness and otherness, and responses about culturally responsive pedagogy were provided.

High quality instructional practices. While many of the respondents did not explicitly describe CRP principles verbatim, they described beliefs and some practices that encouraged the framework's first principle of high academic expectations. For example, one respondent reported a "passion for the content and delivering high quality instruction for their students," which Ladson-Billings (1995a, 2000) and Johnson (2011) suggest is part of having high expectations and is just good teaching. Consequently, it appeared that the survey respondents and interview participants demonstrated a significant understanding of high quality instructional practices, which Johnson (2011) says is a part of demonstrating the first principle of CRP. For example, they described teaching strategies, such as modeling, the use of the five E's (Engage, Explore, Explain, Elaborate, and Evaluate), and using hands-on teaching to help their preservice teachers learn how to teach science. These are believed to be pedagogically sound strategies for teaching science (AAAS, 1993; Christensen, 1995).

Cultural awareness and otherness. Secondly, not many of the responses on either the survey or during the interviews radiated CRP's second principle, cultural competence, but there were responses that suggested an initial understanding of exposing preservice teachers to an appreciation for cultural awareness and recognition of otherness, which could be considered essential for eventually building cultural competence. However, Delpit (1988) suggests teachers must learn how to foster a sort of cultural competence. She advocates that preservice and inservice teachers be prepared to

confront (1) ideas of discrimination and systemic racism, (2) their personal biases, and (3) understand their influence of power. She says these are so important because effective teachers of black and other children of color need to be able to help black children establish and revere their own voices, while coaching them with the necessary skills to access and participate in mainstream American life. Moreover, Ladson-Billings (1995a, 2000) suggests it is critical that teachers learn how to help African American students appreciate their own identity while simultaneously learn the rules and expectations of the dominant culture. Lastly, none of the respondents reported any beliefs and teaching practices on the survey that demonstrated a proclivity for nurturing a critical consciousness in their students. Ladson-Billings (2000) suggests that fostering critical consciousness in preservice teachers and students is the most often disregarded construct by teacher educators and K-12 teachers. Similar to Ladson-Billings, Delpit (1988) says that teachers must learn how to raise black students' level of critical consciousness about the disparity between the black culture and the dominant's culture's rules because if not, these students will be silenced and helpless to make social changes in the larger society.

Culturally responsive pedagogy. As noted earlier, most of the descriptions and applications of CRP discussed by the participants in part one and two were more characteristic of culturally responsive teaching, or CResP, which usually exemplifies an educators' awareness and appreciation of cultural, racial, linguistic, and ethnic otherness (Gay, 2000, 2010). For example, when the survey respondents and interview participants were asked, "What does it mean to teach in culturally relevant ways," they all described a style of teaching characteristic of CResP, such as incorporating student interests and

acknowledging student diversity in general. In fact, even after a short CRP overview, the interview participants mis-described CRP as being problem-based learning or teaching by debating controversial topics. While problem-based learning and debating controversial topics in science are high quality teaching strategies (Tali & Kedmi, 2006; Zeidler & Nichols, 2009; Zeidler, Saddler, Simmons, & Howes, May 2005) that could potentially foster higher order thinking, these approaches do not necessarily promote students' cultural competence and critical consciousness about social injustices. However, should problem-based learning and debating controversial topics be turned toward confronting injustices in science, this could represent a major step in the direction of embracing CRP in science education.

Beyond CResP. After the CRP overview study participants still were unable to authentically apply CRP to their teaching. However, they attempted to describe ways they could transform their teaching by using CRP. And in doing so, they actually described possible lessons that perpetuated an awareness of cultural and racial difference that appeared to go slightly beyond CResP. For example, when probed further to provide evidence they teach in culturally affirming ways as was suggested from the survey in part one, the interview participants described activities that reflected only varying commitments toward cultural difference and awareness. For example, the culture bump activity, the draw a scientist activity, and group discussions using multicultural literature seemed to foster a sociocultural awareness and create dialogue about otherness, which is certainly a first step in becoming a culturally relevant pedagogue, but teacher educators must go beyond awareness when preparing preservice teachers, so they can learn how to consider the implications of the power they hold in classrooms and schools (Delpit,

1988). Further, Ladson-Billings (2000) seems to agree with Delpit in that black students do not need teachers who only accept and encourage diversity within classrooms, but need teachers who are able to show black and other marginalized students that there are various gatekeeping points in society controlled by the dominant culture, who do not regard black students as equal, capable, and worthy of access. Therefore, black students need to be uniquely prepared to overcome these barriers.

Struggle to understand. Over the course of this study, some of the interview participants willingly reflected about CRP. These participants' reported poignant and often times brutally honest comments that suggested they experienced a struggle to understand CRP and a struggle in how to implement it in their science education courses. They identified a cognitive struggle to understand CRP and various institutional barriers, such as not having enough time and support from the university, that seem to prevent them from implementing CRP in their post-secondary teaching settings.

The findings suggested that while science teacher educators in this study understood ideas that contributed to racism, they still did not understand CRP as a teaching approach that could be used with their preservice teachers to counteract racism in science classrooms. For example, it was reported in Chapter 4 that the survey responses and most of the interview participants rejected ideas of tolerance, colorblindness, and other manifestations that contributed to the white-black science achievement gap.

Additionally, they reported beliefs and practices that were more characteristic of CResP. However, the CResP framework does not provide teachers a structured platform to help students explicitly confront the sociopolitical implications of injustices within teaching and learning. Conversely, the CRP framework does provide such a structured platform

for science teachers to approach the social injustices in science. Further, many science education scholars embolden CRP as an alternative teaching strategy for preservice teachers to learn and later use in the K-12 setting to engage marginalized groups in science and to instill a genuine and heightened sense of critical thinking and scientific literacy in all students (Johnson, 2011; Mensah, 2011, 203; Parsons, 2008; Patchen & Cox-Peterson, 2008).

In regards to research question one, none of the responses in the study completely encapsulated the concepts of CRP because the ideas of promoting cultural competence and critical consciousness were largely missing. Thus, taken together, the findings of part one and two suggest CRP is an emerging skill because there is a struggle to understand and fully implement CRP in science education teaching because science teacher educators only express an emerging understanding of CRP, which is largely misunderstood as CResP.

Research Question 2. Research question two asked, “In what ways do science teacher educators report they prepare preservice teachers to engage African American students in science?” As previously established, those who participated in this investigation reported a lack of understanding about CRP and did not appear to understand how CRP could serve as a means to train preservice teachers to instill an enthusiasm for teaching African American learners. Instead, the way science teacher educators in part one and part two suggested they prepared preservice teachers to engage African Americans was by using conventional science teaching practices and beliefs to prepare preservice teachers to engage all learners.

When explicitly asked on the survey, “how do you prepare preservice teachers to engage African American students,” the respondents’ did not provide specific information about strategies they use to help their preservice teachers engage black students. Instead the survey respondents reported science-for-all philosophies or suggested they do not do anything differently. This was troubling because it appeared they were suggesting their conventional practices were adequate in preparing future teachers to engage all black students and all students in general. Secondly, in contrast to the survey respondents, the four interview participants in part two were able to provide more detail about how they prepare their preservice students to engage African American students. Specifically, the interview participants described a few racially influenced activities aimed at only instilling a simple awareness and appreciation for cultural otherness. Conversely, the interview data suggested the participants’ preferred to model conventional science teaching strategies and ideologies, such as providing science-for-all by using hands-on inquiry, problem-based learning, and other constructive methods for teaching preservice teachers to engage all learners, as opposed to identifying specific learning needs of African American students. Thus, in regards to preparing preservice teachers to engage African American students in science, the participants in this study for the most part, seemed to articulate the need for ideological change to address issues of cultural and racial otherness that hinder black students in science classrooms, but were unable to demonstrate necessary pedagogical changes to address the needs of black students in science classrooms (Rodriguez, 1998).

