INCREASING LEVELS OF ACHIEVEMENT FOR BLACK SCIENCE STUDENTS: LEARNING FROM THE EXPERIENCES OF EFFECTIVE TEACHERS

by

TONJUA BENITA FREEMAN

(Under the Direction of Mary M. Atwater)

ABSTRACT

The achievement of Black students in the United States continues to fall below the achievement of their White classmates. The purpose of this multiple case study was to seek science teachers' pedagogical philosophies related to increasing levels of achievement for Black students in science. Critical race theory was used as the theoretical framework. Four high school biology teachers (one Black male, one White male, and two White females) from two rural, public schools in the Southeastern region of the United States shared their philosophies about helping Black students to attain high levels of achievement in science. Data were collected through interviews, classroom observations, demographic questionnaires, and lesson artifacts. While there were multiple findings, the findings can be broken down into four categories: (a) teacher characteristics, (b) student characteristics, (c) classroom environment, and (d) instruction, curriculum, and assessment characteristics. The participants suggested such things as integrating students' lives into lessons, creating comfortable classroom environments, using varied instructional strategies and assessments, and developing positive relationships with students and parents. The findings have implications for further research.

INDEX WORDS: Black students, science teachers, science teacher educators, race, culture, curriculum, instruction, assessment, science education, multiple case study, critical race theory

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DEDICATION

This dissertation is dedicated to my family; especially (a) my parents, Ulysses and Alberta Freeman and (b) my late grandparents and aunts who are now my angels guiding me from above.

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I think God for His grace and mercy and for guiding me through this journey. He provided many angels along the way and opened many doors. He has clearly shown me that "I can do all things through Christ which strengtheneth me" (Philippians 4:13 KJV) and "Delight thyself also in the LORD: and he shall give thee the desires of thine heart" (Psalm 37:4 KJV).

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"With men this is impossible; but with God all things are possible."

(Matthew 19:26 KJV)

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CHAPTER 1

INTRODUCTION

Statement of the Problem

"Persistent and widespread differences continue to exist in the access, retention, and achievement of students depending on their culture, gender, race, and/or socioeconomic status" (Hewson, Kahle, Scantlebury, & Davies, 2001, pp. 1130-1131). These differences appear early and persist throughout schooling (Clark, 2014; Stevenson, Chen, & Uttal, 1990). The achievement of Black students falls below that of their White counterparts (Clark, 2014; Irvine, 2003; Ladson-Billings, 1994). Additionally, Black students are "disproportionately placed in low-ability level tracks and special education classes, suspended, and expelled" (Irvine, 2003, p. 3). This study explores the roles teachers play in helping to dispel these discrepancies. More specifically, this study focuses on the pedagogical beliefs of the science teachers of Black students that help to shed light on these discrepancies and that these teachers believe help to increase the levels of achievement for Black students.

Factors Contributing to the Problem

Various explanations for the "achievement gap" between White students and Black students exist. One reason given by Ladson-Billings (1994) is a society "locked in the grips of racism and discrimination" (p. x). She indicates that, "Almost forty years after a Supreme Court decision declaring separate but equal schools to be illegal, most African American students still attend schools that are in reality segregated and unequal" (p. x).

Four explanations for the achievement gap between Black and White students discussed by Irvine (2003) are referred to as socioeconomic, sociopathological, genetic, and cultural. "Socioeconomic explanations relate… school failure to income, class, and wealth variables" (Irvine, 2003, p. 3). According to Irvine, supporters of socioeconomic status (SES)-based theories believe that socioeconomic status is the best predictor of academic achievement. Irvine reveals several main problems with SES-based theories. For example, they do not offer an explanation for discrepancies that exist between the performance on standardized tests of Black students from affluent families and their White counterparts. Additionally, these SES-based theories do not "explain the finding that the average Black child now attends a school in a district that spends as much per pupil as the school attended by the average White child (Jencks & Phillips, 1986)" (Irvine, 2003, p. 4). Furthermore, the large proportions of college graduates, and doctors (of philosophy and medicine) produced by historically Black institutions "with few financial resources and many low-income students" (Irvine, 2003, p. 4) negate SES-based theories.

Sociopathological explanations blame individuals for the unpleasant circumstances in which they find themselves. Labels such as *at risk*, *disadvantaged*, *deprived*, *product of dysfunctional home environment*, *culture of poverty*, and *politically marginalized* (Irvine, 2003) are often used in these explanations. Supporters of sociopathological explanations commonly believe that simply working hard will enable individuals to overcome their circumstances. Another likely aspect of sociopathological explanations is the belief that members of the lower achieving groups internalize the myth that they are less competent. The internalization of incompetence leads students to exhibit a learned helplessness which results in self-fulfilling prophecies of failure (Groulx, 2001; Powell, 1990). The fear that some Black students have of

being accused of acting White is also a potential element of sociopathological explanations. These students do not want to excel academically because they associate intellectual achievement with Whites (Fordham & Ogbu, 1996; Irvine, 2003). The limitations of sociopathological explanations proclaimed by Irvine (2003) are: (a) "the focus on Blacks as incessant victims fails to acknowledge the resilience of African American people and the legacy of their preslave, African heritage" (p. 5); (b) the explanations lack contextual and historical perspectives and time-and-place relationships; and (c) the explanations do "not acknowledge how individuals' own personal experiences and their resolve to succeed act to counter society's perceptions of intellectual incompetence" (p. 5). For example, Rascoe and Atwater (2005) found that gifted Black male students were successful in their science classes when their teachers validated their self-perceived academic abilities, validated that they would need to exert extensive effort, and created a classroom environment in which science was explained well. Additionally, Russell and Atwater (2005) found that Black students who persisted in biology majors were (a) enrolled in college preparatory programs in their high schools, (b) had positive student-teacher interactions, (c) experienced high expectations from parents and teachers, and (d) had vicarious learning experiences and academically challenging programs.

Genetic explanations seek to prove that Black students lack the intellect and intelligence possessed by White students (Irvine, 2003). Irvine points out that environmental factors, school attendance, and nutrition play a role in level of intelligence. Contrary to some assertions, no gene has been linked to intelligence (Sternberg, Grigorenko, & Kidd, 2005). Therefore, it is not feasible to link race to intelligence (Sternberg et al., 2005). Furthermore, race is a social construct rather than a biological concept (Cavalli-Sforza & Cavalli-Sforza, 1995). More genetic

variation occurs within these socially constructed groups of races than between the groups (Sternberg et al., 2005).

Irvine supports cultural explanations for the gap in achievement between Black and White students. Irvine (2003) describes culture as "a group's history, language, values, norms, rituals, and symbols" (p. 6). She adds:

> It is these shared behaviors and knowledge that represent the total ways of living and are important for any group's survival in a given environment. Garcia (2001) points out that "only one-tenth of a person's culture is apparent" and that the overwhelming components of culture are "not conscious to the individual" (p. 287). (p. 6)

The culture that is typically most compatible with the culture of schools in the United States is that of middle-class White students. The cultures of other students are typically excluded from the culture of United States' schools. This exclusion is partially a result of the majority of teachers being White. The teachers bring their own cultures to school. This combination of exclusion of the students' cultures and inclusion of the teachers' cultures increases the possibility that non-White students will experience a "lack of cultural synchronization" (Irvine, 2003, p. 7) between the cultures of home and school. Such a conflict can result in such things as: "miscommunication and confrontation between the student, the teacher, and the home; hostility; alienation; diminished self-esteem; and eventually school failure" (Irvine, 2003, p. 7). Although, Irvine supports cultural explanations for the Black/White achievement gap, she also stresses its conceptual limitations. She points out that although culture plays a major role in determining a student's susceptibility to learning, cultural behaviors are learned. Hence, these behaviors can be modified. It is also important to realize "that culture is constantly evolving" (p. 7). The ultimate goal in overcoming a lack of cultural synchronization between home and school is to cultivate a

"seamlessness between home and school that is connected by vision, shared values, and a sense of mission and purpose" (p. 7).

The shortage of Black teachers has also been given as an explanation for the achievement gap between Black and White students. While the student populations in the schools of the United States are becoming "more ethnically, linguistically, and culturally different" (Ladson-Billings, 2005, p. 230), the teacher populations serving these schools are becoming less ethnically, linguistically, and culturally diverse. Ladson-Billings asserts that this difference in demographics is causing a disconnection between and among students and teachers.

> The percentage of White teachers grew from 88 percent in 1971 to 90.7 percent in 1996, while the number of Black teachers decreased from 8.1 percent to 7.3 percent and the number classified as "other" has decreased from 3.6 percent to 2.0 percent during the same time. (Nieto, 2000, p. 15)

According to the National Center for Education Statistics (Strizek, et al., 2006), White teachers made up 83.7% of the teachers in the United States during the 2003 – 2004 school year; while only 7.4% of the nation's teachers were Black. During this same time, 61.8% of the nation's students were White and 16.0% were Black (Strizek et al., 2006). In 2011, the percentage of White K-12 teachers in the United States was 84% and the percentage of Black teachers was 7% (Feistritzer, 2012). According to the National Center for Education Statistics (2012a), 52.4 % of students enrolled in public schools in the United States in 2011 were White and 15.9% were Black. This means that over a period of seven years, the percentages of White teachers, Black teachers, and Black students essentially remained unchanged. However, the percentage for White students decreased. The number of Black teachers in public schools in the United States is low and is not in line with the number of Black students in public schools in the

United States. "Forty-four percent of all schools [in the United States] do not have any teachers of color on their faculty" (Irvine, 2003, p. 41). Irvine (2003) points out that there is an acute need for science teachers in the United States. Since there exists an overall shortage of Black teachers and there is a nation-wide shortage of science teachers, it stands to reason that there is a shortage of Black science teachers.

In the year 2000 when approximately 40% of the students in the United States' schools were racial "minorities" (Black, Hispanic, American Indian, Pacific Islander, Asian), only 10 - 12% of the science teachers were racial "minorities" (Weiss, 2001). When looking at just the percentage of Black science teachers, the numbers were even more alarming. For grades K – 4, 88% of science teachers were White, while only 5% were Black. For grades 5 – 8, 87% of science teachers were White and 5% were Black. Roughly 90% of high school science teachers were White and around 4% were Black. In 2011, approximately 84.5% of high school science teachers were White and approximately 5.4% were Black (National Center for Education Statistics, 2012b). The percentage for Black high school science teachers remained low.

A shortage of Black teachers presents many problems in schools in the United States. Cooper (1986) expounds on one reason, in general, why a shortage of Black teachers is a problem:

> The school always has been more than simply a place where teaching and learning occur. It is also a place where culture and value systems are fashioned and built. In addition, the experiences and backgrounds that teachers bring to the school affect the school's pedagogical practices and cultural climate. If this history runs true to form, the absence of the black teachers will mean that the school's pedagogical practices and cultural climate will not reflect the perspective of the black minority. Thus, the teachers and the

> students – and indeed the nation – will be deprived of a component of the educational experience that is increasingly important to our pluralistic society. (p. 50)

Furthermore, Black teachers typically have higher expectations and more positive attitudes towards Black students than do White teachers (McKinley, 2010; Irvine, 1988). Sometimes the low expectations and negative attitudes of White teachers toward Black students are interpreted by the students as dislike. This augments the problem, because:

> Children who feel unliked by their teachers frequently do not like themselves or school. They feel alienated and discouraged, and they eventually fail. This effect is exaggerated for low-income and minority students because they are more likely than middle-class students to hold teachers in high esteem. (Coleman et al., 1966 as cited in Irvine, 1988, p. 507)

Also, the low expectations of teachers are often internalized by students leading them to exhibiting a learned helplessness and allowing the expectations of failure to become self-fulfilling prophecies (Groulx, 2001; Powell, 1990). Groulx (2001) also shares the ideas of Gillette (1996) and King (1991) that "this naiveté can become a form of 'dysconscious racism,' a pattern of resistance in thinking about differences that is characterized by a chronic lack of self-awareness about one's own assumptions" (p. 62). The lack of Black teachers is also a problem for White students. Irvine (1988) explains:

> White students need black teachers as role models so that they can gain accurate perceptions of our multiethnic society. In addition, the presence of black teachers in schools helps counter negative stereotypes that white children have about black people – stereotypes perpetuated by ignorance, prejudice, isolation, and distortion in the media. (p. 506)

Irvine (1988) affirms that students should be "taught by competent teachers who want to teach them, by a significant number of teachers who share their racial and cultural identity, and by teachers who are caring, patient, and sensitive" (p. 506).

These problems associated with a shortage of Black teachers in general also cause problems in the science classroom. Toolin (2003) shares one reason why the shortage of Black science teachers is a problem by asserting that "the background and culture of the science teachers often does not mirror that of the student population that they teach, leaving these students with few role models and mentors with whom they can identify and relate to in the science classroom" (p. 457). The shortage of Black science teachers and (science teachers in general) is becoming more of a problem due to fewer students pursuing science teaching careers and poor science teacher retention (Moin, Dorfield, & Schunn, 2005). This growing shortage can potentially result in a wider achievement gap between White and Black students, because "students are more likely to excel educationally when matched with teachers who share their race or ethnicity" (Dee, 2004, p. 195). This growing shortage also leads to an increased need for preparing all teachers to meet the needs of diverse student populations.

Instructional strategies, curricula, assessment, and evaluation used in classrooms also contribute to the achievement gap. Beyer (2001) has summarized "the social-political ramifications of classroom activities and the educational policies that are consistent with them" (p. 155) that have been scrutinized in the research. He lists the following as the most important thoughts:

1. the values embedded in the hidden curriculum that affect students' self-perceptions and their possible futures (Anyon, 1980; Apple, 1975; Bowles & Gintis, 1976; Dreeben, 1968; Jackson 1968);

2. the texts, tests, and standards that compose the overt curriculum, whose interests are represented in the curriculum and whose are not (Apple & Weis, 1983; Shor, 1986; Whitty, 1985);
3. the kinds of cultural values and structures of power that dominate in schools and classrooms and what their effects are, especially in terms of race, gender, class, ethnicity, and disability issues (Cochran-Smith, 1995; Nasaw, 1979);
4. the forms of assessment that occur in classrooms and how they affect students and teachers (Beyer & Apple, 1998; Lawton, 1980); and
5. the aims or purposes of schooling and how they are related to moral questions, political influences, ideological frameworks, and social possibilities (Freire, 1973; Kincheloe & Steinberg, 1995). (p. 155)

When specifically considering science curricula, certain groups of people are seen as the elite in science and their interests are protected (Zerai, 2000). For those people who are not members of the elite group, "contributions have been systematically denied, ignored, and 'gate kept' " (Zerai, 2000, p. 183). The omission of these contributions has been categorized as racism (Cole, 1995; Kalra, 1989; Kleinsmith, 1993). The kind of racism brought about by these discriminatory curricula is defined by the outcomes rather than the intents (Kleinsmith, 1993). This type of curriculum is harmful to the students who are members of the non-elite groups (Cole, 1995). It tends to continue creating privilege for the elite and increasing the inequalities for the non-elite (Matthews, 2002). It is also harmful to students because it carries the hidden message that culturally diverse individuals cannot do science (Barba, 1998) and contributes to the self-fulfilling prophecies of culturally diverse students resulting in low achievement (Davis, 2003).