Cultural otherness. In addition to using the before mentioned constructivist or high quality instructional science teaching ideas and practices, there were responses

within the study that briefly mentioned African Americans in particular and described practices that reflected CResP. However, these responses seemed to illustrate what Banks and McGee Banks (2010) would deem as additive or stereotypical, and Delpit (1988) would suggest does not prepare teachers with the necessary skills to engage black children in K-16 learning. For example, when asked how do you prepare your preservice teachers to engage black students in K-12 science, many of the survey respondents suggested that they prepare their students to engage all students despite race and did not provide any specific response regarding black students. However, one of the responses highlighted her perception of the learning needs of African Americans in particular. Specifically, Respondent three, a black science teacher educator from the survey mentioned that from her experience, “black students love music,” so she suggests her preservice teachers use music in their future science classrooms. While it is not clear that this strategy would work for all black students, Delpit (1988) would suggest preservice teachers and other educators need to seriously consider this sort of advice because it comes from a person who shares the culture of other black students; thus, her input should not immediately be dismissed by white educators, who feel they know better than her.

Racially influenced teaching activities. In all, most of the survey responses that highlighted strategies used to prepare preservice teachers to engage African American students in K-12 science were described in Chapter 4 as general statements that suggest the science teacher educators from the survey intended to engage all learners in the same way, despite the category of diversity represented. However, during the interviews, the participants’ communicated a sense for cultural awareness and otherness in preparing

preservice teachers to engage all learners. Moreover, they described activities that had the potential to consider racial otherness. For example, Dr. Daly described in detail about a lesson series she initially alluded to on the survey where she helps her preservice teachers examine cultural bumps. However, while this experience provides her students with a safe space to examine different types of otherness, which may or may not include race that make them uncomfortable, Dr. Daly reported she does not go beyond addressing an awareness of otherness, nor does she help her students learn how to confront the sociopolitical injustices diverse students will face. Similarly, Dr. Jackson reported that she encourages her students to accept all types of diversity in science classrooms, and in doing so her students examine the gender and racial stereotypes of scientists by drawing what they think a scientist looks like. Delpit (1988) makes it clear that teachers must not only “encourage and accept diversity within classrooms” (p. 292). Additionally, they must also learn “how to communicate across cultures to address the more fundamental issues of power, of whose voices get heard in determining what is best for children of color” (p. 296). Therefore, science teacher educators must explicitly provide instruction to preservice teachers on how to communicate with and engage black children and their families.

Unlike the other participants, Ms. Alleyne, a black science teacher educator, is the only participant who reported she highlighted specific characteristics about black students. Specifically, she reported she holds one class discussion about the burden of black students and other students of color to act white to expose her mostly white students to a social constraint black students face, so they can more readily accept diverse students in their future K-12 classes. With that said, Mr. Williams, also a black science

teacher educator, was the only science teacher educator who prepared mostly black preservice teachers. He suggested his students already had an understanding of what it meant to be marginalized in K-12 settings. Accordingly, he focused on preparing his students to address how marginalized students can gain access to high quality science experiences, which admittedly is ideal for fostering his preservice teachers' capacities to reach all students in science. However, he did not describe in detail how he does this, except to say that he encourages his students to use the resources around them to promote prior knowledge and spark interest in science. More notably, Dr. Williams made reference that he makes it a priority to prepare his mostly black preservice teachers for not only careers in the classroom but also uses round table discussions to help his students begin to contemplate factors that contribute to the white-black science achievement gap, such as the lack of diverse students enrolled in advanced science courses.

Thus, the brief discussion Ms. Alleyne holds with her students could be a gateway toward increasing her preservice teachers' knowledge about the societal burdens black students face in America. In addition to facilitating an article discussion, she said she uses her experiences as a black person to discuss possible differences between the black and white cultures. Similarly, Dr. Williams' tendency to encourage black preservice teachers to think as educational researchers could be used as a strategy to begin to promote more diverse faculty in science teacher education. Therefore, it seems important that teacher education programs increase diversity among the faculty, so that preservice teachers can glean expertise from those who are members of diverse groups (Mensah & Jackson, 2012).

Science-for-all inquiry preferred. Despite the few instances of culturally responsive teaching activities that fostered an awareness and acceptance of general diversity, the survey respondents and the interview participants overwhelmingly described the ways they prepare preservice teachers to engage African American students was by modeling and advancing inquiry-based or hands-on practices, which they reported were the preferred ways they intended their preservice students to engage all learners, including black students in science. Accordingly, these science teacher educators' seemed to suggest that inquiry-based learning is a non-racist preferred way to teach science in general, which could or could not be hands-on in nature, because it promotes an enthusiasm in all students for problem-solving. Furthermore, it was suggested inquiry also allows all students freedom to independently think through a task, ask good questions, and assert original solutions. In addition, all the interview participants were adamant about their preservice students avoiding the direct instruction teaching practice because direct instruction suggested to students that they must only rely on the teacher's knowledge because they are not capable of forming their own conclusions about a topic or task. However, it remains unclear what the participants meant by "direct instruction" because it seems that all of the participants agreed that some level of direct instruction was necessary in science instruction per the "explain" component of the 5E model. This idea of "scientific inquiry," which is the foundation upon which science-for-all initiatives have been built, is threaded throughout the science education community (AAAS, 1989; Mutegi, 2011). For this reason, supporters of the inquiry teaching method suggest that learning is maximized for all students. For example, Geier et al. (2008) suggest that inquiry-based instruction was effective in reducing the science achievement

gap in a group of African American male middle school students in a large-scale study in the Midwest. Moreover, in a study with 2,000 students, inquiry-based learning increased engagement and content mastery among disadvantaged and diverse students in the treatment group (Lynch et al., 2005). Likewise, the participants in part one and two of the current study also appeared to be advocates of this method because they reported it would increase science achievement and literacy for all students, including black K-12 students and other students of color.

On the other hand, critics of inquiry methods of science teaching suggest this system of discovery does not work well in part because such teaching methods require the learners to already have high content and prior knowledge (Kirschner, Sweller, & Clark, 2006). More so, these critics suggest that inquiry-based teaching is not effective for all students because even the highest functioning students may leave the classroom with wrong assumptions or inaccurate content knowledge. Thus, using the inquiry teaching method exclusively may not be appropriate for already reluctant science learners, such as many African American students. For example, Mutegi (2011) suggests African American students require a transformed way of teaching because they have an oppressed status in American schooling. Further, children whose culture differs from American schooling may not be aware of or place value in the routines and expectations set forth by the teacher. For this reason, it is important that science teacher educators model and advance teaching methodologies for their preservice students that provide black K-12 students not only the necessary content skills, but also an accurate view of teacher and school expectations. Thus, preservice teachers in science and all content areas need to be trained on how to deliver their content in such a way as to teach black

students how to not only master the content, but how to use the content to improve their lives and social condition. Additionally, black students engaging in decontextualized inquiry experiences may further alienate them in a classroom and from seeking careers in science because they are not provided meaningful connections between the teacher's expert knowledge and their own expertise. Thus, colorblind science-for-all approaches to instruction, such as using unguided inquiry experiments are likely to continue to fail or discourage African American students in science because it "creates situations in which many black students ultimately find themselves accountable for knowing a set of rules about which no one has ever directly informed them" (Delpit, 1988, p.288; Mutegi, 2011).

Confronting racism. It is believed the major themes in part one and two emerged in regards to the second research question because the science teacher educators' in this study did not have a understanding of the specific instructional needs for African American students. Additionally, findings from RQ1 suggested the participants did not understand CRP; therefore, it was not surprising the participants were unable to report how inquiry methods could be turned toward confronting social injustices in science as a possible accessory to inquiry teaching methods to help black students contextualize the often abstract content to their lives and cultural experiences. Conversely, when asked which practices were used to prepare preservice teachers to engage African American students in K-12 science, the science teacher educators' from part one and two responded by enumerating the standard inquiry teaching methods and other general constructive methods that have been passed down through the generations. So, while the survey respondents and the interview participants in general seemed to ideologically reject

explicit ideas of racism, they overwhelmingly reported they did virtually nothing to teach their preservice students to do the same. On the other hand, they reported using strategies that exposed their students to anecdotal examples of racial and cultural inequity, such as using literature to reveal racial injustices, like the Henrietta Lacks story and the history of contemporary segregation in a major American city. So, the participants' reported the idea of rejecting explicit racism is conveyed to their preservice teachers. However, no one who participated in this study described any pedagogical changes or teaching practices that helped preservice learn how to actually confront the manifestations of racism, such as confronting the structural inequalities in the educational system and in science, an institution that has historically viewed African American as less inferior.