Purpose of the Study

As a Black science teacher, I have had many low-achieving and high-achieving Black students. I often tried to figure out what factors made a difference in terms of levels of achievement with my students. It was clear to me that levels of intelligence and ability were not always the determining factors for level of achievement. I also wondered why my advanced classes were filled with White students, while my general and technical preparation (tech prep) classes were filled with Black and Latino students. My curiosity was especially piqued when I realized (very early in my career) that many of my Black and Latino students should have been in my advanced classes and several of my White students needed to be in my general or tech prep classes. This was my opinion based on how these students performed in my classes. It seemed that Black students tended to be tracked down to lower levels and that White students tended to be tracked up to higher levels. What factors are playing roles in these injustices and how can they be overcome? Pondering answers to this question lead to the development of this study. There are obviously science teachers who have figured out how to help students to achieve their maximum potential. More specifically, what can we learn from these science teachers that can be used by other science teachers in maximizing the achievement levels for their Black students?

This study focuses on seeking ways to increase the levels of achievement for Black students in science by learning from science teachers' philosophies related to Black students and what they believe to be keys to increasing the levels of achievement for Black students in high school science courses. It is important to point out that this does not mean that the goal is simply to determine ways to close the achievement gap and help Black students to attain the levels of their White counterparts. A gap also exists between the achievement of students from the United

States and students from other countries (Boykin & Noquera, 2011). The overall goal for this type of study is better stated as establishing "a standard of excellence… for the knowledge skills, and cultural codes that students are expected to master, regardless of their racial identification" (Howard, 2010, p. 6). Raising this bar for all American students will raise the bar for Black students and hopefully result in higher levels of achievement for Black students. To determine the philosophies science teachers hold related to helping to increase the levels of achievement for Black students, this study will focus on the following research questions:

1. What kinds of pedagogical philosophies related to instructional strategies, curriculum, assessment, and evaluation do science teachers hold?
2. What kinds of pedagogical philosophies related to race do science teachers hold?
3. How do teachers negotiate their philosophies surrounding race to create their science curricula, instructional strategies, and kinds of assessments used?

Significance of the Study

This study is important for many reasons. First of all, it relies on "the 'wisdom of practice' of experienced teachers" (Foster, 1990, p. 123). What better way to learn how to do something well than from someone who has already figured it out? Furthermore, Foster points out that most studies exclude the role a teacher's racial identity plays in beliefs and teaching practices (which help to form teachers' pedagogical philosophies). Willinsky (1998) stresses that "race as an everyday lived idea is… present and felt in the experiences of students and teachers" (p. 73). Cochran-Smith (2004) asserts that "the educational community must take action in order to alter the disparities deeply embedded in the American educational system" (p. 4). This is one of the goals that may be reached as a result of the findings of this study. "Very few teacher education programs have successfully tackled the challenging task of preparing

teachers to meet the needs of diverse populations" (Watson et al., 2006, p. 396). This results in many teachers having "limited and distorted understandings… about inequity and cultural diversity" (King, Hollins, & Hayman, 1997, p. 158). The findings of this study will also hopefully reveal some ideas for improving teacher education programs so that teachers are better prepared to meet the needs of all of their students. Many inservice and preservice teachers want to know how to teach students who are different from them (Teel & Obidah, 2008).

Terms Defined

For clarity purposes, the definitions of several terms as used in this study will be given. The terms are: curricula, resource kits, artifacts, state-mandated science curriculum, pedagogical philosophies, instructional strategies, assessment, evaluation, achievement, race, racialized, Black, African American, Honors level, and Academic level.

In this study, *curricula* consist of textbooks, their accompanying resource kits, and any other resources used to enhance learning. The *resource kits* may contain such items as laboratory manuals, study guides, workbooks, and enrichment activities. Examples of additional resources are videos, transparencies, computer programs, computer simulations, computer games, other games, laboratory equipment, and topic-related literature. The specific parts of the teachers' science curricula that helped to form the specific units observed by the researcher will be referred to as *artifacts*. In this study, *state-mandated science curriculum* refers to the standards developed by the state that govern what students need to learn about science.

Pedagogical philosophies focus on such aspects of teaching as instructional strategies, classroom management, classroom interactions, and type of learning environment desired. Pedagogical philosophies are based on a teacher's knowledge, experiences, and beliefs. A more in-depth discussion of pedagogical philosophies is found in the review of literature.

Instructional strategies include any teacher actions that provide learning opportunities for students. This includes not only how teachers teach, but how they create appropriate learning environments.

Assessment and evaluation play important roles in instruction. *Assessment* is "the process of collecting a full range of information about students and classrooms for the purpose of making instructional decisions" (Arends, 1994, p. 284). In other words, assessment involves determining what students have learned from a lesson or series of lessons. It gauges if the objectives have been achieved. *Evaluation* is defined as "the process of making a judgment, assigning value, or deciding on the worth of a particular program, approach, or student's work (Arends, 1994, p. 286). During the evaluation process, teachers focus partly on themselves and what they have done or used. For example, did the activities used provide an opportunity for all of the objectives to be met? In evaluating the students, the teachers try to determine the degree to which an objective is achieved.

The American Heritage College Dictionary (1993) defines *achievement* as: "1. The act of accomplishing or finishing. 2. Something accomplished successfully, esp. by means of exertion, skill, or perseverance" (p. 11). Many indicators can be used to gauge students' levels of achievement. Among the most popularly used indicators are course grades and standardized test scores. Teachers also often establish their own criteria for student achievement. For example, teachers may rely on levels of interest or growth. For the purposes of the study, the specific definition of achievement that will be used for each case will emerge from the data.

Although *race* is anthropologically based on phenotypical differences, defining the term race can be problematic (Brooker, 1999). "Given the possible genetic variation within races and the effects of migration, resettlement and intermarriage, the existence of races, as such, is itself

often disputed" (Brooker, 1999, p. 183). Race has more of a social and ideological basis than a biological basis. Additionally, "race is the social expression of power and privilege" (Freeman, 2005, p. 190). Referring to the world as being *racialized* emphasizes the effects people's races may have on how they view and are viewed in their worlds. This is especially in terms of feeling or being viewed as "other." Viewing the world as racialized also refers to inequalities "maintained through the pervasive power of white privilege…. and how patterns of racialization originate in the ordinary cloth of everyday life" (Freeman, 2005, p. 191). The concept of race is "central to everyone's identity and understanding of the social world" (Omi & Winant, 1994, p. 55). During a following discussion of the theoretical framework of critical race theory, race will be discussed in more detail.

Since this study focuses on beliefs about increasing levels of achievement for Black students, it is important that *Black* be defined. Like in this study, Black is often used interchangeably with *African American*. References and participants sometimes used the term African American, while the researcher used the term Black. Because race is a social construct, it is difficult to define Black and African American as racial categories. However, for the purposes of this study, both terms refer to Americans of "acknowledged African descent" (Tatum, 1997, p. 15).

The participants in this study describe their classes as being either *Honors-level* or *Academic-level* classes. The Biology courses in this study that are labeled as Honors-level consist of freshman students who have skipped Physical Science. In these schools, Biology is typically taken the sophomore year or later. Those Biology classes are labeled as Academic-level. The science classes that are not Honors level and are offered so that students can meet high school science requirements are considered to be Academic level.

CHAPTER 2

REVIEW OF LITERATURE

The first part of this chapter will discuss details about the theoretical framework that has been chosen for this study: critical race theory. The second part of this chapter ponders answers to the following questions: How can science teachers be effective teachers of Black students? How can science teachers create science learning environments that help minimize the achievement gap between Black students and White students? This part of the chapter shares some suggestions from the current literature in terms of what is believed to be effective teaching, curriculum, assessment, and evaluation for Black students in science.

Theoretical Framework of Study

Critical Race Theory Overview

"Critical race theory is both an outgrowth of and a separate entity from an earlier legal movement called critical legal studies (CLS)" (Ladson-Billings, 1999, p. 212). "CRT begins with the notion that racism is 'normal, not aberrant, in American society' (Delgado, 1995, p. xiv), and, because it is so enmeshed in the fabric of our social order, it appears both normal and natural to people in this culture" (Ladson-Billings, 1999, p. 213).

> The critical race theory (CRT) movement is a collection of activists and scholars interested in studying and transforming the relationship among race, racism, and power. The movement considers many of the same issues that conventional civil rights and ethnic studies discourses take up, but places them in a broader perspective that includes

> economics, history, context, group- and self-interest, and even feelings and the unconscious. (Delgado & Stefancic, 2001, pp. 2-3)

"There are at least five defining elements that form the basic assumptions, perspectives, research methods, and pedagogies of CRT" (Villalpando, 2003, p. 622). These five elements are: "(a) the centrality of race and racism and their intersectionality with other forms of subordination, (b) the challenge to dominant ideology, (c) the commitment to social justice, (d) the centrality of experiential knowledge" (Smith-Maddox & Solorzano, 2002, p. 68), and (e) "an historical context and interdisciplinary perspective" (Villalpando, 2003, p. 624).

Centrality of race and racism. Race is conventionally thought of in terms of physical characteristics. Many believe race "is simply a matter of skin color" (Omi & Winant, 1994, p. 54). Race is understood "as a matter of biological variation among humans" (Grant & Ladson-Billings, 1997, p. 227). However, Cavalli-Sforza and Cavalli-Sforza (1995) stress that as much variation occurs within racial groups as between racial groups. "Races are categories that society [or an individual] invents, manipulates, or retires when convenient" (Delgado & Stefancic, 2001, p. 7). Delgado and Stefancic (2001) emphasize that the physical traits, "such as skin color, physique, and hair texture," (p. 8) shared by people "have little or nothing to do with personality, intelligence, and moral behavior" (p. 8). "The effort must be made to understand race as an unstable and 'decentered' complex of social meanings constantly being transformed by political struggle" (Omi & Winant, 1994, p. 55). Therefore, the signification of race is both a social and historical process (Grant & Ladson-Billings, 1997; Omi & Winant, 1994).

Because race is constructed through a social and historical process, Omi and Winant (1994) have developed a theory of racial formation to explain the "sociohistorical process by which racial categories are created, inhabited, transformed, and destroyed (p. 55). In developing

their theory of racial formation, Omi and Winant maintain that (a) "racial formation is a process of historically situated *projects* in which human bodies and social structures are represented and organized" (pp. 55-56) and (b) racial formation is linked "to the evolution of hegemony, the way in which society is organized and ruled" (p. 56). Approaching the theory of racial formation in this way "can facilitate understanding of a whole range of contemporary controversies and dilemmas involving race, including the nature of racism, the relationship of race to other forms of differences, inequalities, and oppression…, and the dilemmas of racial identity today" (p. 56).

> The concept of racism entered the lexicon of 'common sense' only in the 1960s. Before that, although the term had surfaced occasionally, the problem of racial injustice and inequality was generally understood in a more limited fashion, as a matter of prejudiced attitudes or bigotry on the one hand, and discriminatory practices on the other" (Omi & Winant, 1994, p. 69).

The realization that the roots of racial inequality and injustice were much deeper came later in the 1960s. It was realized that "patterns of socialization" (Omi & Winant, 1994, p. 69) in the United States along with societal structures from "centuries of systematic exclusion, exploitation, and disregard of racially defined minorities" (p. 69) form the basis for racism. Anything that "creates or reproduces structures of domination based on essentialist categories of race" (Omi & Winant, 1994, p. 71) is described as being racist. Omi and Winant maintain that it is important to locate racism "within a fluid and contested history of racially based social structures and discourses" (p. 71). Delgado and Stefancic (2001) assert that "racism advances the interests of both white elites (materially) and working-class people (psychically)" (p. 7). These advances are often framed in the form of "appropriate collective attitudes to rationalize what was done" (Delgado & Stefancic, 2001, p. 18). For example, "civil rights *gains* for communities of color

coincide with the dictates of white self-interest" (Delgado & Stefancic, 2001, p. 18). Because some forms of racism appear to be advantageous to all involved, "large segments of society have little incentive to eradicate it" (Delgado & Stefancic, 2001, p. 7).

Whites often have perspectives of racism that differ from the perspectives of non-Whites. The following quotation helps to illustrate these differing perspectives.

> Whites tend to locate racism in color consciousness and find its absence color-blindness. In so doing, they see affirmation of difference and racial identity among racially defined minority students as racist. Non-white students, by contrast, see racism as a system of power, and correspondingly argue that blacks, for example, cannot be racist because they lack power.
>
> (Omi & Winant, 1994, p. 70)

The perspective of non-Whites tends to include "the centrality of race in history and everyday experience" (Omi & Winant, 1994, p. 71). The perspective of Whites includes "race as 'a peripheral, nonessential reality'" (Omi & Winant, 1994, p. 71).

Challenge to dominant ideology. "Challenging the dominant racial ideology inherently involves not only reconceptualizing one's own racial identity, but a reformulation of the meaning of race in general. To challenge the position of blacks in society is to challenge the position of whites" (Omi & Winant, 1994, p. 91). Villalpando (2003) asserts that critical race theory as a framework can "reveal how the dominant ideology of color-blindness and race neutrality act as a camouflage for the self-interest, power, and privilege of dominant groups in American society" (p. 623). Ladson-Billings states that "CRT theorists attempt to interject minority cultural viewpoints, derived from a common history of oppression, into their efforts to reconstruct a society crumbling under the burden of racial hegemony (Barnes, 1990)" (Ladson-Billings, 1999,

p. 215). Revisionist history is a theme within CRT that challenges dominant ideologies. "It reexamines America's historical record, replacing comforting majoritarian interpretations of events with ones that square more accurately with minorities' experiences" (Delgado & Stefancic, 2001, p. 20). Furthermore, it "offers evidence, sometimes suppressed, in that very record, to support those new interpretations" (Delgado & Stefancic, 2001, p. 20).