Thus, taken together, the findings of part one and two suggest science teacher educators prefer modeling conventional science teaching practices and ideologies to prepare PST to engage all learners instead of identifying specific learning needs of African American students.

Research question 3. Considering the general importance of educators examining their beliefs and practices (Apple, 1996; Bernstein, 1976; Lather, 1988; Kincheloe & McLaren, 1994; Wallace & Brand, 2012), research question three was, “How do science teacher educators describe their beliefs and personal experiences related to race that may have impacted their teaching beliefs and practices?” Much like what has been seen with RQ 1 and RQ 2, the findings from the survey provided a corresponding glimpse to what was found with the interviews for RQ 3. On the survey and during the interviews, responses were reported regarding an awareness of the contributions of

African American scientists, advantages and disadvantages of talking about racism in the classroom, how race matters in science education, and the roles science teacher educators' play in ameliorating the white-black science achievement gap. Additionally, responses regarding experiences related to race were initially reported on the survey and then discussed in more detail during the interviews. The surveys and interviews alluded to the idea that subjective and varied experiences led to an awareness of race and otherness, such as having a black playmate during childhood or growing up within the context of socio-politically conscious African American family. Thus, the findings from the survey and the interviews suggested the participants in the study generally reported that issues of race mattered in science education. Moreover, the science teacher educators' early experiences helped to shape their beliefs about race and their teaching beliefs and practices.

Early experiences. One of the major assumptions inherent in critical theory is that each person has formed a reality that has been shaped by his or her social and cultural experiences, and over time, this reality becomes truth (Giroux, 1988). Therefore, in keeping with the critical theory paradigm, the interview participants and the researcher discussed in great detail how their teaching practices might be impacted by their early experiences related to race. In so doing, they suggested that race mattered in American society and within science education in particular. Further they indicated their early experiences whether positive or negative, helped to form their subjective beliefs about racism. Specifically, the stories they shared about their families, the context in which they grew up, their schooling experiences, and the various anecdotal situations related to race coalesced to create their worldviews about teaching and people of other races,

cultures, and ethnicities. The way the participants described their experiences and sociocultural position in society were particularly important. The educators, especially those who are interested in teaching in a transformational way, must take the time to reflect about how they have come to view the world to be able to later critique their own ontological and epistemological beliefs, so they can assist their students in the same process.

To illustrate this dynamic, Dr. Daly and Dr. Jackson, two white science teacher educators, shared they were for the most part insulated from black people early in their lives and characterized their families as ones that did not normally socialize with black people. For this reason, they shared beliefs about how this impacted their paradigm of thought as it pertains to race, which exemplifies the critical theory tenant that ideas about race and other collective group memberships are socially constructed (Giroux, 1988; Kincheloe & McLaren, 1994). Specifically, Dr. Daly shared that despite her concerted attempts to change her thinking about black people she realized she still harbored some racist residue from her upbringing and from her racist father in particular. For example, Dr. Daly reported that in spite of having a black best friend and pursuing equity research in science education, she still struggles to navigate what she calls her own culture bumps with race. Similarly, Dr. Jackson reported that she wondered what negative impacts she may have had on her mostly black K-12 students. As a K-12 teacher, she stated she was totally clueless about her position of power and issues of white supremacy.

Conversely, Dr. Williams and Ms. Alleyne, two black science teacher educators, shared similar upbringing experiences in which their families engrained in them a sociopolitical context for their race, which also exemplifies the critical theory assumption

that ideas about culture and race are socially constructed (Giroux, 1988, Kincheloe & McLaren, 1994). For example, they shared how their families and teachers, who protested during the Civil Rights era and experienced the Jim Crow era taught them unwritten rules for how to conduct themselves in American society, such as blacks being viewed as less than or inferior to whites. As a result, these experiences have impacted their teaching. For example, Dr. Williams shared that he works to prevent this very same inferiority belief from taking root in his mostly all black preservice teachers, and Ms. Alleyne shared that she attempts to introduce the idea of the burden some black students' feel to act white to her mostly white preservice teachers.

Race matters. First, the survey respondents reported beliefs that suggested issues of race in science education matter. Accordingly, the findings from the survey indicated science teacher educators understood general ideas that contribute to racism, such as colorblindness and tolerance, as well as understanding how racism is manifested in science education in particular, such as the case with ameliorating the white-black science achievement gap and the benefits of discussing racism in science methods courses. Additionally, examining the awareness of the survey respondents' beliefs in the scientific contributions made by people of color was important to explore because the responses could allude to additional information about the respondents' thoughts regarding the extent to which the intellectual contributions made by black scientists may or may not be revered. For that reason, providing preservice science teachers an awareness of black scientists' contributions such as those who were not given credit for their contributions due to the oppressive forces from slavery and white supremacy may

later help those preservice teachers help their African American students see themselves in the overall contributions by science.

Secondly, the interview participants shared that their experiences related to race influenced their beliefs about race and racism. Considering RQ 3 specifically purported to find out how the participants' experiences have impacted their beliefs about race and teaching practices, it was not surprising to find that the participants reported how their social consciousness related to race prompted them to integrate multicultural content and images reflecting student diversity in their methods courses. For example, Dr. Daly added an unrepresented scientist assignment to her syllabus and Dr. Jackson used the draw a scientist activity. Interestingly, it appeared that Dr. Daly operated from a familiar "do as I say, and not as I do" philosophy because she shared that her lesson plans did not include the names of black or other unrepresented scientists, but she expected unrepresented scientists in her students' lessons plans. Conversely, Dr. Williams and Ms. Alleyne suggested preservice teachers must understand the culture of the black family to be able to engage black students. However, as mentioned earlier Ms. Alleyne, an educator who shares a similar culture as her black preservice teachers was "silenced" by a white colleague who suggested her input was not appropriate when sharing her experience teaching black students to her preservice teachers. Moreover, I would suggest this may have happened to Ms. Alleyne because white educators either have a desire to avoid topics of race or inadvertently dismiss the experiences of educators who share a cultural link with students of color as being stereotypical or useless in imposing progressive educational strategies upon black and poor children of color (Delpit, 1988).

Ultimately, the interview participants ideologically suggested race mattered in the larger society and within science education. Specifically, the interview participants reported the white-black science achievement gap, colorblindness, tolerance, and the possibility of racist teachers in classrooms were animate expressions of racism in schools. As a result of the belief in these various manifestations of racism, the participants reported teaching practices, as mentioned earlier, they use to help their students gain an awareness of otherness and accept all types of diversity. However, as was established previously, the participants shared for the most part they did not explicitly prepare their teachers to specifically address the learning needs of black students. Instead they reported providing general instruction on how preservice teachers can interface with all types of diverse students, and do not equip them with the necessary tools to address the racial inequities and injustices they and their future students will face in the K-12 setting and beyond. Thus, these science teacher educators in this study believe themselves competent in promoting progressive educational strategies that are palatable for all students, but fail to train preservice teachers to provide the necessary skills and cultural capital for black students to learn how to matriculate within the dominant culture's codes of power. With that said, it is this researcher's hope that as a result of participating in this study, these participants may consider the usefulness of CRP as a formidable tool to use with their preservice teachers, who in turn can one day model its use with their future students.

In summary, the interview participants shared varied experiences and beliefs related to race imposed on them during their upbringing, which they suggested helped to form their diverse and personal ideas about race and racism. More importantly, they also say these beliefs and experiences have impacted their teaching practices. Similarly, it is

plausible that these subjective experiences and beliefs are the reason why science teacher educators suggest race matters, but provide no clear directions to move from theory to practice. Thus, taken together, the findings of part one and two suggest science teacher educators propose general beliefs and experiences that race matters in science education, but in reaction to this, they recapitulate the use of before mentioned CResP strategies, so their preservice students only gain an awareness of racist manifestations in science and education in contrast to learning strategies to confront them. Therefore, despite suggesting the ideological importance of race in science education, the participants do not provide their preservice teachers clear directions for pedagogical change to move from theory to practice.

Significance and Implications for Stakeholders

As was suggested in the discussion of findings, this exploratory case study is important for a myriad of reasons. First, this study adds to the current body of knowledge about teacher educators' practices, beliefs, and experiences, which seem disproportionate to the current body of knowledge about preservice and in-service K-12 teachers, who normally shoulder the onus for the achievement gap (Oats, 2009). Secondly, the findings have implications for teacher educators, policy makers, and K-12 teachers. Specifically, as was suggested in Chapter 2, teacher educators could serve as bridge for transformational change in public schools because they set a template for teaching and learning that eventually trickles down to K-12 students (Buehler, Gere, Dallavis, & Haviland, 2009; Darling-Hammond, 1998; Murrell, 2006). Therefore, what follows is a discussion regarding the implications for teacher education and various science education stakeholders in particular.

Teacher educators. Teacher educators have an obligation to prepare preservice teachers to engage African American students, which requires a transformational change in teacher education (Ladson-Billings, 2000). Culturally relevant pedagogy (CRP) is one recipe for transformational change in teacher preparation programs and K-12 settings because implementing CRP can prevent well-intended educators from unknowingly advancing racist ideologies and practices in education, as well as help teachers to empower marginalized students within virtually any content area (Hyland, 2005; Morrison, Robbins, & Rose, 2008; Young, 2010; 2011). Further Ladson-Billings (2000) asserts that teacher education programs have generally failed to prepare classroom teachers to engage black students because most teacher educators exclusively model conventional styles of teaching, which usually includes only pedestrian principles of multiculturalism. Likewise, the science teacher educators in this study reported they model the very teaching strategies they hope their students will use in their future K-12 science classrooms, which Buehler et al. (2009) suggest is typical of most teacher educators. Also, the interview participants clearly articulated they embolden culturally responsive teaching ideologies and practices with their preservice teachers as opposed to CRP principles. Therefore, if teacher educators in general would model CRP and other transformational teaching strategies as opposed to culturally responsive pedagogy (CResP) or other mild multicultural efforts, then perhaps CRP would be more widely modeled in K-12 classrooms and black students might engage more within the culture of schools.

Science teacher educators. In reaction to the perceived inequities in K-16 science classrooms, the science-for-all initiatives were implemented (American

Association for the Advancement of Science, 1989). However, these science-for-all initiatives have failed at providing equitable access for marginalized groups of students (Johnson, 2011) and African American students in particular (Mutegi, 2011).

Consequently, many advocate for including CRP in science teacher preparation programs because this strategy systematically confronts the rigid institutionalized science principles and practices that have for generations consumed the American education system and science education (Johnson, 2011; Mensah, 2011, 2013). However, the science teacher educators in this study reported they were not familiar with transformational ways of teaching, such as CRP, and instead relied upon culturally responsive strategies to instill an awareness and appreciation of cultural and racial otherness. Therefore, science teacher educators need to know the difference between CRP and CResP, so that they can better articulate the features of CRP to their preservice teachers.

Accordingly, there is a need for more formal and informal discussions about CRP and how it can be implemented in K-16 settings. Even during this study when the researcher tried to explain the difference between CRP and CResP, the participants continued to struggle to understand what CRP was and how to implement it. Therefore, the science education community and teacher education in general must clearly and formally differentiate between CRP and CResP within theoretical and practitioner journals, at local and national conferences, and even within classrooms where informal discussions on how CRP can be implemented in science education classrooms.

Moreover, science teacher educators need to learn how to incorporate CRP principles into their teaching, which would require they first submit to an authentic process of on-going personal reflection to consider their own ideas about ethnicity, bias, and systemic racism

in society. This idea of teacher educators' engaging in reflection of personal bias and modeling this for preservice teachers is reiterated by Bryan and Atwater (2002) and Mensah (2009), who warn that science-for-all will never be realized unless teacher educators assist K-12 science teachers in uncovering their negative stereotypes and prejudices.

As previously mentioned, the science teacher educators in this study reported overall they model constructivist teaching practices, such as the use of hands-on inquiry teaching, problem-based learning, class discussions, and the use of CResP teaching. Additionally, the participants' appeared to criticize direct instruction in favor of inquiry-based teaching as a meaningful approach to engaging all learners in K-12 science classrooms. So, it is believed that if science teacher educators modeled social justice approaches to teaching, such as culturally relevant pedagogy, as a strategy within the context of already high quality science teaching practices, then perhaps it may be regarded by classroom science teachers as a reliable and concrete instructional strategy to increase academic achievement for African American students and all students. Specifically, inquiry-based learning and problem-based learning approaches could be transformed to include CRP principles (Tali & Kedmi, 2006; Zeidler & Nichols, 2009; Zeidler, Saddler, Simmons, & Howes, 2005). Further, contrary to what the science teacher educators reported in this study, Reigeluth and Carr-Chellman (2009) suggest direct instruction is the most effective instructional design method for increasing achievement because it combines instructional principles from operant conditioning, cognitive learning theory, humanistic approaches for affective learning, and components of the social cognitive approach to learning. Thus, science teacher educators need to also

consider how CRP and direct instruction is a meaningful accessory to inquiry teaching if implemented correctly to help African American students first acquire the essential skills to be able to fully participate in science classrooms.

Educational policy leaders. Delpit (1988) says educational policy leaders hold the most power and responsibility to reform teaching, in which the learning needs of black children and other children of color are more holistically considered. The interview participants' reported a cognitive struggle to understand CRP and institutional resistance for teaching in culturally relevant ways. Accordingly, these findings suggest that educational policy decision makers play an important role in reforming teaching to be more transformational because they possess the influence to change institutions of teacher education. Specifically, policy leaders within teacher education and at the local, state, and federal levels need to address teacher educators' struggle to understand CRP and institutional barriers for implementing CRP, such as restructuring coursework and field experiences so preservice teachers experience, learn about, model, and come to embrace transformational teaching strategies, such as CRP (Mensah, 2011). Further, addressing these barriers will require policy leaders to advocate for the next generations of science teachers to rely more heavily on teaching strategies, such as CRP to engage black children in K-12 settings and use other meaningful measures to document student growth and progress other than an over reliance on standardized testing (Underwood & Burns, 2014).

K-12 science teachers. The National Science Teachers Association published the Next Generation Science Standards (2013) to address performance expectations for students in K-12 science. These standards suggest K-12 science teachers are expected to

develop science learning goals that provide all students the necessary skills and knowledge to be informed and college ready citizens. However, I would expect that many K-12 classroom teachers would suggest they are not prepared to teach African American students because they were trained by teacher educators who did not provide them with the competencies necessary to engage black and other marginalized students (Ladson-Billings, 2000; Johnson, 2000). Therefore, all K-12 educators (and science teacher educators) would benefit from participating in anti-racist professional development that includes explicit conversations about personal bias, the white-black achievement gap, colorblindness vs. color consciousness, and race and racism in schools, as well as how to implement CRP into their K-16 teaching.

Recommendations for Future Study

While it is clear this study has implications for teacher educators, policy leaders, and K-12 teachers, it also has implications for future study. The implications for future study are framed by the researcher's thoughts about the marginalization of African Americans students. The marginalization of African American students in public school classrooms is important to consider in future research efforts because teacher educators play a significant role in what goes on in K-12 settings.

The current investigation analyzed a small subset of science teacher educators in a mid-Atlantic state to discover how they prepared preservice teachers to engage African American students in science. First, this examination of science teacher educators' beliefs and practices must be broadened to include more specific questions and a larger participant pool in other states. For example, to what extent do science teacher educators confront their own culpability for the science achievement gap? In contrast, educational

researchers must also go beyond studying the beliefs and practices of science educators and examine the beliefs and practices of all teacher educators in all content areas because teacher educators in general are not as frequently studied as preservice and in-service teachers. So, practical questions for additional researcher may include: What are the best practices to help all teacher educators confront their personal biases? Which teaching ideologies and practices specifically contribute to the white-black [science] achievement gap? How can K-12 and post-secondary [science] education teaching be transformed to include CRP principles?

Secondly, the researcher was not able to find studies that quantified the effects of CRP on student achievement. So, what are the effects of CRP on science achievement? Answering this question may encourage science teacher educators to model this framework for preservice teachers and inform classroom teachers as they navigate increasingly more diverse classrooms. For example, many educational scholars have already correlated socioscientific teaching frameworks with increased student outcomes (Tali & Kedmi; Zeidler & Nichols; Zeidler, Sadler, Simmons, & Howes). Therefore, studies that were able to empirically link the use of CRP in science teaching with student achievement or cultivating a national CRP program in science that could be studied longitudinally would be prudent in the quest for increased academic achievement and scientific literacy.