Commitment to social justice. Banks and Banks (1995) assert that "pedagogies that merely prepare students to fit into society and to experience social class mobility within existing structures – which are characterized by pernicious class divisions and racial, ethnic, and gender stratification – are not building a democratic and just society" (p. 152). Instead, these pedagogies should "create, recreate, and recover knowledge that can empower people of color to better understand and resist their subordinate status" (Smith-Maddox & Solorzano, 2002, p. 72). Pedagogies with elements of critical race theory can help to foster this type of empowerment because "critical race theory contains an activist dimension" (Delgado & Stefancic, 2001, p. 3). CRT "not only tries to understand our social situation, but to change it; it sets out not only to ascertain how society organizes itself along racial lines and hierarchies, but to transform it for the better" (Delgado & Stefancic, 2001, p. 3). It seeks to develop "independent learners who can sift through arguments and evidence and make reasoned judgments" (Loewen, 1995, p. 313).

Centrality of experiential knowledge. It is important to realize "that the experiential knowledge of people of color is legitimate and critical to understanding racial subordination" (Villalpando, 2003, p. 623). Furthermore, "the experiential knowledge of people of color [should] be centered and viewed as a resource stemming directly from their lived experiences" (Villalpando, 2003, p. 623). "Storytelling, family history, biographies, scenarios, parables, *cuentos*, chronicles, and narratives" (p. 624) can be used to obtain this experiential knowledge.

"Minority status… brings with it a presumed competence to speak about race and racism" (Delgado & Stefancic, 2001, p. 9). "Because of their different histories and experiences with oppression, black, Indian, Asian, and Latino/a writers and thinkers may be able to communicate to their white counterparts matters that the whites are unlikely to know" (Delgado & Stefancic, 2001, p. 9). Delgado and Stefancic reveal that people's everyday experiences lead to different perspectives and viewpoints and contribute to how two people can interpret a single body of evidence very differently. These alternative realities are sometimes the result of the inability for "this country's majority group… [to] grasp what it is like to be nonwhite" (Delgado & Stefancic, 2001, p. 39). Stories and narratives can be used "as a means of building cohesion within minority groups and shattering the mindset created by the stories of the dominant group" (Delgado & Stefancic, 2001, p. 91).

Historical context and interdisciplinary perspective. Historical perspectives and historical roots of ideas should be infused into science curricula (Atwater, 2003). For example, questions should be raised "about the positions from which females and people of color entered various science fields and the positions into which they sometimes were pushed" (Atwater, 2003, p. 12). Revisionist history can be used as a vehicle for revealing perspectives that are different from the typically Eurocentric ones that are included in current school curricula. Textbooks "leave out anything that might reflect badly upon our national character" (Loewen, 1995, p. 13). In order to provide a better education for their students, "schools must help [students] learn how to ask questions about our society and its history and how to figure out answers for [them]selves" (Loewen, 1995, p. 313).

Pertinent Research Findings on Teaching Black Students

Effective Teachers

It can be argued that an effective science teacher must first hone general effective teaching skills. "After years of formal academic preparation, most teachers enter teaching and experience a common jolt. Equipped with theoretical understandings, they lack the practical knowledge that they need for survival" (Liebermann & Miller as cited in MacDonald & Healy, 1999, p. 1). Therefore, beginning teachers may spend the first one to three years of teaching trying to gain this practical knowledge (Adams & Krockover, 1997; Trowbridge, Bybee, & Powell, 2000). Figuring out how to best handle discipline within the classroom is one of the most significant concerns of beginning teachers (Adams & Krockover, 1997). A considerable amount of effort may also be given to determining how to handle "basic organization, record keeping, and communication with students" (Adams & Krockover, 1997, p. 644). Teachers can become more effective in their classrooms as their practical knowledge increases.

An effective teacher provides students with opportunities to attain high levels of achievement. The characteristics of effective teachers are discussed in the subsequent sections. The first part of the discussion focuses on the development of teachers' pedagogical beliefs. Next is a discussion of characteristics of effective teachers of all fields, followed by a discussion of some characteristics specific to effective teachers of science.

Pedagogical philosophies and beliefs. "A classroom is a complex culture (Geertz, 1973; Lieberman, 1992) in which the teachers and students explore, negotiate, and assemble personal knowledge, beliefs, and interpretations of their environments through ongoing epistemological processes (von Glaserfeld, 1987)" (Simmons et al., 2005, p. 932). These

experiences and beliefs are used by teachers to determine "what constitutes good teaching and learning" (Simmons et al., 2005, p. 932) and to develop their pedagogical philosophies.

Simmons et al. (2005) define a philosophy as "a group of statements or beliefs which are generally consistent, coherent, and adequate" (p. 932). When people develop philosophies, they question their "views for adequacy, consistency, and coherence of reasons for believing what [they] do is justified" (Simmons et al., 2005, p. 932). This process involves making explicit the implicit beliefs, assumptions, and values about worldviews (Simmons et al., 2005). Beliefs, assumptions, and values help teachers to develop their pedagogical philosophies and therefore determine how and what does or does not happen in the classroom. These philosophies often begin to form prior to actual teaching experience. Bryan and Atwater (2002) "contend that the process of learning to teach begins with making explicit one's beliefs about teaching and learning" (p. 822).

Beliefs form the foundation of pedagogical philosophies and "are presumed to drive… actions" (Bryan & Atwater, 2002, p. 823). Several definitions exist for the term beliefs. For example, Bryan and Atwater (2002) include a quotation that defines beliefs as "psychologically held understandings, premises, or propositions about the world that are felt to be true (Richardson, 1996, p. 103)." Another quotation from Bryan and Atwater (2002) offers this definition: "beliefs… are accepted as guides for assessing the future, are cited in support of decisions, or are referred to in passing judgment on the behavior of others (Goodenough, 1963, p. 151)." Bryan and Atwater (2002) also share Dewey's definition of beliefs:

> it makes an assertion about some matter of fact or some principle or law. It covers all the matters of which we have no sure knowledge and yet which we are sufficiently confident to act upon and also matters that we now accept as certainly

> true, as knowledge, but which nevertheless may be questioned in the future. (Dewey, 1933, p. 6) (p. 824)

Kagan (1992) stresses that "teachers' beliefs appear to be relatively stable and resistant to change (e.g., Brousseau, Book, & Byers, 1988; Herrmann & Duffy, 1989)" (p. 66). Although "these beliefs tend to be associated with a congruent style of teaching" (Kagan, 1992, p. 66), "teachers are often unaware of their own beliefs, they do not always possess language with which to describe and label their beliefs, and they may be reluctant to espouse them publicly (Cooney, 1985; Thompson, 1984)" (Kagan, 1992, p. 66). Therefore, Kagan recommends that these beliefs that help develop pedagogical philosophies be indirectly elicited.

Noddings (2001) considers caring as a salient belief upon which pedagogical philosophies are formed. Caring can be manifested in different ways. For example, "a teacher might be tough with one student and gentle, almost permissive, with another in roughly similar situations and, in both cases, rightly be called caring" (Noddings, 2001, p. 99). Irvine (2003), who believes "that teaching is synonymous with caring" (p. 42), has heard the following adjectives to describe caring teachers: "*sympathetic*, *dedicated*, *friendly*, … *funny*, [yet] in control" (p. 42). She has also heard caring teachers described as having "firm, fair discipline, high standards and expectations, and [having] an unwillingness… to let students 'slide by'" (Irvine, 2003, p. 43). This type of caring is sometimes misinterpreted as simply harsh discipline (Irvine, 2003). Exhibiting caring can often be problematic because it may "conflict with the hard intellectual and managerial work of teaching" (Noddings, 2001, p. 99) or "with the current interest in professionalization" (p. 99).

Kagan (1992) maintains that two main categories of teacher beliefs are involved in pedagogical philosophies: “teachers’ sense of self-efficacy and content-specific beliefs” (p. 67). For example:

> A teachers’s sense of self-efficacy has been positively related to a number of specific classroom behaviors, including the tendency to use praise rather than criticism; to persevere with low achievers; to be task oriented, enthusiastic, and accepting of student opinion; and to raise students’ levels of achievement in reading and mathematics (Ashton & Webb, 1986; Gibson & Dembo, 1984). (Kagan, 1992, p. 67)

Furthermore, teachers with high self-efficacy “believe that they can make a difference in student’s performance” (Kagan, 1992, p. 67) and “accept responsibility for student failure as well as success” (p. 67). Content-specific beliefs are manifested in a variety of ways. Kagan (1992) states that “science teachers who have conceptual understandings of their fields tend to emphasize conceptual explanations and modify textbooks, whereas teachers with superficial understandings tend to lean heavily on prepared texts, rarely modifying them (Grossman et al., 1989)” (p. 73).

Bryan and Atwater (2002) disclose a “genre of beliefs that [they] propose have a strong bearing on teaching and learning in increasingly diverse classrooms” (p. 822). Most of these beliefs are not conducive to pedagogical philosophies that result in effective teaching of Black (or other non-White) students. For example, Bryan and Atwater state that “one of the most commonly held beliefs by both practicing and prospective teachers is the belief that students from culturally diverse backgrounds are less capable than other students” (p. 827). This belief leads teachers to “construct simpler goals for their instruction and simpler methods of teaching.

Children are afforded less autonomy in the classroom, less opportunity to interact with one another, and most often required to passively "receive" their education" (Bryan & Atwater, 2002, p. 827). This belief about culturally diverse students often also includes the belief that these students lack motivation and control, leading the teachers to have a more controlled and authoritarian classroom (Bryan & Atwater, 2002). Some teachers even believe "that *failure* is simply inevitable for some students – specifically, students of color and/or from low socioeconomic backgrounds" (Bryan & Atwater, 2002, p. 827). Teachers also sometimes believe that the learning problems of students are not related to any of the teachers' beliefs or actions, but to what happens in the lives of the students outside of school (Bryan & Atwater, 2002). One of the most widely held beliefs about outside forces that affect learning involves lack of parental involvement. Some teachers believe that parents from certain cultures just do not want to be involved in the educational process (Bryan & Atwater, 2002). Teachers' "beliefs about acceptable classroom behavior patterns, classroom interactions, and academic performance" may also help to form pedagogical philosophies which are not conducive to effective teaching of Black (or other non-White) students. The teachers expect students to conform to Eurocentric behaviors, interactions, and performances (Bryan & Atwater, 2002) resulting in a "lack of cultural synchronization" (Irvine, 2003, p. 7). Teachers might also hold beliefs portrayed as 'dysconscious racism' (King, 1991; Ladson-Billings, 1994, p. 31)" (p. 830). Dysconscious racism occurs when racial differences are purposefully overlooked and inequities are accepted as a given condition (Bryan & Atwater, 2002; King, 1991). Bryan and Atwater stress that:

> Dysconscious racism is not an effort to purposefully deprive, harm, or punish people on the basis of their race or ethnicity. However, underlying the

> "overlooking" attitude is an awareness of the ways in which some children are privileged in the classroom, while others are disadvantaged (Ladson-Billings, 1994). (p. 830)

Additionally, teachers' beliefs can lead them to give culturally diverse students a different type of attention than their White classmates. The attention given to culturally diverse students is often related to behavior, whereas the attention given to White students is based more on academic performance (Bryan & Atwater, 2002). Furthermore, White students are often believed to be intrinsically motivated, while other students are believed to be extrinsically motivated (Bryan & Atwater, 2002). Finally, Bryan and Atwater divulge that teachers generally have "lower expectations of diverse students" (p. 831) based on their beliefs that "culturally diverse children are less academically capable" (p. 831)

Certain teaching philosophies and belief systems are more conducive than others to effective teaching. The following sections share more possible facets of the pedagogical philosophies of effective teachers.

All fields. Many opinions exist about what makes a teacher effective (Arends, 1994). Arends elaborates:

> Some have argued that an effective teacher is one who can establish rapport with students and a nurturing, caring environment for personal development. Others have defined an effective teacher as a person who has love for learning and a superior command of a particular academic subject. Still others argue that an effective teacher is one who can activate student energy to work toward a more just and humane social order. (p. 8)

Arends also states:

- Effective teachers have control of the **knowledge bases** on teaching and learning and use this knowledge to guide the science and art of their teaching practice.
- Effective teachers command a **repertoire** of best teaching practices (models, strategies, procedures) and can use these to instruct children in classrooms and to work with adults in the school setting.
- Effective teachers have the dispositions and skills to approach all aspects of their work in a **reflective**, collegial, and problem-solving manner.
- Effective teachers view learning to teach as a **lifelong process** and have dispositions and skills for working toward improving their own teaching as well as improving schools. (p. 9)

Tell (2001) writes about a conversation with Lee Shulman in which Shulman shares that he believes that "good teaching includes nurturing the moral and spiritual development, the civic engagement, and the socialization of students" (p. 6). Cochran-Smith (1995) adds that effective teachers:

> regard teaching as a political activity and embrace social change as part of the job – teachers who enter the profession not expecting to carry on business as usual but prepared to join other educators and parents in major reforms. (p. 494)

Irvine (2003) asserts:

> While it is essential for teachers to have a mastery of content knowledge and pedagogical skills, these characteristics are not sufficient. To be effective in today's diverse schools, teachers must be culturally sensitive, view teaching as a calling, have a sense of identity with their students, and care about them deeply.

> Effective teachers are also "dreamkeepers" and advocates for their students. (p. xi)

An effective teacher realizes that "any knowledge worth having is inextricably linked to culture" (Meier, 1989, p. 12 as cited in Irvine, 2003, p. 65). These teachers:

> tend to be knowledgeable, sensitive, and comfortable with students' language, style of presentation, community values, traditions, rituals, legends, myths, history, symbols, and norms. Using their cultural expertise, they help students make appropriate adaptations for and transitions into mainstream culture. (Irvine, 2003, p. 55-56)

Irvine points out that although these teachers typically share the race of their students, this is not always the case. "Some White teachers are excellent instructors for students of color and… some teachers of color are ineffective with culturally diverse students" (Ladson-Billings 1995 as cited in Irvine, 2003, p. 53). So, how are these effective teachers described by Irvine developed? Banks (1994) promotes multicultural education. Ladson-Billings recommends that teachers use a culturally relevant pedagogy in order to be effective. Irvine and Gay promote culturally responsive teaching for effectiveness.