Limitations

All research studies have limitations and this researcher has openly admitted various limitations throughout the description of this investigation. As such, this investigation has limitations typical of qualitative study. First, the results of this study

are not generalizable to a larger population. However, this limitation was purposeful because the intention of this study was never for it to contain a large sample size; instead, the researcher deliberately examined a smaller group of participants to be able to uncover a deeper understanding of the ways racial beliefs and experiences may have impacted the participants' teaching beliefs and practices. Secondly, the researcher admitted in previous chapters that the tenant of critical race theory that suggests manifestations of racism appear normal in American society (Delgado & Stefancic, 2012) undergirded this study. The researcher realizes that this major assumption or belief about race is also based on her life experiences, but others who examine issues of race and science education may not hold this major assumption. Thus, ideas of race are subjective. However, as result of this assumption, the researcher attempted to clearly and comprehensively articulate her positions and epistemological framework in Chapter 3. In addition, the researcher worked with a peer debriefer throughout the data analysis stage to come to agreement of how the data emerged and offer alternative explanations within the data. A third limitation was the use of the yes-no survey questions, which did not provide the survey respondents an opportunity to expound on their selections. However, these questions were only used to select possible interview candidates for part two of the study.

Summary

In general the science education community reports training preservice teachers to teach in culturally affirming ways is an important part in addressing the K-12 science achievement gap, yet the profession largely does not know how to effectively prepare their preservice students to address issues of race and diversity in the K-12 classroom (American Association for the Advancement of Science, 1989; Lee & Buxton, 2010,

2013; National Science Teachers Association, 2013; Rodriguez, 1998). Therefore, the purpose of this study was to examine the beliefs and practices of science teacher educators in an effort to learn how they prepare future K-12 science teachers to engage African American students in science. As a result, this exploratory two-part case study investigated the teaching beliefs, practices, and beliefs and experiences related to CRP and race among science teacher educators in a mid-Atlantic state. Using Moustakas' (1994) strategy for qualitative analysis for part one and two, the researcher's discussion of the findings proposed:

- CRP is an emerging skill because there is a struggle to understand and fully implement CRP in science education teaching because science teacher educators only express an emerging understanding of CRP, which is largely misunderstood as CResP;
- Science teacher educators prefer modeling conventional science teaching practices and ideologies to prepare PST to engage all learners instead of identifying specific learning needs of African American students; and
- Racially charged experiences have persuaded science teacher educators to suggest that race matters in science education, but there are no clear directions for action to move from theory to practice.

The findings of this study suggested science teacher educators were unaware of transformational teaching strategies, such as CRP, to train preservice science teachers to engage black students in K-12 science. Instead as a result of their past experiences with race and individual upbringings, they appeared to rely on teaching practices that helped

their students build an introductory awareness and appreciation for cultural or racial differences as opposed to providing a structured and comprehensive approach in assisting their students in confronting and critiquing their worldviews about black children. Thus, the science teacher educators in this study reported they prepared their preservice teachers with conventional science teaching practices that are aimed at engaging all students, in lieu of addressing the specific learning needs of African American students.

Moreover, the findings of this study suggested important implications for science teacher educators, K-12 teachers, policy makers, and educational researchers in how to transform science education to genuinely be accessible to all students. For instance, debates about appreciating cultural otherness tend to dominate conversations of science-for-all initiatives (Mutegi, 2011) and multicultural education in general (Gorski, 2009). But these lukewarm debates obscure the far more important issue of how CRP could be used to provide evidence of increased academic achievement for all students, particularly African American students, who lag behind their white counterparts. Thus, future studies are needed that empirically examine the effect of CRP on student learning and science learning in particular. Other worthwhile directions for future study include longitudinal studies about science teacher educators, the white-black science achievement gap, or a national CRP science program aimed at increasing academic achievement and scientific literacy. Finally, the study's limitations were characteristic of qualitative research in that the findings were not generalizable to a larger population because of a small non-random sample size. Secondly, the study was largely based on the researcher's assumptions about racism. Lastly, restrictive yes-no questions were used within the survey to select possible interview candidates for part two of the study.

Final statement. To conclude, it is this researcher's great hope this study will positively affect the ways science teacher educators' and teacher educators in general prepare preservice teachers to engage African American students in K-12 classrooms because this study reveals how impactful personal experiences and beliefs related to race are in shaping beliefs and teaching practices. Also, the researcher desires that this study at the very least will encourage a discussion about personal reflection of bias and the sociocultural influences race has on science teacher educators and teacher educators in general. This was an important study because understanding how classroom teachers engage students of color in science is largely influenced on how they were prepared to teach science in their methods course. Accordingly, science teacher educators and all teacher educators need to subscribe to innovative strategies, such as CRP that go beyond their conventional practices to be able to prepare future K-12 teachers to contextualize learning so that overall achievement among black students will increase, to foster pride in students' cultural identity, and to instill a moral sense of social justice in all students. Specifically, K-12 science teachers have the responsibility to help African American students who have been historically "caged" by the societal limitations placed upon them and assist them in transforming from marginalized students in science classrooms into self-actualized forces capable of confronting racism and other social injustices in science (Angelou, 1970, p. 1; Johnson, 2011). So, incorporating transformational teaching, such as CRP into teacher education has the potential to positively impact society because the majority of children, who U.S. matriculate in public and private K-12 schools will eventually grow up and go into a variety of professions. Thus, over generations, CRP

could positively change the way students learn how to view the world, otherness, and social injustice, which could serve as a genuine long-term remedy for racism and bigotry.

Lastly, researchers need to specifically deconstruct why current science-for-all approaches are not working to engage African American students and perhaps consider how CRP can transform current teaching methodologies. If not, African American students and other students of color will be further excluded from science, which undoubtedly will contribute to an even more robust Sputnik crisis in which America falls victim to the loss of potential expertise and innovation by future black scientists, who may just have the solutions for our world's most pressing STEM concerns.

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APPENDIX A

Recommendations for Teacher Educators (Hill, 2009)

Resolutions for Teacher Education Programs	Recommended Readings
<ol style="list-style-type: none"> 1. Teacher education programs must implement a genuine dialogue component throughout the program because dialogue is a powerful tool to help preservice teachers examine social structures that have impacted themselves and others. 2. Dialogue should be used to examine the concept of whiteness. 3. Dialogue is useful in examining the programs' commitment to diversity. Dialogue should be used to support inquiry-driven communities of practice. 4. Dialogue should be used to challenges notions of cultural encapsulation, to enact change, and to explore the assumption that middle-class values are the norm and that standard middleclass pedagogy is right for everyone. Students should be trained in cultural content knowledge and the potential to misinterpret cultural norms as lack of interest or behavior problems. The work of Weinstein et al. (2004) offers case studies and suggestions that confront these matters in a manner that may appeal to preservice teachers. 5. Dialogue in response to multicultural literature and autobiography should be utilized to openly challenge and reflect on candidates' existing belief systems and create a space where they can acknowledge it in their practice (Florio-Ruane, 2001). 6. Preservice teacher should have opportunities to participate in non-school settings with minority students prior to enrollment in the program. This includes church functions, community centers, camps, and day care centers (Irvine, 2003). 7. Culturally relevant pedagogy (Ladson-Billings, 1994, 1995), which undergirds cross-cultural knowledge to align instruction with children's interests, backgrounds, and strengths, should be emphasized. 8. Placements with cooperating teachers who are nurturing and who implement literacy instruction that is culturally responsive should be ensured (Cochran-Smith, 2000; Zeichner et al., 1998). Moreover, placements must be in successful schools and classrooms (Cochran-Smith, 2000). 9. Among successful cooperating teachers who enact literacy instruction that is more skills based, it becomes necessary for teacher preparation to integrate a theoretical framework that supports it (Cochran-Smith, 2000). Programs must therefore provide candidates with examples of successful teachers who lean more toward skills-based instruction. 10. Preservice teachers must be made aware that teaching in an urban setting or the potential for the urban child to enter a suburban setting is likely. Students must openly engage in dialogue surrounding racial controversies in suburban settings. They must understand that all-white teaching settings that resembled theirs are waning and diversity is a salient job feature. Arrangements should be made to place preservice teachers in more successful urban schools. 	<ol style="list-style-type: none"> 1. Anyon's (1997) <i>Ghetto Schooling</i> and Wilson's (1996) <i>When Work Disappears</i> are highly recommended for they explicitly inform about marginalized groups as they experience the consequences of failed reform and decisions enacted by policy makers. 2. McIntire's (1997) <i>Making Meaning of Whiteness: Exploring the Racial Identity of White Teachers</i> and Florio-Ruane's (2001) <i>Teacher Education and the Cultural Imagination</i> are recommended as required readings. Both embody work with White middle- and upper-middle-class female preservice teachers. 3. The work of Weinstein et al. (2004) offers case studies and suggestions that confront the status quo in a manner that may appeal to preservice teachers. 4. Rodriguez's (1982) <i>Hunger for Memory</i>, Maya Angelou's (1997) <i>I Know Why the Caged Bird Sings</i>, and Richard Wright's (1993) <i>Black Boy</i> are recommended, for they explore the authors' experiences with compromising their ethnic identity to acquire the dominant discourse and the experiences of non-dominant groups in America. 5. Preservice teachers should be explicitly exposed to Ladson-Billings' (1994) <i>The Dreamkeepers</i> and Delpit's (1995) <i>Other People's Children</i>. 6. Rose's (2001) <i>Possible Lives</i> is an important work to share, for it illuminates the possibility of caring teachers enacting culturally relevant pedagogy in contexts where success is not expected.