The goal of multicultural education as expressed by Banks (1994) is "to reform the school and other educational institutions so that students from diverse racial, ethnic, and social-class groups will experience educational equality" (p. 3). An effective teacher is "able to identify, to differentiate, and to understand the meanings of each dimension of multicultural education" (p. 4). Banks' five dimensions of multicultural education are "(1) *content integration*, (2) *the knowledge construction process*, (3) *prejudice reduction*, (4) *an equity*

pedagogy, and (5) *an empowering school culture and social structure*" (p. 4). Banks describes these dimensions in the following ways:

1. Content integration deals with the extent to which teachers use examples and content from a variety of cultures and groups to illustrate key concepts, principles, generalizations, and theories in their subject area or discipline. (p. 5)
2. The knowledge construction process relates to the extent to which teachers help students to understand, investigate, and determine how the implicit cultural assumptions, frames of references, perspectives, and biases within a discipline influence the ways in which knowledge is constructed within it. (p. 5)
3. [The] dimension [of prejudice reduction] focuses on the characteristics of students' racial attitudes and how they can be modified by teaching methods and materials. (p. 5)
4. An equity pedagogy exists when teachers modify their teaching in ways that facilitate the academic achievement of students from diverse racial, cultural, and social-class groups. This includes using a variety of teaching styles that are consistent with the wide range of learning styles within various cultural and ethnic groups. (p. 5)
5. Grouping and labeling practices, sports participation, disproportionality in achievement, and the interaction of the staff and the students across ethnic and racial lines are among the components of the school culture that must be examined to create a school culture that empowers students from diverse racial, cultural, and ethnic groups. (p. 5)

Atwater (2003) discusses how these five dimensions are essential to science education. With content integration, examples and content "to illustrate contributions made by different groups" (p. 12) must be "infused in the science curriculum and are not viewed as extra material 'if there is time'" (p. 12). Revealed in this science content should be historical perspectives and historical

roots of ideas. Atwater asserts that it is important to point out during the knowledge construction process in science that science is not completely objective and does indeed contain biases. Science teachers can take steps to reduce prejudice "by examining their notions of student abilities, their own attitudes toward science, the images that they and their students have of prototypical 'scientist,' and students' belief about ability" (Atwater, 2003, p.14). "Appropriate use of manipulatives and hands-on activities, group work, and a wide range of experience[s] contribute to an equity pedagogy in the classroom" (Atwater, 2003, p. 19). Science curricular and instructional practices may require systemic regulation to best facilitate an empowering school structure and social structure. Some pertinent areas for science education are "tracking, assessment and evaluation, and career development" (Atwater, 2003, p. 19).

Ladson-Billings describes what makes culturally relevant teaching effective. A culturally relevant pedagogy "helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (Ladson-Billings, 1995, p. 469). The importance of multilingualism and the role of students' home languages are recognized in a culturally relevant pedagogy (Johns, 2011). A teacher who implements a culturally relevant pedagogy allows "students to maintain their cultural integrity while succeeding academically" (Ladson-Billings, 1995, p. 476). While encouraging academic success and cultural competence, they also "help students to recognize, understand, and critique current social inequities" (Ladson-Billings, 1995, p. 476). Teachers who employ a culturally relevant pedagogy view "their pedagogy as art" (Ladson-Billings, 1995, p. 478), "themselves as members of the community" (Ladson-Billings, 1995, p. 478), and "teaching as a way to give back to the community" (Ladson-Billings, 1995, p. 478). Ladson-Billings explains (1995):

> The teachers demonstrated their commitment to these conceptions of self and others in a consistent and deliberate manner. Students were not permitted to choose failure in their classrooms. They cajoled, nagged, pestered, and bribed the students to work at high intellectual levels. Absent from their discourse about students was the "language of lacking." (p. 479)

Culturally relevant teachers consciously decide to become a part of their students' community and instill community pride in their students. These teachers know "the larger sociopolitical context of the school-community-nation-world" (Ladson-Billings, 2001, p. 120) because they widely expose themselves. Culturally relevant teachers intentionally create classroom environments that promote the academic success, cultural competence, and critical consciousness of their students by "maintain[ing] fluid student-teacher relationships, demonstrate[ing] a connectedness with all of the students, develop[ing] a community of learners, [and] encourage[ing] students to learn collaboratively and be responsible for another" (Ladson-Billings, 1995, p. 480).

One way culturally relevant teachers maintain fluid student-teacher relationships is by allowing the students to act as teachers and experts. The community of learners is developed by stressing academic success for the class as a whole rather than individual success. All of the students are responsible for the academic success of their classmates. Culturally relevant teachers stress that "knowledge is not static; it is shared, recycled, and constructed" (p. 481). Also, "knowledge must be viewed critically" (p. 481). Culturally relevant teachers have a pedagogy that allows students to learn from the teacher and each other. Furthermore, culturally relevant teachers have a passion for knowledge and learning. Additionally, they "*scaffold*, or build bridges, to facilitate learning" (p. 481). Culturally relevant teachers fight "students' *right*-

answer approach to school tasks without putting the students' [*sic*] down" (p. 482). Finally, culturally relevant teachers often help their "students to choose both the standards by which they [are] evaluated and the pieces of evidence they [want] to use as proof of their mastery of particular concepts and skills" (p. 482).

Irvine (2003) expresses many characteristics of culturally responsive teachers. They are aware of the influences of culture on the behavioral and mental ecology of classrooms and are able to respond to these influences. They "give attention to the immediate needs and cultural experiences of the students they teach" (Irvine, 2003, p. 67). Culturally responsive teachers dedicate time, inside and outside of the classroom, to develop personal relationships with their students. This is done daily and spontaneously. Their students are allowed to share personal stories during class time to which the teacher listens patiently and nonjudgmentally. Culturally responsive teachers also share stories from their personal lives with their students. As compared to their peers, culturally responsive teachers "wait longer for students to respond, and probe, prompt, praise, and encourage more lavishly" (Irvine, 2003, p. 67). Furthermore, these teachers differ with their "pacing, timing, and coverage of materials" (p. 67). Included in their repertoire are "acceptance of students' ideas, frequent feedback, demonstrations, explanations, questions, rephrases, reviews, drills, recitations, monitoring, individualizing, summarizing, and reinforcing" (p. 68). Culturally responsive teachers take advantage of "teachable moments" by using such things as catastrophic events and students' concerns to drive instruction. Because "they understand the interplay of instructional context and culture,… they examine their actions, instructional goals, methods, and materials in reference to their students' cultural experiences and preferred learning environment" (p. 68). Culturally responsive teachers value the cultural knowledge of their students and use this information to help students make connections between

prior and new knowledge. These teachers even "probe the school, community, and home environments… for insights into" (p. 68) the "abilities, preferences and motivations" (p. 68) of their students.

According to Gay (2002), culturally responsive teachers develop "a knowledge base about ethnic and cultural diversity" (p. 108), learn how to use this knowledge in developing "culturally responsive curriculum designs and instructional strategies" (p. 108), create classroom environments which help maximize learning for students, implement "effective cross-cultural communication" (p. 110), and match "instructional techniques to the learning styles of diverse students" (p. 112).

All of the descriptions given for what constitutes an effective teacher convey that these teachers have a tremendous role to play. Ladson-Billings (2001) summarizes effective teachers as those who make "sure that students achieve, develop a positive sense of themselves, and develop a commitment to larger social and community concerns." (p. 16). Darling-Hammond (2002) describes "an effective teacher of diverse students" as one who understands individuals in "nonstereotypical ways while acknowledging and comprehending the ways in which culture and context influence their lives and learning" (p. 209).

Science fields. In addition to possessing these skills needed to be an effective teacher in any field, effective secondary science teachers should possess some additional characteristics. *Science for all Americans* (Rutherford & Ahlgren, 1990) details many characteristics of effective science teachers. For example, science teachers should:

1. give students problems which "require them to decide what evidence is relevant and to offer their own interpretations of what the evidence means" (Rutherford & Ahlgren, 1990, p. 188);

2. “emphasize clear expression, because the role of evidence and the unambiguous replication of evidence cannot be understood without some struggle to express one’s own procedures, findings, and ideas rigorously, and to decode the accounts of others” (p. 189);
3. “help students to acquire both scientific knowledge of the world and scientific habits of mind at the same time” (p. 190);
4. emphasize “understanding rather than vocabulary” (p. 190) and “introduce technical terms only as needed to clarify thinking and promote effective communication” (p. 190);
5. accept, foster, incorporate, and discipline curiosity (p. 190);
6. “establish a learning environment in which students are able to broaden and deepen their response to the beauty of ideas, methods, tools, structures, objects, and living organisms” (p. 191);
7. realize that “science involves feelings of severe anxiety and fear of failure” (p. 192) for some students and “assure students that they understand the problem and will work with them to overcome it” (p. 192);
8. “make sure students have some sense of success in learning science… and they should deemphasize getting all the right answers as being the main criterion for success” (p. 192); and
9. “select learning materials that illustrate the contribution of women and minorities, bring in role models, and make clear to female and minority students that they are expected to study the same subjects at the same level as everyone else and to perform as well” (p. 192).

An effective science teacher demonstrates “to students that all cultures (including their own) participate in science” (Luft, 1998, p. 111). Furthermore, these teachers “help students see

themselves as future scientists and appreciate the multicultural history of science" (Allen-Sommerville, 1996, p. 23).

The National Research Council (NRC) (1996) has developed standards for effective science teaching. The six main areas covered by these standards are the: "planning of inquiry-based science programs, planning of inquiry-based science programs the actions taken to guide and facilitate student learning, assessments made of teaching and learning, developments of environments that enable students to learn science, creation of communities of science learners, and, planning and development of the school science program" (p. 4).

In general, these standards state that:

> Good teachers of science create environments in which they and their students work together as active learners. They have continually expanding theoretical and practical knowledge about science, learning, and science teaching. They use assessments of students and of their own teaching to plan and conduct their teaching. They build strong, sustained relationships with students that are grounded in their knowledge of students' similarities and differences. And they are active as members of science-learning communities.
>
> (National Research Council, 1996, p. 4)

For greater detail please refer to Appendix A.

Trowbridge, Bybee and Powell (2000) stress that a science teacher must "*be prepared*" (p. 13) in order to be effective. They define prepared as having "knowledge of their scientific discipline,… understanding the purposes of science teaching, organizing science instruction, understanding student learning, and managing the classroom" (p. 13). According to Trowbridge et al., individual science teachers best know what they need to do in order to be most effective.

However, they specify that the following continually occur: “demonstrating an adequate understanding of scientific knowledge… and the role of science in our society, an adequate understanding of scientific inquiry…., an adequate awareness of educational foundations and the place of science education as a discipline in the larger realm of education, n adequate understanding of and ability to use teaching methods…., and adequate interpersonal relations and an enthusiasm for working with all students” (Trowbridge et al., 2000, pp. 13-14). Trowbridge et al. also look to psychological research to determine characteristics of effective secondary science teachers. They use psychological principles to stress the importance of learner-centered pedagogy. Many of these suggestions are in line with characteristics already mentioned. For example, an effective science teacher “provides opportunities for students to explore ideas and make connections among extant scientific knowledge, new information, and their current conceptions” (p. 322). Trowbridge et al. suggest that inquiry-oriented activities be used to explore these ideas and make these connections. Another example they share: an effective science teacher “encourages students to elaborate and generalize their understandings through new inquiries, investigations, debates, group projects, and personal actions that require higher-order thinking” (p. 322). A suggestion given by Trowbridge et al. for effective science teaching not yet mentioned is the use of authentic assessments which “are embedded in the instructional activities and are consistent with the goals of the science program” (p. 323). Furthermore these assessments are free from bias and incorporate self-reflection from students. Effective assessments will be further discussed in another section of this chapter.

Some researchers (Atwater, 1993; Barton, 2000; Luft, 1998) assert that a science teacher needs to be a multicultural science teacher in order to be effective. A multicultural science teacher believes that “all students can learn science “ and that “every student is worthwhile to

have in the science classroom" (Atwater, 1993, p. 35). Atwater (1993) summarizes effective science teachers in the following way:

> Science teachers should possess a profound understanding of the motivations, aspirations, learning modes, linguistics, and culture of their students if they are to be effective science teachers. Students should not be perceived as deficient or disadvantaged simply because they do not share the teacher's beliefs and attitudes. Instead, teachers should try to take advantage of the different cultural perspectives and viewpoints that exist in their classrooms. (p. 35)

Effective Curricula

"Clearly, there are few issues that are more central to the experience that students have in schools than the content of the curriculum and the ways in which it is mediated" (Eisner, 1993, p. 38). Curricula emerge in several forms in schools. Levine (1994) points out that a curriculum includes "what we teach, how we teach, and the entire learning environment that surrounds the child" (p. 168). Eisner (1985) and Joseph (2000) refer to an explicit, implicit, and null curriculum. The explicit curriculum is "obviously stated" (Joseph, 2000, p. 3) and is "manifest[ed] in publicly stated goals of education" (p. 3). The implicit curriculum is "not official, often referred to as 'hidden'," (p. 3) and consists of "learning and interaction that occurs that is not explicitly announced in school programs" (p. 4). Bloom (as cited in Gordon, 1984) argues that the hidden (implicit) curriculum is more effective than the manifested (explicit) curriculum due to its pervasiveness and consistency throughout the many years students are schooled. "What is systematically excluded, neglected, or not considered" (Joseph, 2000, p. 4) is referred to as the null curriculum.

Bybee (1991) describes intended, actual, and learned curricula. He defines the intended curriculum as "the curriculum represented by those persons and policies describing a particular emphasis" (Bybee, 1991, p. 294). "What science teachers use and what they do" (p. 296) is the actual curriculum. "Learned curriculum refers to the knowledge, attitudes, and skills that educators intend to influence via the curriculum" (p. 298) – what the students are learning. Cuban (1995) refers to the official, taught, learned, and tested curricula. "The *official* curriculum is what state and district officials set forth in curricular frameworks and courses of study" (p. 5). The content chosen and presented by individual teachers is the taught curriculum. Like Bybee, Cuban defines the learned curriculum as what students learn. In regards to the tested curriculum, Cuban states, "To the degree that teachers attend to such tests, portions of the official and taught curricula merge. But what is tested is a limited part of what is intended by policymakers, taught by teachers, and learned by students (p. 5). The *enacted* curriculum has also been discussed. It is defined by Blank (2002) as "the subject content and instructional practices taught in classrooms and experienced by students, as reported by teachers" (p. 87) With all of these forms of curricula, what are some suggestions for enhancing its effectiveness for Black science students?

Some suggestions for effective curricula were implied in discussing characteristics of effective teachers. For example, the curriculum should embrace social change, be multicultural, culturally relevant, and culturally responsive. However, what are some of the specific suggestions for effective curricula?

Peterson (1994) promotes a "social-justice classroom" (p. 30) and asserts that "the voices and lives of the students are an integral part of the curriculum" (p. 30). He points out that acquiring a social-justice classroom is a goal that is always sought by good teachers, but is

usually not completely met. He shares some aspects he uses in trying to reach this goal. Peterson believes the following five characteristics are vital parts of the curriculum in a social-justice classroom: (a) "a curriculum grounded in the lives of students," (b) "dialogue," (c) "a questioning/problem-solving approach," (d) "an emphasis on critiquing bias and attitudes," and (e) "the teaching of activism for social justice" (p. 30). He also stresses that "a well-organized class based on collaboration and student participation is a prerequisite for implementing such a program" (p. 30). Peterson affirms that students best remember information "if it relates to what they already know, if they have input into what 'stuff' is actually studied, and if it is studied through activities rather than just listening" (p. 33). Furthermore, Peterson promotes a curriculum that helps "students understand the world and their relationship to it by encouraging social action" (p. 38).

Cross (1995) promotes a culturally coherent curriculum. Using culture as the framework for curriculum creates a curriculum "that allows children to view the world through multiple perspectives" (p. 75). Cross expounds:

> As culture moves to the foreground, the boundaries between schools, the lives of children, and larger society become blurred: knowledge and skills come together, and cognitive, affective, and psychomotor development are viewed as inseparable parts of the whole person. (p. 75)

A culturally coherent curriculum allows students "to see themselves and others in the curriculum" (p 75). Additionally, "the identity of children is inseparable from the curriculum of schools and from cultural contexts" (p. 75). With this type of curriculum, the students first use their own communities for the basis of their learning before branching out to "their state, nation,

and world" (p. 75). "Community members, official records, tours, and newspapers" (p. 75) are among the resources used in a culturally coherent curriculum. Cross adds:

> Children begin to understand themselves and each other, how their current experiences are connected to their past, and how they fit into a larger society. The curriculum becomes a means to connecting "book learning" to larger ideas, to humanity, to life. (p. 75)

What are some of the guidelines for creating a culturally coherent curriculum? "First, the context for curriculum becomes participatory, inquiry driven, dialogic, and critical" (p. 77). All cultural alternatives are subject to examination and are not viewed as positive or negative. "Second, the curriculum become situated around big ideas, real life, personal and societal issues, choices, and emotional issues" (p. 77). "Connections between meaningful experiences and ideas" (pp. 77-78) shape the curriculum. Students "become constructors of knowledge" (p. 78). "Third, the context expands beyond the classroom and textbooks" (p. 78). Teachers, textbooks, and the written curriculum are not the sole sources of knowledge. A culturally coherent curriculum is not one in which information about cultures is added in cursory forms to an existing curriculum, but is a totally transformed curriculum. A culturally coherent curriculum allows schools to become learning communities that can best meet the needs of its students. Moreover, it prepares students "to pursue additional education, to interact within a diverse society, to find out how they fit into society, and to think about the rest of their lives" (p. 84). In stressing the importance of a culturally coherent curriculum, Cross concludes:

> To continue to deny the significance of culture in the curriculum, especially the culture of minority groups, is to "foster mediocre classroom experiences and exacerbate existing barriers to the attainment of academic success" for minority

> children (Lomotey, 1990, p. 6). We must acknowledge the curriculum has a profound and lasting effect on children. We must also recognize that children and who they are have a profound effect on the curriculum. (p. 85)

Once an effective curriculum is determined, there are other factors which affect its implementation. These factors come mainly in the form of resources. "In particular, these resources include (1) the money necessary to purchase materials, facilities, and time and expertise for adequate in-service training; (2) the availability of appropriate materials, expertise, and teaching personnel; and (3) administrative moral and organizational support" (Boyd, 1978, p. 607).

Effective Assessment and Evaluation

In addition to effective teaching and effective curricula, Black students also need effective assessment and evaluation. What kinds of suggestions exist for effective assessment and evaluation? Bigelow (1994) recommends that assignments "be flexible enough to adjust to students' interests or abilities" (p. 58) and that "the method of evaluating students… should embody… flexibility and caring" (p. 59).

Angelo (1999) recommends that assessment be done "as if learning matters most" (p. 4). He argues that "we've sometimes confused means and ends, doing assessment as if the assessment process matters most, losing ourselves in the technique and the method" (p. 4). Angelo promotes learning communities with "students and teachers working intensively and collaboratively toward shared, significant learning goals" (p. 4). These learning communities must "value self-examination, reflection, and continuous improvement" (p. 5). Angelo asserts that when learning matters most, "assessment practices should help students develop the skills, dispositions, and knowledge needed to:"

- Engage actively – intellectually and emotionally – in their academic work.
- Set and maintain realistically high, personally meaningful expectations and goals.
- Provide, receive, and make use of regular, timely, specific feedback.
- Become explicitly aware of their values, beliefs, preconceptions, and prior learning, and be willing to unlearn when necessary.
- Work in ways that recognize (and stretch) their present learning styles or preferences and levels of development.
- Seek and find connections to real-world applications of what they're learning.
- Understand and value the criteria, standards, and methods by which they are assessed and evaluated.
- Work regularly and productively with academic staff.
- Work regularly and productively with other students.
- Invest as much engaged time and high-quality effort as possible in academic work. (p. 6)

Black and Wiliam (1998) believe that assessment, specifically formative assessment "is at the heart of effective teaching" (p. 140). "All of those activities undertaken by teachers – and by their students in assessing themselves – that provide information to be used as feedback to modify teaching and learning activities" (p. 140) is the definition given for *assessment* by Black and Wiliam. It "becomes *formative assessment* when the evidence is actually used to adapt the teaching to meet student needs" (p. 140). Since instructional adjustments may be made as a result of formative assessment, evaluation is an integral part. Formative assessment is in contrast to *summative assessment* "which generally takes place after a period of instruction and requires making a judgment about the learning that has occurred" (Boston, 2002, p. 1). With formative

assessment, “the dialogue between pupils and a teacher should be thoughtful, reflective, focused to evoke and explore understanding, and conducted so that all pupils have an opportunity to think and to express their ideas” (Black & Wiliam, 1998, p. 144). Some suggestions given by Black and Wiliam for implementing this type of dialogue in the classroom include increasing wait time, using think-pair-share, allowing students to vote for an answer out of a list of options, and asking each student to write down an answer followed by the reading of a selected few. Another aspect of formative assessment described by Black and Wiliam is “that the feedback on tests, seatwork, and homework should give each pupil guidance on how to improve, and each pupil must be given help and an opportunity to work on improvement” (p. 144). When students are given specific feedback, they are enabled to determine their strengths and weaknesses. This helps them determine how they can make improvements. Boston (2002) adds that “formative assessment helps support the expectation that all children can learn to high levels and counteracts the cycle in which students attribute poor performance to lack of ability and therefore become discouraged and unwilling to invest in further learning (Ames, 1992; Vispoel & Austin, 1995)” (p. 2). Black and Wiliam (1998) suggest that the following question guide the teacher’s thinking about assessment, “Do I really know enough about the understanding of my pupils to be able to help each of them” (p. 144)?

Shepard (2000) bases her suggestions for effective assessment and evaluation on the following cognitive and constructivist learning theories: “intellectual abilities are socially and culturally developed, learners construct knowledge and understandings within a social context, new learning is shaped by prior knowledge and cultural perspectives, intelligent thought involves “metacognition” or self monitoring of learning and thinking, deep understanding is principled and supports transfer, and cognitive performance depends on dispositions and personal identity”

(p. 8). Shepard affirms that the form and content of assessment "must be changed to better represent important thinking and problem solving skills" (p.7). Furthermore, Shepard insists "that teachers need help in fending off the distorting and de-motivating effects of external assessments" (p. 7). Additionally, assessment should be connected to ongoing instruction and should match the subject standards. Shepard also recommends "open-ended performance tasks to ensure that students are able to reason critically, to solve complex problems, and to apply their knowledge in real-world contexts" (p. 8). Shepard adds that "if instructional goals include developing students' metacognitive abilities, fostering important dispositions, and socializing students into the discourse and practices of academic disciplines, then it is essential that classroom routines and corresponding assessments reflect these goals as well" (p. 8). She summarizes her ideas for assessment and evaluation in the following way:

- Challenging tasks to elicit higher order thinking
- Addresses learning processes as well as learning outcomes
- As on-going process, integrated with instruction
- Used formatively in support of student learning
- Expectations visible to students
- Students active in evaluating their own work
- Used to evaluate teaching as well as student learning. (p. 8)

Having an effective teacher who creates an effective curriculum, and uses effective assessments and evaluations hopefully sets the stage for high achievement for Black science students. It is a tremendous task for teachers. However, caring teachers will feel that the results are worth the effort.

CHAPTER 3

METHODOLOGY

The research questions that will guide this study are:

1. What kinds of pedagogical philosophies related to instructional strategies, curriculum, assessment, and evaluation do science teachers hold?
2. What kinds of pedagogical philosophies related to race do science teachers hold?
3. How do teachers negotiate their philosophies surrounding race to create their science curricula, instructional strategies, and kinds of assessments used?

In order to best answer these research questions, critical race theory is chosen as the theoretical framework and the case study is chosen as the methodological framework.

Theoretical Framework

The main goal of this study is to determine how to be an effective teacher of science to Black students. Critical race theory (CRT) will be used as the theoretical framework in this effort. "As a theoretical framework, CRT provides a way to expand our examination of race that moves beyond cultural deficit models (Banfield, 1970; Berstein, 1977; Lewis, 1968; Valencia, 1997: Valencia & Solorzano, 1997)" (Smith-Maddox & Solorzano, 2002, p. 71). Lynn (1999) shares that a critical race theory allows an analysis of the "failure of the educational system of the United States to properly educate the majority of culturally and racially subordinated students" (p. 611). According to Ladson-Billings and Tate (1995), using CRT within educational research involves three propositions:

1. Race continues to be a significant factor in determining inequity in the United States.
2. U.S. society is based on property rights.
3. The intersection of race and property creates an analytic tool through which we can understand social (and, consequently, school) inequity. (p. 48)

CRT allows different voices to be added to the canon (Ladson-Billings, 1999) and helps Black students and teachers to see that they are not alone in their situations (Sleeter & Bernal, 2004). Tate (1997) points out that " CRT recognizes that racism is endemic in the U.S. society" (p. 234) and is "deeply ingrained legally, culturally, and even psychologically" (p. 234). CRT "is a social justice paradigm that seeks to combat racism as part of a larger goal of ending all forms of subordination" (Sleeter & Bernal, 2004, p. 246). As a framework in teacher education, CRT is "a developing theoretical, conceptual, methodological, and pedagogical strategy" (Sleeter & Bernal, 2004, p. 245) that:

> simultaneously tries to (a) foreground race and racism in the curriculum; (b) challenge the traditional paradigms, methods, texts, and separate discourse on race, gender, and class by showing how these social constructs intersect to affect communities of color; (c) help us focus on the racialized and genderized experiences of communities of color; (d) offer a liberatory and transformative method when examining racial, gender, and class discrimination; and (e) use the transdisciplinary knowledge and methodological base of ethnic studies, women's studies, sociology, history, and the law to better understand the various forms of discrimination. (Smith-Maddox & Solorzano, 2002, pp. 68-69)

CRT as a theoretical framework allows race to be used as a tool for analysis rather than only being viewed as "a biological or socially constructed category" (Sleeter & Bernal, 2004, p. 246)

within the entities being researched. This type of analysis provides more meaningful information about the educational obstacles that exist for Black students and how these students are able to surmount these obstacles (Sleeter & Bernal, 2004). Critical race theory as a theoretical framework, allows such binaries as male/female, public/private, White/non-White, able/disabled, native/foreign, and wealthy/poor to be emphasized rather than treated the same as taken-for-granted norms (Ladson-Billings & Donnor, 2005). Anything associated with Whiteness and White privilege is viewed as the norm. Anything "other than White and middle class" (Ladson-Billings, 1999, p. 219) is perceived as diverse and is often viewed as inferior. "Because Eurocentrism and White privilege appear to be the norm, many people continue to believe that education in the United States is a meritocratic, unbiased, and fair process" (Sleeter & Bernal, 2004, p. 249). However, with CRT, prominent notions of fairness, neutrality, color blindness, and meritocracy are seen as camouflages for those trying to maintain the power structures associated with White privilege (Sleeter & Bernal, 2004; Tate, 1997). CRT offers knowledge that helps in dismantling these notions.

Some proponents for the use of critical race theory within educational research suggest that "multicultural research conducted within a CRT framework might offer a way to understand and analyze the multiple identities and knowledges of people of color without essentializing their various experiences" (Sleeter & Bernal, 2004, p. 246). It is argued that without the CRT perspective, the stories of the dominant culture with the incorporation of *other* is often the result (Sleeter & Bernal, 2004). Ladson-Billings and Tate (1997) state that "as critical race theory scholars we unabashedly reject a paradigm that attempts to be everything to everyone and consequently becomes nothing for anyone, allowing the status quo to prevail" (p. 62). CRT helps to create a better alternative by promoting the exploration and utilization of the "shared and

individual experiences of race, class, gender, immigration status, language, and sexuality in education" (Sleeter & Bernal, 2004, p. 248). Understanding everyone's experiences and how the experiences "may represent confirmation or counterknowledge of the way society works" is a significant aspect of CRT (Ladson-Billings, 1999). Sleeter and Bernal elaborate that CRT is beneficial within multiculturalism because

> a) it theorizes about race while also addressing the intersectionality of racism, classism, sexism, and other forms of oppression; b) it challenges Eurocentric epistemologies and dominant ideologies such as meritocracy, objectivity, and neutrality; and c) it uses counterstorytelling as a methodological and pedagogical tool. (p. 245)

This approach encourages a movement "away from simply celebrating difference and reducing prejudice, to a 'critical race curriculum' that actively names and challenges racism and other forms of injustice" (Sleeter & Bernal, 2004, p. 248). Lynn (1999) asserts that we are "in desperate need of some direction and guidance as to how we can begin to build a democracy that acknowledges and incorporates all of its citizenry and takes into account the special gifts that each person; each community; and each cultural, racial, and ethnic group has to offer" (p.622). Lynn considers the use of critical race pedagogy in schools as a starting point for this transformation of U.S. society. Furthermore, critical race pedagogy can be used "as a vehicle for counteracting the devaluation of racially oppressed students" (Lynn, 1999, p. 611).