APPENDIX B

Consent Form 1

A Case Study About Science Teacher Educators' Beliefs and Teaching Practices in Preparing K-12 Science Teachers to Engage African American Students in K-12 Science

INTRODUCTION

The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participate in this dissertation study and to record the consent of those who say YES. The data collection will be conducted by Janice Underwood from approximately May to December 2014 at Old Dominion University.

RESEARCHERS

Janice Underwood is the primary researcher, and Dr. Sue Kimmel at Old Dominion University will supervise the doctoral student. Drs. Steve Myran (smyran@odu.edu), Stephen Burgin (sburgin@odu.edu), and Felicia Moore Mensah (fm2140@tc.columbia.edu) serve on the dissertation committee. This research study was approved by the Human Subjects Committee of the Darden College of Education at Old Dominion University. The approved application number is 201403007.

DESCRIPTION OF RESEARCH STUDY

The purposes of this study are to examine the teaching practices science teacher educators' report they use to prepare K-12 preservice teachers to engage diverse learners and to explore how the personal experiences related to race may have impacted the espoused teaching beliefs and practices of science teacher educators' in regards to preparing preservice teachers to engage African American students in science. Lastly, personal reflection will be encouraged. If you decide to participate, then you will be asked to participate in a qualitative survey with 11 questions, a demographic protocol, and seven quick yes or no questions that is all expected to take less than 60 minutes. At the end of the survey, you will be asked if you would agree to be contacted for further study. No personal identifying information will be collected unless you agree to be contacted for an interview. Your participation in this survey is entirely voluntary. You may choose to skip any questions or discontinue the survey at any time.

RISKS AND BENEFITS:

Risks: This project is deemed as no risk. The researcher does not foresee or anticipate any direct or major risk to the participants. Several measures by the researcher have been planned to your confidentiality, such as allowing you to skip questions or discontinue the online survey at any time. Also, data from the online survey will only be used in aggregate form, so that no personal identifying information will be disclosed. In the extremely unlikely event of physical injury resulting from research procedures, the University will provide first aid medical treatment or emergency care. Additional medical care will be provided if the University determines that it is responsible to provide such treatment. By signing this form, you do not give up your right to seek additional compensation if you are harmed as a result of participation in this study.

BENEFITS: No benefits are expected other than those associated with graduate study.

CONFIDENTIALITY

The results of this study may be used in reports, presentations, and publications, but the researcher will never identify you, unless you request differently.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University, the researcher, or otherwise cause a loss of benefits to which you might otherwise be entitled.

VOLUNTARY CONSENT

To consent for the on-line qualitative survey, demographic protocol, and yes-or-no questions you may select the button on the online survey that will read, "I consent, and my decision to move from this page and on to the first question of this survey serves as an indication of my consent." If you consent to the study, you are saying that you have read and understood this form. You may contact the primary researcher, Janice Underwood, junde013@odu.edu or Dr. Sue Kimmel, the Chair of the dissertation committee at skimmel@odu.edu should have any questions at any time. If you do not consent to participate in the study, you may ignore the online invitation to the study all together or you may select the online button that reads, "I do NOT consent to this study."

"I have read [or been informed] of the information given on the previous pages. The research team has offered to answer any questions I may have concerning the study. I understand that my participation is voluntary and I may withdraw at any time should I decide.

I consent and my decision to move from this page and on to the first question of this survey serves as an indication of my consent."

APPENDIX C

Consent Form 2 for Interview Participants

A Case Study About Science Teacher Educators' Beliefs and Teaching Practices in Preparing K-12 Science Teachers to Engage African American Students in K-12 Science

INTRODUCTION

The purposes of this form is to give you information that may affect your decision whether to say YES or NO to participate in the second part of this research study and to record the consent of those who say YES. The data collection will be conducted by Janice Underwood during summer 2014. This research study was approved by the Human Subjects Committee of the Darden College of Education at Old Dominion University. The approved application number is 201403007.

RESEARCHERS

Janice Underwood is the primary researcher, and Dr. Sue Kimmel at Old Dominion University will supervise the doctoral student. Drs. Steve Myran (smyran@odu.edu), Stephen Burgin (sburgin@odu.edu), and Felicia Moore Mensah (fm2140@tc.columbia.edu) serve on the dissertation committee.

DESCRIPTION OF RESEARCH STUDY

The purpose of part two of this study is to explore how the personal experiences related to race may have impacted your espoused teaching beliefs and practices in regards to preparing preservice teachers to engage African American students in science. If you decide to participate, then you will participate in three 45 minute interviews, an analysis of your class syllabus and a teaching artifact of your choice, and a teaching beliefs and practices survey. The interviews may be conducted in-person or electronically, and the final beliefs and practices survey is expected to take 30 minutes to complete. Transcripts from these interviews and the analysis will be used for the study, and your name will never be used. Your participation in the study is entirely voluntary.

RISKS AND BENEFITS:

***Risks:** This project is deemed as no risk. The researcher does not foresee or anticipate any direct or major risk to the participants.* If you decide to participate in the interview part of study, and you face discomfort related to the discussion of multicultural education, please let the researcher know and the interview will stop immediately. Several measures by the researcher have been planned to protect your confidentiality, such as: scrubbing the surveys and interview transcripts from any identifying information by using pseudonyms for the participants and their workplaces. *In the extremely unlikely event of physical injury resulting from research procedures, the University will provide first aid medical treatment or emergency care. Additional medical care will be provided if the University determines that it is responsible to provide such treatment. By signing this form, you do not give up your right to seek additional compensation if you are harmed as a result of participation in this study.*

BENEFITS: No major benefits to the researcher are expected other than those associated with graduate study. At the completion of the study, there will be a small financial compensation associated with your participation in this study.

CONFIDENTIALITY

The interviews will be recorded. Transcripts from the interview or any notes from the observations will be retained with personal names replaced by pseudonyms. Audio-records will be kept either in a locked file cabinet or password protected depending on the nature of the recording device until they have been transcribed at which point they will be destroyed. The results of this study may be used in reports, presentations, and publications; but the researcher will never identify you, unless you request differently.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University or the researcher.

VOLUNTARY CONSENT

To consent to participate in the three interviews, the artifact analysis, and the teaching beliefs and practices survey, you may sign a hard copy of the consent form if the interview is in person. If the interview is conducted electronically, you may type a consent message in the "notes" box of the videoconferencing software, sign and return an electronic consent form, or email a consent message in the body of an email back to the researcher. The consent to participate message will read, "I consent to phase two of this study, which includes multiple interviews, an artifact analysis, and surveys. I understand that I have the right to withdraw at any time with no explanations necessary."