In using CRT as a theoretical framework in educational research, Tate (1997) recommends that five questions be considered:

1. How do federalism, traditional values, standards, established property interests, and choice "serve as vehicles to limit and bind the educational opportunities of students of color" (p. 234)?
2. As a theoretical or conceptual framework, does it provide the most powerful analysis?
3. "What limitations do these perspectives have and how can they be reinterpreted to the advantage of traditionally underserved students of color?" (p. 235)
4. If other theoretical perspectives fail to address the camouflages of neutrality, objectivity, color blindness, and meritocracy; "what does CRT offer to remedy this lack of conceptual depth" (p. 235)?
5. "Do we in education challenge ahistorical treatment of education, equity, and students of color" and "what role should experiential knowledge of race, class, and gender play in educational discourse" (p. 235)?

Tate views these questions as a starting point and stresses that they "should be viewed as a part of an iterative project of scholarship and social justice" (p. 235). The research should be ongoing to account for ever-changing realities of race and society (Tate, 1997).

Methodological Framework

Miller and Salkind (2002) affirm that case studies can be used to determine unique characteristics and common features shared by all people associated with a particular phenomenon. The case study allows "naturalistic everyday, cultural and interactional phenomena" (Hitchcock & Hughes, 1995, p. 316) to be "studied in their own right and in their own territory" (p. 316). Hitchcock and Hughes (1995) add:

> the qualitative or ethnographic case study is the research approach that offers most to teachers because its principal rationale is to reproduce social action in its

> natural setting, i.e. classrooms and workplaces, and that it can be used either to test existing theory or practice in an everyday environment, or it can be used to develop new theory or improve and evaluate existing professional practice. (p. 323)

The phenomenon of interest in this study is the pedagogical philosophies held by science teachers that relate to their beliefs about Black students and how to increase levels of achievement for Black students in high school science classes. This study uses the case study method to determine commonalities that exist within science classrooms and with science teachers of these Black students. Miles and Huberman (1994) note that it is important to understand individual cases; however, findings can be enhanced through comparative analysis of several individual cases. Stake (2006) recommends that four to ten cases be used in a multiple case study. This study consists of four cases that were compared and contrasted. Using multiple case studies was a useful research design for this study because it provided more detail about teachers' philosophies related to helping to increase the levels of achievement of Black students in science.

Data collection consisted of demographic questionnaires (see Appendix B), interviews (see Appendix C), classroom observations, field notes, and teachers' artifacts. The instrument included as Appendix D was used to guide classroom observations. It was created by the researcher based on the literature review. The parts of the teachers' science curricula that helped to form the specific units observed by the researcher are being referred to as *artifacts*. Teachers' artifacts were evaluated using the instrument included as Appendix E. This instrument was created by the researcher for a previous, unpublished study that she conducted. It is based on standards found in a publication by the American Association for the Advancement of Science

(AAAS) (1993) entitled *Benchmarks for Science Literacy* [*Benchmarks*] and a publication by the National Research Council (1996) entitled the *National Science Education Standards* [*NSES*]. The following guideline was used to conduct data collection:

1. Administer demographic questionnaires,
2. Further describe study and complete first interviews (based on interview protocol),
3. Observe classes (three times per teacher),
4. Collect teachers' artifacts (related to classes observed), and
5. Complete follow-up interviews (to discuss observations and artifacts).

Data collection began in February in order to allow teachers time to establish classroom routines and procedures and to build relationships with students. The teachers received and had ample time to complete the demographic surveys prior to the first interviews. This allowed the researcher an opportunity to incorporate into the interviews any questions that may have arisen from the survey answers. Each teacher was observed for a minimum of three ninety-minute class periods. Data collection was completed by the middle of May.

Selection of Schools and Participants

Eisner (1993) shares a description of the "three populations or tiers" (p. 39) of schools in the United States. About 10% of the nation's schools are in the first tier and "are succeeding by any reasonable set of educational standards" (Eisner, 1993, p. 39). "These schools tend to serve affluent White communities and are located in wealthy suburban areas" (p. 39). Approximately 50% of the nation's schools are in the second tier and "are now making efforts to improve an essentially mediocre level of school performance" (p. 39). Over 33% of the nation's schools fall into the third tier. These schools "are located largely in the center city with large percentages of minority students" (p. 39). These are typically the schools most in need of improvement.

Because urban schools with predominately Black and/or Latino student populations are typically the schools that are most in need of improvement, the researcher wanted to include a school from this category in this study. Additionally, a contrasting school – such as a school that does not have a predominately Black student body, yet has a substantial number of Black students – was desired. Proposals to conduct this study were submitted to several school districts that had schools that met the characteristics of each tier. However, the only proposal that was accepted was one that was submitted to a district that includes only two high schools. Neither of these high schools is in tier three. However, they do fit the characteristics of the contrasting school that was desired. The majority of students in these high schools are classified as White, and about 15% of the students in each school are classified as Black.

After the researcher received permission from the school district to collect data, she emailed the principals of the schools and requested recommendations for participants. She specifically asked the principals to "please identify the science teachers at your school who have exhibited a desire to help increase the levels of achievement for Black students and have been effective in doing so." One of the principals responded with four recommendations. All four of these teachers were contacted. One of these recommended teachers agreed to participate in this study. The researcher was never able to communicate with the other principal. However, she was able to meet with one of the assistant principals who, along with a science teacher in the school, was able to recommend three teachers. All three of these recommended teachers agreed to participate in the study.

Data Analysis

Data included interview transcripts, field notes, demographic questionnaires, and teachers' artifacts. The wealth of data collected allowed a detailed description of the cases to

emerge (Creswell, 1998). The researcher read through the data multiple times. She then coded the data by searching for answers to the research questions. This coding combined with "categorization and analytic reflection" (Saldana, 2009, p. 13) led to the development of themes for each case. An "analysis of themes" (Creswell, 1998, p. 63) within and across cases was completed. Finally, "interpretation of the meaning of the case[s]" (Creswell, 1998, p. 63) was developed and the "lessons learned" (p. 63) were shared.

Description of Sites and Participants

Teachers at two public high schools in a district located in the Southeastern region of the United States participated in this study. In 2011, the total population for the county in which the schools are located was 69,637 (U.S. Census Bureau, 2012). This population was comprised of 82% "White", 12 % "Black," 0.5% "American Indian and Alaska Native," 3.5% "Asian," 0.1% "Native Hawaiian and Other Pacific Islander," 2.0% "Multi-Racial," and 9.1% "Hispanic or Latino Origin" persons (U.S. Census Bureau, 2012). This data source pointed out that "Hispanics may be of any race, so also are included in applicable race categories" (U.S. Census Bureau, 2012). Therefore, the number of "Hispanic or Latino Origin" persons may comprise a higher percentage of the population than indicated.

School One. Three of the participants are teachers at School One. This school is in a rural area and has a large percentage of White students. More specifically, 62% of the students during the 2010-2011 school year were White, 15% were Black, 11% were "Hispanic," 7% were Asian, and 4% were Multi-Racial (Department of Education, 2011). The total school enrollment was 1,831 during the Fall semester and 1,767 during the Spring semester (Department of Education, 2011).

Jonathan (pseudonym) is a male who describes himself as Black/African-American. He is originally from a town that is in a county that neighbors the county in which he now resides and works. He describes his hometown as a rural town with approximately 60% of the residents being White and 40% being Black. He designates the high school he attended as a public high school where 90% of the students were White and 10% were Black. During a time when Jonathan was unemployed after graduating from college, he decided to become a substitute teacher. Since he already had a degree in biology, he was encouraged to become a science teacher. Jonathan originally obtained a provisional general science teacher certificate, but he later earned a Master of Arts in Science Education and an Educational Leadership certificate. He describes his undergraduate university as a rural, public university where about 80% of the students were White and about 20% were Black. At the time of this study, Jonathan was teaching one Biology class and two Zoology classes. Both classes were considered to be Academic level.

Matthew (pseudonym) describes himself as a White male. He is originally from a rural Canadian town which he describes as being "almost all white." He also states that although the town was only "about 20 minutes outside of a large city," agriculture was its main industry. Matthew describes his high school as a public school where 90% of the students were White. He received his broad-field science teacher certification through a traditional route. He attended two different Canadian universities. Matthew described one of these universities as a public, suburban university that was 60 to 70 percent White and is a well known agriculture and veterinary school. He described the other university as a public, urban school that was 55 to 60 percent White and is well known for medicine, business, engineering, and education. He also shared that this university was one of the largest research universities in Canada. During the

school year in which Matthew participated in this study, he taught three Biology classes. Two of these classes are Honors level and the other one is Academic level. Matthew lives in a suburban county that neighbors the county in which he works.

Blair (pseudonym), who describes herself as a White female, is originally from an urban, coastal town in a Southern state (a different state from the one in which she currently resides and works). She shared that her hometown has a "large military presence and transient population." She attended a public high school that had approximately 1800 students. About 56% of the students in this school were Black and about 34% were White. Blair became certified in biology and general science through a university certification program after receiving a Bachelor of Science in Biology, a Master of Science in Microbiology, and working as an environmental scientist. She describes her undergraduate institution as a rural university with a student population that was approximately 77% White, 8% Asian, 5% Hispanic, and 4% Black. Blair was teaching one Earth Systems class and two Biology classes during the time in which she participated in this study. The Earth Systems class is specifically for ESOL (English as Second Official Language) students. Her classes were not Honors level and were described as being Academic level. Blair lives in a more urban county that neighbors the county in which she works.

School Two. The other participant is a teacher at School Two. This school is also located in a rural area and has a student population that is predominately White. During the 2010-2011 school year, the student population was approximately 63% White and 15% Black (Department of Education, 2011). The student population also included approximately 3% Multi-Racial, 7% Asian, and 12% "Hispanic" students (Department of Education, 2011). The

total enrollment during the Fall semester was approximately 1,585. The enrollment dropped to 1,569 during the Spring semester (Department of Education, 2011).

Helen (pseudonym) describes herself as a White female. She moved multiple times as a child, but graduated from a high school that is approximately 40 miles from the county in which she currently resides and works. Helen described the high school from which she graduated as a suburban school with a predominantly White student population. She believed that about 13% of the student population was Asian and about 5 to 6% was Black at the time she attended. Helen became certified in biology and general science through university certification courses after working as a lab technician and an environmental technician. After becoming certified, she earned a Master of Education degree in science education. She attended a predominately White research university. Helen taught an Advanced Placement Biology class and two Honors Biology classes at the time of this study. Helen lives in the county in which she works.

Limitations to the Study

There are several limitations to this study. One limitation involves the analysis of data through the lens of the researcher. The researcher is a Black female who was able to experience success in the science field. She holds some beliefs about the factors that were involved in her ability to succeed in science. She also holds some beliefs about various barriers she faced. It was important to the researcher to prevent these beliefs from guiding her interpretations of the data. The researcher also needed to be conscious of her insider versus outsider (Banks, 1998) roles during data collection. Banks states that, in seeking the "truth," both insider and outsider perspectives are necessary. In this data collection effort, the researcher also incorporated member checks of data and verifications for field notes by requesting assistance from the participating teachers.

The Black female researcher served as the interviewer. This may have prevented the non-Black participants from being totally honest. To help alleviate this possibility, the researcher reminded the participants that this study is about helping the students rather than judging the teachers. The participants were told that they were the experts and the researcher wanted to learn from them. The researcher also assured the participants that her goal was to focus on the positive and seek ways to increase levels of achievement for ALL students. Furthermore, the researcher shared with the participants that steps were being taken to protect the privacy of the individuals, schools, and districts. For example, the names of the participants, schools and locations would not be used. The data would be labeled in a way that only the researcher would know from whom the data were obtained. Additionally, the interviewer had to remember to remain objective during the interviews so that her beliefs did not influence the participants.

Receiving approval from the Institutional Review Board (IRB) to conduct this study was a challenge. Initially, IRB approval was not received because approval from school districts was required for IRB approval. However, all of the school districts wanted proof of IRB approval prior to processing the requests to conduct research in the districts. After IRB approval was finally obtained and requests to conduct research were sent to districts, another limitation developed. The researcher was limited in her selection of schools. Schools were chosen based on proximity and ability to gain access rather than based only on reputation for success with Black science students. Most of the districts to which research proposals were submitted rejected the proposal. Unfortunately, this drastically changed the study. The researcher had wanted two schools that were different in terms of overall student demographics. However, the

schools in which the participants of this study worked were quite similar in terms of student demographics.

CHAPTER 4

RESULTS

The purpose of this study was to learn science teachers' philosophies related to their beliefs about Black students and what might help to increase levels of achievement for Black students in high school science courses. Four high school science teachers – Jonathan, Matthew, Blair, and Helen – participated in this study. All four of the participants worked in the same school district. Three of the four teachers worked in the same high school. The data collected for each participant will be shared as individual cases in this chapter. Each case focuses upon a specific individual bound by a specific context (Hitchcock & Hughes, 1995). In analyzing the individual cases, data from interviews, demographic questionnaires, observation field notes, and teachers' artifacts were used. Information about the races of the students in each class was provided by each participant. The participants obtained this information from computer files that noted the races selected by the students or their parents. The chapter ends with a cross-case analysis to help "deepen understanding" (Miles & Huberman, 1994, p. 173) of the teachers' philosophies related to their beliefs about Black students and what might help to increase their levels of achievement.

Context for Case One

Jonathan (pseudonym) is an African American male who was in his twenty-first year of teaching when he participated in this study. He worked as a substitute teacher prior to becoming a certified science teacher. He has taught science courses at the middle and high school levels.

During the time of this study, Jonathan was teaching academic-level high school biology and zoology courses. The researcher observed Jonathan during his fourth period zoology class. The unit that was observed focused on animal laws and rights. The class was composed of 28 students who were mostly junior and seniors and had already taken general biology. There were 17 males (4 African American, 1 Asian, 1 Latino, 7 White, and 4 Multi-Racial) and 11 females (3 African American, 2 Latina, 5 White, and 1 Multi-Racial) enrolled in the class. On the days the researcher observed Jonathan's zoology class, there were anywhere from 20 to 26 students present.

Jonathan works in School One, which is located in a rural community. During the 2010-2011 school year, 62% of the students attending the school were White, 15% were Black, 11% were "Hispanic," 7% were Asian, and 4% were Multi-Racial (Department of Education, 2011). However, Jonathan's class had the following demographic background: 48.0% White, 25.0% Black, 10.7% "Hispanic," 3.6% Asian, and 17.9% Multi-Racial. The percentages of Black and Multi-Racial students in his class were noticeably higher than the whole-school percentages for these groups of students. The percentages for White and Asian students were noticeably lower than the whole-school percentages. The percentage of "Hispanic" students in the class was essentially equivalent to the whole-school percentage.

Jonathan was observed for three ninety-minute periods. Among the artifacts shared with the researcher by Jonathan are PowerPoint presentations, question handouts, and web addresses for some of the videos showed during the animal laws and rights unit. There were some other pertinent artifacts that the researcher viewed as a result of observing lessons, such as bulletin board items and additional videos. There was not a textbook used for this class.

Case One: Jonathan

> According to Jonathan, a student who has attained a high level of achievement in science: can take all the facts and the data that we give'em, but then can be faced with some kind of problem that's not necessarily a A/B or C/D problem. You know, some problem that's kinda out-of-the-box but use all that knowledge that they've gained to make a reasonable explanation or hypothesis based on what they've seen. So, you know, I'm more about them learning to think than actually just learning the facts.

In other words a student needs to be able "to take everything you know and make a reasonable judgment about something." Jonathan has many ideas about how to help Black students to attain a high level of achievement in science.

Theme One: Lessons Should Integrate Students' Lives and Opinions and Use a Variety of Instructional and Assessment Strategies

A lot of the data supported Jonathan's belief that teachers should integrate the lives and opinions of the students into lessons and that teachers should use a variety of instructional and assessment strategies. In order to better express this theme, the researcher created categories within the theme. The conclusions for this theme are expressed in terms of Jonathan's beliefs concerning (a) pedagogy, (b) science curriculum, and (c) assessment and evaluation.

Pedagogy. Jonathan has an extensive pedagogical philosophy. He tries "to teach in more of a non-traditional way" and tries to get the students "to think and be more creative." He wants to know the students' opinions about the science topics discussed in class. He encourages the students "to form an opinion based on facts." Jonathan incorporates "a lot of collaborative work" in his classes. He has his students rotate between the various tasks that need to be completed by the groups so that each student can experience each role. For example, during rat

dissections, each student had an opportunity to perform a portion of the dissection as well as be the recorder of data or the person responsible for ensuring the appropriate steps were being taken during the procedure. Jonathan also integrates videos into his lessons. He sees the appropriate video as a good tool for helping to clarify some of the science concepts he covers: "I use a lot of YouTube videos… that will kind of break it more down to their levels so they can understand it." He also sometimes uses videos as a basis for debates. This leads the students to "kind of interact because they have opposing views." Jonathan has often picked a video "that really grabs their attention." The students will then "start asking questions" and then he will "use those questions to kind of cover other stuff." For example, a question about vegetarian diets leads to a discussion about the importance of eating foods that provide all of the nutrients needed by our bodies. In particular, they discussed the importance of vegetarians eating foods that provide proteins. Jonathan likes to "use real-life examples to explain stuff." He wants the material to be "relatable" and "on their level." Videos have also been useful to him in these facets. One of the videos that Jonathan's students viewed during the animal laws and rights unit was about the slaughter of pigs. Some of the questions the students had to answer on the handout for the video not only connected the students' personal lives to the video, but also solicited the students' opinions. For example, they were asked if certain practices revealed in the video were ethical or unethical. They were also asked to explain why. Additionally, they were asked about their diets and if they had engaged in any acts similar to the ones covered in the video.

Jonathan believes "the teacher needs to be nonbiased, because you know we all have our different views of what we think is correct or incorrect." He elaborates:

> You gotta realize when you teach you have a lot of people coming into your room that have their own views, their own moral background, their own ideas of how things go. So

> you wanna present it in a way that it doesn't um, um alienate any of your students to making them think that they're dumb, or you know that they're not right because they don't believe what you believe. But then you do need to present it in a way that's easy enough for, anybody can get it. You know sometimes as science teachers we start talking on this high plane and start using these high-level vocabulary words and we throw off a lot of kids 'cause they can't keep up. So, if you break it down where any and every body can get it and then they make a judgment for themselves, you know, of what they believe and don't believe that's what it means to be effective.

Jonathan stresses that information needs to be presented "in a way that's easy for them to understand." However, he warns that breaking concepts down too much, or oversimplifying concepts, is not a good instructional strategy. He admits that he needs to monitor this for himself, especially because of his middle school teaching background. He shares:

> Sometimes I may have the tendency to break down stuff a little too much. And so one thing I had to learn coming to high school was to be a little more technical and not being so broad. Because in middle school, it is very broad, you know. But in high school, you really have to be more technical.

Jonathan believes that teachers need to "make sure that they are available." Teachers "need to be walking around the classroom asking questions…. and checking work." A teacher "can't have one set strategy that's gonna work with everybody." A teacher needs to try:

> different things; so not lecturing the whole time, not showing videos the whole time, but not doing labs the whole time. You know, trying to have a balance. I think if you do all of those things and you have a safe environment, it will, not only will people feel physically safe, but like if you ask a question, other kids won't be calling you dumb or

> something like that. And you feel like you have the right and the ability to ask the question.

When Jonathan has students who claim that they cannot do an assignment, he will encourage them to try to figure out some aspect of the assignment. Once the students find a starting point, they can usually complete the assignment. When the students are not able or willing to discover this starting point on their own, Jonathan will guide the students until they are able to continue on their own. For example , there was a Black male student who claimed not to be able to answer some of the questions on a handout for a video that had been watched in class. Jonathan began asking the student questions about the video that prompted the student's thinking and memory which enabled the student to complete the assignment.

Jonathan suggests that students who seem to have "problems with reading" be given "more hands-on stuff." Students who are "better with reading" need to be provided with a wide variety topics and subjects rather than be limited "to certain things."

Jonathan explains an issue that he has noticed with some of his coworkers:

> I've had a lot of teachers who have had students and they assume that they're from a single parent or that their parents don't care or they're low economic and stuff. And I know some of those kids and they have supportive parents. They don't live in the projects or anything. But a lot of people, they assume they have different ideas of what they think the Black kids are already like. And if you've already got it in your mind and what they can and can't do, then you're gonna teach them with a very limited, you know, leeway on what they can and cannot do.

Jonathan believes teachers should not make drastic adjustments for the students that they view in this way. He states:

> You need to teach'em like everybody else. You know, don't give them any special points or make things easier. Because, to be honest, you know, people think well they're minorities so I need to make it easier so they have a better chance of succeeding, but that's not helping them. You just need to treat them like everybody else, cause they can do what everybody else can do, you know, but you have to present them in that same environment.

Furthermore, he believes:

> You need to incorporate an overall educational experience. So you got to look at the language arts, the math, the social studies and look at the total student. You can't just emphasize the science…. We need to do a better job of incorporating real-life examples and more activities that reinforce what we're teaching…. I do think more diversity in the teaching and that kind of goes with the life experiences.

Jonathan feels that he can relate to Black students more than some teachers who are not Black, because he knows "where they're coming from because [he's] in that culture…. so [he] can experience that." However, he emphasizes the point that he's "not saying that you just have to be Black to teach Black kids," because he feels as though he does a good job teaching White students although he is not White. Jonathan thinks it is wrong for a student to "get to high school and that's the first time they've had a Black teacher or a male teacher." He has noticed that "the population of students has become diverse, but [not] the people teaching the students." He believes that "the staff should represent the population more." Moreover, this diversity in staff needs to extend beyond the classroom: "We need to have more diversity, and not only in the classroom, but in leadership, too." Jonathan is not fond of the message that a lack of staff diversity may be portraying to the students. He explains:

> If you're a minority, you're just like, well, you know, it's just not for me. You know, education isn't for me. I don't see anybody who looks like me. You know, they're not trying to approach me, you know provide opportunities for me to feel comfortable.

This can lead the students to becoming disengaged.

When Jonathan began thinking about what many of his high achieving Black students had in common, he once again thought about parental support. The parents of these students "had high standards,… were informed,… were available,… came to open house…, wanted meetings,… were calling," but were not "harassing." He elaborates

> If I said I had an issue, or if I notice anything; they were available to the point of me being able to talk to them and to the point that they would listen. You know, they might not totally agree, but we could actually have a conversation, and it wouldn't get like confrontational or accusatory.

He and the parents would work together to resolve the issues. Simply establishing a relationship with the parents was helpful, because the students did not want to do (or refrain from doing) anything that would cause Jonathan to contact their parents. Maintaining contact with parents also helped Jonathan to learn the importance of getting assignments graded in a timely manner. He, the students, and the parents had a better chance of detecting some problems early on because they were all aware of the grades.

Science curriculum. Jonathan believes that the nature of the science curriculum can lead to the poor performance of Black students. "Science is, to me, the main subject that incorporates everything. And, so, if you struggle in any other areas, you're gonna struggle in the science." When Jonathan is asked if the state mandated science curriculum is culturally sensitive or applicable to Black students, he responded:

> I don't really think it is sensitive. Because I guess when you look at the people who are making the decisions on the curriculum, if you look at the makeup of the board, you don't really have a diverse board. So if you have the same group of people who are coming up with these standards, then they are looking at it from their background and their experience. So, I don't think it's really cultural at all and… that's any race. Because you probably don't really have a good representation of Blacks or Hispanics or Asians or anybody else. So, you know, I think it's pretty basic, standard, you know, science curriculum; but as far as being diverse and meeting the needs of the different types of students, it's probably not doing it.

Jonathan was asked how the state mandated science curriculum was culturally insensitive or non-applicable to Black students. He responded:

> I wouldn't really say it's culturally insensitive you know because to me - this is the science teacher in me coming out - science is science; so it's really not a cultural thing you know because science is about problem solving and everybody regardless of the culture can solve problems…. I wouldn't really say the standards are culturally insensitive. I think that it is just culturally neutral. You know, that's not saying in the future it couldn't be culturally insensitive. For what it is right now, I think it's just, it's kinda, it is what it is.

Jonathan elaborates why a curriculum that does not integrate multiple races and cultures can be problematic and once again states that the problem begins at the elementary-school level. Beginning at the elementary level, the science books need to "show more diversity as far as the people that have studied science." He adds, "It's like always some old English guy." The students need to see more "minorities and women" so that all students can see that science can be

"for me." Jonathan tells why this is a big problem for high school teachers, "By the time we get them, you know, you gotta break through all these stereotypes and stuff that they've built up just so you can teach'em." Jonathan believes that students need to be exposed to a science curriculum at a much earlier age and be shown that all races and genders have contributed to the science discipline via a diversified science curriculum. Jonathan shares, "One thing I try to do every time I do a PowerPoint or video or even examples, I try to do it diverse." He elaborates:

> I try to do a variety of faces. You know I don't really try to do the old White man and the uhm lab coat thing. You know I try to do women, men, you know Black, White, you know young, old to try to say every, you know, throughout the course, hopefully they'll see somebody who looks like them. And that lets them know that they can do it, too and not just a certain group, you know, can do it.

The PowerPoint presentations and videos shown during the Animal Rights and Laws unit did include males and females of various cultures, races, and ages. Some of the videos were even filmed in other countries. Additionally, there were posters on the wall of Black and White, male and female scientists with brief descriptions of their scientific contributions. There was not a textbook for this class that could be analyzed for the inclusion of males and females of various cultures, races, and ages.

Assessment and evaluation. Jonathan believes that the ways teachers have traditionally assessed students has possibly lead to stifling students' creativity. He says, "Maybe we've gotten so rubric, multiple choice based that a lot of the kids either they really don't know or can't be creative thinkers." Jonathan pushes his students "to form an opinion based on facts." However, his students sometimes get frustrated and begin questioning him about how many points will be deducted if certain parts of the assignment are not done. He adds:

> I think maybe that's partially our fault because this is the generation of kids who've been tested and tested and tested and rubriced and now they've gotten to the point that they have to have a guideline to be able to do stuff instead of being able to creatively figure it out themselves.

Jonathan has noticed that students who have very strong opinions about issues due to their experiences outside of the classroom are sometimes better able to write about their opinions. In other words, when the issues have arisen as a part of the students' cultures, they can better connect to the topic and can more clearly "arrange their thoughts on why they were for or against it." He also noticed that with some of his lower level students, if he questioned them "they didn't have a problem relaying it; but as far as being able to write it down, you know, they weren't really able to do that as much." These students require more guidance from Jonathan.

Jonathan offered some advice regarding assessment and evaluation designed to increase levels of achievement in science for Black students. Jonathan feels that assessment "shouldn't always be just multiple choice, because we don't live in a multiple choice world." He knows that "a lot of teachers do that because it's easier to grade." Jonathan recommends:

> You need to do more like short answer, essay so you can really see what they're thinking and teach them how to organize their thoughts. I mean a lot of the kids have, um, they have good ideas, but they don't know how to organize it. So, they're just all over the place. So, help them to organize their thoughts.

In addition to multiple choice, short answer, and essay questions; Jonathan also sees matching questions as beneficial for assessing students. Teachers should also sit down and have discussions with students. Jonathan did not share any actual quizzes or tests with the researcher, but the handouts he shared did include short answer and opinion-based questions. For example,

"What in the hoarder's background may have resulted in the hoarding behavior taking place?" was a question asked on the handout for a video on animal hoarding that was shown to the students during the animal laws and rights unit. Jonathan was also observed having discussions with the students. One discussion was about different perceptions held about animals seen as food versus animals not seen as food.

Theme Two: A Non-Threatening Environment and Positive Relationships with Students and Parents are Important

As stated earlier, Jonathan believes a safe environment is vital. He stresses the importance of good classroom management in helping to achieve a safe classroom environment. Teachers must "have your classes under control." "You've gotta have fairness." "You gotta treat everybody the same regardless." He warns, "If they feel you're not fair, they're not gonna learn." He shares that the students "pick up on that" and may stop being receptive to the teacher. Jonathan builds relationships with his students. "I would probably say that if I didn't know them or didn't have a relationship, I probably wouldn't be able to get as much out of them." Jonathan believes that teachers need "to have high standards for all students." He continues, "You have to have high standards, treating those students like everyone else." He then adds:

> I know a lot of people would say, you should have special programs and all this stuff set aside, but we've had special programs for years and it hasn't worked. So, I'm like instead of trying to set stuff aside and make it just, you know, very nice and easy, to try to motivate people to do better, a lot of people just want to get pushed to do better.