If you consent to the study, you are saying that you have read and understood this this form. You may contact the primary researcher, Janice Underwood, junde013@odu.edu or Dr. Sue Kimmel, the Chair of the dissertation committee at skimmel@odu.edu should have any questions at any time.

If you do not consent to participate in the this part of the study, you may select only one of the following:

- 1) I do NOT consent to part two of this study, but I continue to consent to my involvement in part one of the study,
- 2) I do NOT consent to part two of this study, and I also wish to withdraw from part one of the study.

My signature on this form or my emailed typed statement indicates:

"I have read [or been informed] of the information given on the previous pages. The research team has offered to answer any questions I may have concerning the study. I understand that my participation is voluntary, and I may withdraw at any time should I decide.

"I consent to phase two of this study, titled, *A Case Study about Science Teacher Educators' Sharing Personal Experiences Related to Race that Impacts their Beliefs and Teaching Practices in Preparing Culturally Competent K-12 Science Teachers*, which includes multiple interviews, an artifact analysis, and a survey. I understand that I have the right to withdraw at any time with no explanations necessary."

Sign Your Name

Print Your Name

Date

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APPENDIX D

Demographic Protocol (Part I of the Study)

1. What is your gender? Male or Female

2. What is your age range?
 - a. ____ Less than 25 b. ____ 25-30 c. ____ 31-40 d. ____ 41-50 e. ____ 50+

3. What is your ethnicity? Identify all that apply:
 - a. From European or Anglo-Saxon decent or European/Anglo-Saxon American or Caucasian American
 - b. African descent or African American
 - c. Hispanic descent or Hispanic American
 - d. Pacific Islander or Pacific Islander American
 - e. Asian decent or Asian-American
 - f. Native American/Indigenous to the Americas
 - g. Multiethnic or multiracial
 - h. My ethnicity is: _____

Teaching Experience

- 10a. How many years of K-12 teaching experience do you have?
 - a. 0 years b. 1– 5 years c. 6-15 years d. 16 years or more

- 10b. If you had K-12 teaching experience, indicate the percentage that best describes how many African American students were in your classes? _____

11. Please check any or all of the following that may apply to you:
 - _____ a. I received training in a traditional teacher education preparatory program within a four year college or university.
 - _____ b. My entire teacher education preparatory program was created around the ideals of multiculturalism.

12. Briefly describe the demographics of the college/university in which you teach science education. Identify all that apply:

<ol style="list-style-type: none"> a. HBCU (Historically Black College and University) c. Private University/College e. Religious-affiliated University/College g. Research Intensive 	<ol style="list-style-type: none"> b. PWI (Predominantly White Institution) d. Public University/College f. Liberal Arts h. Other: _____
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APPENDIX E

Qualitative Survey (Part I of the Study)

DIRECTIONS: Respond briefly to the following short questions based on your perceptions of your teaching philosophies and instructional practices in your science methods courses. This should take approximately 30 minutes to complete. Thank you for your time and feedback.

1. Describe your teaching strengths and weaknesses.
2. What is the main theme around which you build your science education method(s) course(s)?
3. Briefly describe your teaching style in your science methods course(s). Indicate if you teach methods courses related to elementary, middle, and/or high school science.
4. In your opinion, who is the most notable African American scientist? Why do you think this?
5. What does it mean to be tolerant of racial differences?
6. Describe the earliest time you interacted with someone of African heritage (a black person). What was that like for you?
7. What are the advantages and disadvantages of talking about racism in your science methods courses?
8. Overall, how does race matter in science education?
9. Describe how you prepare your preservice teachers to engage black students in K-12 science?
10. What does it mean to teach science in *culturally relevant* ways?
11. What role do science teacher education faculty play in ameliorating the K-12 science achievement gap between black and white students?

Directions: After reading each of the seven short responses, please select yes or no based on your personal perceptions and actual teaching practices:

Yes or No	1. I am colorblind to skin color because I treat all students the same; so, it really doesn't matter.
Yes or No	2. I teach students how to solve socio-political injustices within the content of the class.
Yes or No	3. I talk to my students about the hidden curriculum that marginalizes African American or black students in science.
Yes or No	4. I facilitate opportunities for my students to learn how to confront racism in education with real world science projects and inquiry.
Yes or No	5. My goal in teaching preservice teachers to engage students who represent a diverse racial or ethnic group is to facilitate tolerance of racial and ethnic differences.
Yes or No	6. I believe that understanding my own cultural identity is an important element to teaching my students how to engage their future K-12 students in science.
Yes or No	7. Are you willing to participate in a follow-up interview? If so, provide your contact information.

APPENDIX F

Protocol Matrices

1. How do science teacher educators describe the personal life experiences that have impacted their teaching beliefs and practices?
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- | |
|--|
| <ol style="list-style-type: none"> 1. Tell me about yourself and what it was like to grow up in your family? 2. What did your parents tell you about black people? Segregation etc. 3. How do you describe your ethnicity or race? 4. What do you remember about elementary school, about your teachers, classmates... 5. What was your high school like? 6. Tell me what it was like to hang out in your neighborhood. 7. Describe the first time you had to interact with someone of African heritage (a black person). What was that like for you? 8. Tell me about a time you ever experienced hatred for who you are or what you looked like. 9. Tell me about a time when you witnessed someone else experiencing hatred or discrimination for who they were based on their race. 10. Tell me about a time when you felt compelled to stand up for someone you thought was experiencing discrimination or racism. What happened? What did you do? 11. How has race ever impacted your classroom? Your teaching? 12. Have racial issues ever come up in class discussions? How have you handled it? 13. How should issues of race and science education be approached? 14. Describe how you prepare your preservice teachers to engage black students in science? Or other students of color? |
|--|

<p>1. In what ways do science teacher educators describe culturally relevant pedagogy (CRP) principles?</p> <p>(Qualitative Survey, Interviews)</p>	<p>(Qualitative Survey, Interviews)</p>	<p>2. In what ways do science teacher educators report that they prepare preservice teachers to engage African American students in science? (Surveys and Interviews)</p>
<ol style="list-style-type: none"> 1. (11) Describe your teaching strengths and weaknesses. 2. (12) What is the main theme around which you build your science education courses? 3. What do you know about culturally relevant pedagogy? 4. Overall, how does race matter in Education? 5. How would you describe the kind of power you have as a teacher of teachers? 6. What is the difference between culturally “responsive” pedagogy and culturally “relevant” pedagogy? 7. (16) What does it mean to be tolerant of racial differences? 8. What is your opinion about being color-blind to skin color or race? 9. In what ways does race impact teaching? 	<ol style="list-style-type: none"> 1. (13) Describe your teaching style in your science education courses. Indicate if you teach elementary, middle, and/or secondary methods courses. 2. How would you describe your role in the science education courses you teach? 3. Describe the instructional strategies you use in the science education courses you teach. 4. In your opinion, who is the most notable African American scientist? And why do you think this? 5. (14) What does it mean to teach science in culturally relevant ways? 6. Which topics in your science education course(s) are ideal for teaching in a culturally relevant way? 	<ol style="list-style-type: none"> 1. Describe the instructional strategies you use to teach preservice science teachers to reach African American students. 2. Tell me more about your position on racial color-blindness. 3. In what ways does race impact your science teaching? 4. How do you prepare your students to confront the social constraints imposed on African American students in science? 5. What comes to mind when you hear, “white-black science achievement gap? Or Racism?” 6. In your opinion, what are some reasons for the K-12 science achievement gap between African-American (black) and Caucasian-American (white) students? 7. How does race matter in your science education course(s)? 8. What role(s) do science education faculty play in ameliorating the K-12 science achievement gap between African-American (black) and Caucasian-American (white) students? 9. How do you facilitate a critical consciousness in your students about societal injustices and

		<p>race bias that African American students face?</p> <p>10. In your opinion, why do preservice and inservice science teachers indicate (as identified in the literature) as being unprepared to engage African American students?</p> <p>11. Here's a scenario I would like you to respond to: A white teacher says to you, "Several of my black students called me a racist. What should I do?" What do you say to him or her?</p>
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APPENDIX G

Semi-structured Interview Protocols – (Part II of the Study)

Interview 1

Opening Script:

Good afternoon/morning...as you know, my name is Janice Underwood and today I am conducting an interview about your teaching experiences of which should take about 45 minutes or so. Thank you so much for taking the time out of your schedule to talk with me. As a precaution to you, I am required to get your informed consent. I have a form here that explains the purpose of today's interview with my contact information should you ever like to contact me. I would also like to give you a copy for your records. Finally, as we talked about earlier, I will be recording our conversation.

[Turn on recording device] Ok, I have turned on the recorder. Is that still okay? [Pause].

If at any time you want me to turn off the recorder or end this interview, please let me know. The content of today's interview will not be controversial and will pose you no harm. I will keep all of your responses confidential, and you will remain anonymous. With that said, while I may reference your name today in the interview, is there a pseudonym you would prefer I use when writing up my report? [Pause for response]. Also, I have some demographic information that I would like for you to fill out. **[Hand the form to the participant]**. Finally, is there anything you want me to ask or clarify before we get started? [Pause]. Are you comfortable? [Pause]. **Okay, today I want us to talk about any life experiences that may have shaped your perceptions about race.**

1. Tell me about yourself and what it was like to grow up in your family?
2. As you grew up, what did your parents tell you about black people? Segregation etc.
3. How do you describe your ethnicity or race?
4. What do you remember about elementary school, about your teachers, classmates...
5. What was your high school like?
6. Tell me what it was like to hang out in your neighborhood.
7. Describe the earliest time you interacted with someone of African heritage (a black person). What was that like for you?
8. Tell me about a time you ever experienced hatred for who you are or what you looked like.
9. Tell me about a time when you witnessed someone experiencing hatred or discrimination.
10. Tell me about a time when you felt compelled to stand up for someone you thought was experiencing discrimination or racism. What happened? What did you do?
11. How has race ever impacted your classroom? Your teaching?
12. Have racial issues ever come up in class discussions? How do you handle it?
13. How should issues of race and science education be approached?
14. Describe how you prepare your preservice teachers to engage black students in science? Or other students of color?
15. How do you describe the word, "racism"?
16. Tell me more about your position on color-blindness.

Okay, we have come to the end of our interview. I have a couple of final questions:

1. Is there anything that surprised you?
2. Is there anything that I didn't ask that you think I should have asked?
3. Is there anything that you would like to add or comment about?

Thank you so very much for your time. I enjoyed you taking the time to talk with me and for sharing your thoughts. I am happy to review the final transcript with you. I will send you a copy of the transcript as soon as it is transcribed.

[Do not stop recording until you walk away or are asked to by the participant].

Semi-structured Interview Protocol – Interview 2

Part Two: In this interview today, I want us to talk about your general beliefs and practices in teaching your science methods course(s).

1. Describe what an effective lesson looks like in your class on any given day?
2. How do you encourage student input?
3. What do you believe is your role as the teacher?
4. How does race matter in Education?
5. Tell me more about opinion of tolerance in education.
6. Describe a time when you modeled the instructional strategies you want your preservice teachers to emulate?
7. What is the main theme around which you build your class?
8. What is the difference between culturally responsive pedagogy and culturally relevant pedagogy?
9. What does culturally relevant teaching look like at the university level? The K-12 level?
10. What kind of power do you have as the teacher of teachers?
11. Describe the instructional strategies you use and the types of assignments you give in the science methods course(s) you teach.
12. Which topics in your science methods course(s) are ideal for teaching in a culturally relevant way?
13. Describe the first time you had to interact with someone of African heritage (a black person). What was that like for you?
14. Tell me about your position on the idea that there are many interpretations of the nature of science.
15. Here's a scenario. A first year teacher says to you, "Several of my black students called me a racist. Help me, what do I do?" What do you say to this teacher?

Okay, we have come to the end of our interview. I have a couple of final questions:

1. Is there anything that surprised you?
2. Is there anything that I didn't ask that you think I should have asked?
3. Is there anything that you would like to add or comment about?

Thank you so very much for your time. I enjoyed you taking the time to talk with me and for sharing your thoughts. I am happy to review the final transcript with you. I will send you a copy of the transcript as soon as it is transcribed.

[Do not stop recording until you walk away or are asked to by the participant].

Semi-structured Interview Protocol – Interview 3

Part Three: In this interview today, I want us to talk more about your beliefs and practices as it relates to your science methods course(s).

1. Describe the instructional strategies you use to teach preservice science teachers to reach African American students.
2. In what ways does race impact your science teaching?
3. How do you prepare your students to confront the social constraints imposed on African American students?
4. What comes to mind when you hear, “white-black science achievement gap?”
5. In your opinion, what are some reasons for the white-black K-12 science achievement gap?
6. How do you facilitate a critical consciousness in your students about societal injustices and race bias that African American students face in school?
7. Respond to this scenario: A white student teacher says to you, “Several of my black students called me a racist. What should I do?” What do you say to him or her?
8. In your opinion, why do preservice and inservice teachers indicate (as identified in the literature) they are unprepared to engage African American students in science?

Possible probing questions:

1. What do you think about the idea of viewing the cultures in your classes like a melting pot?
2. What would you consider as your ethnic group?
3. Which contributions by African American scientists do you discuss in your classes?
4. Tell me an example of a personal story you've shared with your students during instruction to illustrate a mistake or life experiences.
5. Which racist practices and policies in Education do you talk about with your students?
6. Is there any merit in/how do you feel about
 - a) putting students into groups to brainstorm practical solutions to social inequities in Education,
 - b) adapting labs and activities to teach preservice teachers how to address racially marginalized students in science, or
 - c) facilitating cultural identity or sociocultural awareness through scholarly writing, reading exercises, or other reflective activities?

Okay, we have come to the end of our interview. I have a couple of final questions:

1. Is there anything that surprised you?
2. Is there anything that I didn't ask that you think I should have asked?
3. Is there anything that you would like to add or comment about?

Thank you so very much for your time. I enjoyed you taking the time to talk with me and for sharing your thoughts. I am happy to review the final transcript with you. I will send you a copy of the transcript as soon as it is transcribed.

[Do not stop recording until you walk away or are asked to by the participant].

APPENDIX H

Teaching Beliefs and Practices Summary Form (Part Two of the Study)

Directions: Think about how you would describe your instruction or philosophy on teaching based on the following questions or statements. In the empty box, please provide an example or two of HOW you achieve the objective, WHY you do or don't approach this objective in your class, or your rationale for your particular belief.

In my science methods course(s) I . . .

Evidence/Clarification

1. use personal stories during instruction to illustrate my mistakes, my life experiences, or my understanding of the content.	
2. I feel it is important to be tolerant of racial and cultural differences	
3. I teach about many interpretations for the nature of science	
4. I provide opportunities for student choice	
5. I view the cultures in my class as a melting pot	
6. I use role plays	
7. I control the learning that takes place	
8. I take student's interests into account	
9. I know something about each student personally	
10. I encourage students to share personal stories during class discussions	
11. I routinely use the lecture format	
12. I talk about career options, life after college, and real world expectations	
13. I change my instructional style to meet everyone's needs	
14. I discuss contributions by African Americans in science	
15. I provide on-going and timely feedback	
16. I teach students how to solve socio-political injustices within the content of the class	
17. I represent an ethnic group.	
18. I put the class into groups to brainstorm practical solutions to social inequities in Education	
19. I talk about racist practices and policies in Education	
20. I adapt labs and activities to teach preservice teachers how to address racially marginalized students in science	
21. I am colorblind to my student's skin color because skin color doesn't matter.	

22. I talk about the hidden curriculum that marginalizes African American students in science	
23. I facilitate cultural identity development through scholarly writing, reading exercises, or other reflective activities.	
24. I facilitate opportunities for my students to learn how to confront racism in education with real world science projects and inquiry.	
25. I believe that understanding my cultural identity is an important element to the learning of my students.	

Additional Information I want to share is that:

VITA

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Education

Doctor of Philosophy (Expected May 2015) Curriculum and Instruction; Old Dominion University; Darden College of Education, Norfolk, VA.

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Experience

Biology Special Education Teacher, 2000-Present, Hampton City Schools; Hampton High School, Hampton, VA

Advisory Board for Teacher Education and Licensure (ABTEL) Member, 2011-2016, Virginia Department of Education

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Publications and Technical Reports

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