Jonathan is "very mobile." He walks around the classroom asking the students questions. He is "constantly moving throughout the labs" so that he does not stay with one group too long and gets to all of the groups. When he is using the board, he makes a "concerted effort to write

on both sides." Since the teacher work station is between the board and the students' desks, Jonathan makes sure to occasionally walk around the teacher workstation so that he is closer to the students. When Jonathan uses PowerPoint presentations, he uses a clicker rather than the computer keyboard to advance the slides so that he can walk around the classroom. He states, "I've noticed, by just me being more active, that helps them remain active." His students know that he will soon be near them, so it helps them to remain on task.

Jonathan believes that in order to maximize learning, students should feel that the classroom is "not a threatening environment." He adds:

> I always try to present myself in a way that if there's something I'm doing or presenting and they're not sure about it that they need to go research it. You know, so I don't make it seem like I'm the go-to person and I know everything. You know, I try to humanize, I guess, myself when I'm teaching. You know, that I can make mistakes and some of the things I say and you're not sure, then research it, you know, for yourself.

He also wants the students to be comfortable with each other. He encourages them to "try to be respectful of everybody's opinion" and to discuss their views "in a non-confrontational way." His students get to a point where "they can actually have an adult conversation." With all aspects of his classes, Jonathan is "very particular on what the boundaries are" and "very big on what [his] expectations are." He shares that this helps to maintain a safe environment even when the lessons reach outside of the classroom. Jonathan discusses a classroom management problem he has noticed:

> I think with classroom management, a lot of times, um, especially with the Black students, Black boys, they get stereotyped into being some thugs or something. And people are already scared of 'em before they all even do anything. So either they're

> going to be scared of them to the point they'll let'em do what they wanna do 'cause they just scared of them; or two, every time they just look like they wanna do something, they'll be all over'em. And so they don't really give'em a chance.

Jonathan does not see that as a non-threatening environment and therefore, does not see it as an environment that is most conducive to high levels of achievement for Black students.

Jonathan stresses to his students:

> I feel like there are certain things, that in any environment, that just shouldn't be stood for. So if like I have guys who are disrespectful toward girls or saying things they don't need to say, you know then, I may, I'll address that on a one-on-one basis but if I see it's an overall like classroom environment thing, then I may say a general – I never really single out a single person – but I'll make a general statement, on in this class, you know "we don't do this" or "we don't do that" And "when you get in the real world, that's not acceptable."

Jonathan also is "very big on the Golden Rule about doing to others." He especially emphasizes this rule during classroom discussions. For example:

> So a lot of times, you know, we'll discuss something, you know we'll discuss something and people will say "oh, those people are evil" or "oh, those people are such and such and that." And I'll try to really say, "Well, think about if you were them and they were you." You know, "What would you want people to say to you to help you change that behavior or encourage you?" So I really try to do more of a "think about how you would feel" kind of situation.

According to Jonathan, many Black students who do well in school are internally motivated. "They have this internal desire to just do good things and do better." Frequently, this

internal motivation is a result of "parents that push and want their kids to do better." There needs to be good "communication between the teachers and students" as well as "the teacher and the parents." Jonathan has also seen the students' desire to earn money or their desire to help people as the bases for the internal motivation of Black students. There are also times that peer pressure plays a role: "You will have groups of kids and that group has decided that they're going to do better." Unfortunately, peer pressure can also prevent the Black students from doing well in school. Although these students have the ability to excel, they "just don't want to be the nerd in class." They "don't want to be the one everybody's picking on", so they do not "push themselves to do what they know they can do." The peer pressure creates an environment that threatens the students' success.

Theme Three: Teachers Should Evaluate Themselves and the "System"

Jonathan believes that teachers need to adjust their egos, because "it doesn't matter how good you think you are if the students don't think you're good." Jonathan warns that it is important for teachers to realize that "if you're failing the majority of your kids, that means you're a failure as a teacher, not their failure as a student." As a teacher, you need to evaluate yourself. "You gotta be willing to soul search and kind of look at what you're doing." As a teacher, you need:

> to be willing to face who you are and kind of work on you. And in the process of working on you, then you'll become a better teacher for them. And when the kids see that you're working on yourself, then it will teach them that they have a right to work on themselves. You know, and make themselves better.

Jonathan points out that most teachers try to "not be racist or stereotypical, but we all are." He adds, "Regardless of your race, you have stereotypes about other people…. Even

people of the same race discriminate against each other." Because of stereotypes, teachers "have a tendency to want to categorize [students who are different from them] or to automatically put limitations on what they can or cannot do." He believes that people need to learn how to identify their stereotypes and learn ways to work passed them. He thinks this is especially important for teachers. As an example, he shared, "I teach a lot of Hispanic kids and so one thing I had to do myself is learn their culture." Furthermore, he asks their advice about what he can do to be a better teacher for them.

Jonathan is not pleased with the distribution of students in higher level versus lower level classes. He has noticed: "When you look at gifted classes or honors or AP, you really don't see a lot of minorities. You know but then if you look at like special ed, it's like full of them." Jonathan attributes behavior issues as one reason students are placed in special education classes. Jonathan feels a better job of re-evaluating these students needs to be done, so that they do not erroneously remain in special education classes. In terms of the higher level classes, Jonathan has noticed another type of problem. Some of his co-workers believe that their classes are too rigorous for certain students.

> They're constantly either trying to get rid of the Black kids, or the Hispanic, or the low achieving kids out of their class by moving them to other classes or they're constantly failing them. And then you'll say, "Well, why they keep failing your class?" And the first thing they say is, "Well, I teach rigor. You know, they just don't have the skills."

Jonathan believes this is often a teacher problem rather than a student problem.

> Sometimes I think, you know, as educators, instead of saying it that way; maybe we're looking at maybe they have the skills, I'm just not doing a good job of getting the skills out of them, you know, and modify it.

The teachers need to evaluate what they can do differently so that they can help their students to be more successful in their classes.

Jonathan believes the lack of diversity with the school's faculty and staff needs to be evaluated. He is concerned about who students can go to when they have problems. He mentions how all of the Black students in his school seem to know him although he does not know many of them. There have been times when Black students he does not know have come to him with problems. Students have told him "I didn't feel like I could go to anybody else." This makes Jonathan question, "Where do the Asian kids go or who do the Hispanic kids go to?" This concern adds to Jonathan's belief that the entire staff of the school needs to become more diverse and more reflective of the student population.

Finally, Jonathan shares that he feels "that the system is broken." The public education system sets some students up to fail and is not designed to allow "these kids to really be as successful as people say they do." Some of the students experience so many failures that they eventually give up. Some of these students do not receive the support they need and are constantly being lead to believe that they are dumb. These students decide, "They're not providing me what I want, so I'll just get it somewhere else." Jonathan thinks that this leads some of these Black students to drop out of school. Jonathan believes that students do better when "they feel like they're a part of the school, a part of the culture." The system needs to better integrate the culture of the students.

Case One Summary

When analyzing Jonathan's beliefs about how to increase levels of achievement for Black students in science, the following themes developed: (a) lessons should integrate the lives and opinions of the students as well as use a variety of instructional and assessment strategies, (b)

teachers should create a non-threatening classroom environment and establish positive relationships with students and parents, and (c) teachers should evaluate themselves and the system as a whole. Jonathan's beliefs can be more specifically summarized as:

- Teachers need to have high expectations for students and treat everyone the same.
- Teachers need to adjust their egos, evaluate themselves, and control the stereotypes they hold.
- Teachers need to use a variety of teaching strategies and assessment techniques.
- Teachers need to be available for students (build relationships) and parents (take advantage of parental support).
- The classroom environment must be non-threatening.
- Students need to be encouraged to think, form opinions, and work collaboratively.
- Students need a stronger science background (with more science emphasis occurring during the elementary school years).
- The curriculum needs to include more "minorities and women" as well as more real-life examples.
- The school staff needs to better mimic the diversity of the student body.

Context for Case Two

Matthew (pseudonym) was in his fifth year of teaching when he participated in this study. He has taught physical science, workplace chemistry, biology, and anatomy. The researcher observed Matthew teaching his first period high school honors biology class during a unit on evolution. The first period class was composed of 31 students who were mostly freshmen. There were 13 males (1 African American, 1 Asian, 1 Latino, and 10 White) and 18 females (3

African American, 1 Latina, 12 White, and 2 Multi-Racial) enrolled in the class. There were 30 to 31 students present on observation days.

Matthew works at School One, which is located in a rural community. During the 2010-2011 school year, the student population was 62% White, 15% Black, 11% "Hispanic," 7% Asian, and 4% Multi-Racial (Department of Education, 2011). Matthew's class had the following demographic background: 70.9% White, 12.9% Black, 6.5% "Hispanic," 3.2% Asian, and 6.5% Multi-Racial. The percentages for every group of students, except for Multi-racial students, were lower in Matthew's class than the overall school percentages. He had a higher percentage of Multi-Racial students than the overall school percentage.

Matthew was observed for four ninety-minute periods. There were no Black students in the first class observed. It was the first day of the unit and the researcher's schedule did not allow her to observe another one of Matthew's classes that day. Since valuable information could still be obtained and the researcher had other observations at that school that day, she continued the observation after realizing there were no Black students in the class. Among the artifacts shared by Matthew were PowerPoint presentations, laboratory activities, homework assignments, project rubric, class handouts, evolution test study guide, and website addresses for some videos shown in class. A textbook for this class did exist. However, Matthew mentioned that he very rarely used it. The textbook was not used during any of the researcher's observations of the evolution unit.

Case Two: Matthew

When Matthew is asked what it means for a student to have a high level of achievement in science, he shared multiple aspects. He began by stating that career choices could be an indicator of science achievement: "a lot of research careers … revolve around science." He also

believes that “just in general for academics, in order to get into colleges and universities, I think you need a background in sciences.” Furthermore, scientific literacy is an indicator of a high level of achievement in science. Students need to be “able to sort of comprehend and understand and communicate new discoveries that are being made in the world today and how they apply to their lives.” Students should be “inquisitive and they wanna know about things.” Additionally, students need to be able to be “contributing member[s] of our society knowing how to, you know, what issues to vote on like environmental issues and political issues and things that affect our country.” Matthew shared his beliefs about being an effective science teacher and helping Black students to reach high levels of achievement in science.

Theme One: Students Need to Be Active and Comfortable

Matthew believes that an effective science teacher plans lessons appropriately and incorporates many laboratories and activities. “Science teachers need to be hands on.” The teacher should provide “lots of hands on activities to kinda demonstrate understanding.” He believes the students need to be “very active,” so he tries to incorporate laboratories or activities “at least two or three times a week.” Sometimes Matthew will begin class with “some sort of lecture for, you know, the first 25 or 30 minutes.” When Matthew’s students are completing worksheets, there are times when “they can work with neighbors across from them.” The students usually complete activities or laboratories in groups “back at their stations.” The students are allowed to determine their own groups and are allowed to remain in these groups unless the students are not “working well or just distracted or talking.” When these problems occur, Matthew assigns students to groups. Matthew elaborates:

> to be an effective teacher I think you need to be able to communicate properly with students. I think you need to have sort of a good sense of humor with students. You

> can't take yourself too seriously. You know, you wanna instill a sense of work ethic, but also make it fun at the same time.

It is very rare for his students to demonstrate behavior that upsets him. If giving them a warning does not correct the misbehavior, he may say something along the lines of, "Listen, this is not what I expect. I want a change…. You need to do this differently." Matthew feels that it is important to let students know when they are doing something wrong. However, "it's unfair to kids to be joking and laughing around and have [*sic*] a good time, then all of a sudden you're just Jekyll and Hyde and start screaming at them."

Matthew describes his disposition as "pretty easygoing…. just basically being very relaxed and humorous with the kids." He likes to tell jokes and stories. Matthew is the main character in some of these jokes and stories that he shares with his class. He believes this makes him "more human and personable." Therefore, students can better relate to him and feel more comfortable in his class. He also shares stories about his family, especially his wife. The personal stories shared by Matthew are sometimes not specifically about biology, but highlight lessons about life. There are even times when they contain both biology and life lessons. For example, he shares what is supposed to be a personal story about deciding where to go "clubbing" and with whom to go clubbing. However, his decision-making process is actually used to illustrate a cladogram.

Matthew is "not one of these teachers that requires complete silence and everybody just quiet and paying attention." He is satisfied with how his class is progressing "as long as I feel like kids are learning and asking questions and on task." In an effort to keep students involved and thinking, Matthew encourages all students to answer questions. He explains:

> I want kids to shout out answers. I'm not overly like "Raise your hand. Everybody be quiet." Wait for one, like if one kid has an answer and they think it's a good answer, then shout it out. Like, we'll talk about it. So kids know that they're pretty safe to give answers, even if it's wrong. I'll be like, "You're getting close" you know, even if I know it's not even close (laughs). You know, you're kind of: keep them interested and don't let them feel rejected about that answer. So every question is a good one. I said as long as, they can ask me any question, like, they want. As long as it's not a silly kind of just, you know ridiculous, just being goofy question. If they're actually inquisitive about it and they want to know about it; I'll answer it as best as I can. So, I think that is kind of one of the best things I do, just as far as getting kids to learn and want to learn.

Matthew states that he feels that inquiry works well with his disposition. However, the activities observed by the researcher were not "true" inquiry activities. Although the students were actively involved, they were following steps outlined on the accompanying handouts.

When school is not in session, students are comfortable texting questions to Matthew. He "think[s] texting is a great way to communicate with kids and it's easy. They don't have to call you up and it's quick." Matthew strives to create a comfortable classroom environment by maintaining a safe classroom environment. "Sometimes they say inappropriate things maybe to one another…. I don't make a huge deal about it." He tells them, "That's not really how we want to phrase that…. You can say that a little bit nicer." He "encourage[s] them to be nice to one another and respectful and respectful to me." Matthew also notes that he stresses laboratory safety in an effort to maintain a safe classroom environment. To keep his students on task, Matthew sometimes uses the following techniques:

> circulating around the room, [giving] nonverbal cues, just giving them a look with the eye or point or just, simply just standing behind them and listening and, uhm, group placements and, you know, separating kids that maybe don't work well together and putting them in groups.

When Matthew is specifically asked how to be an effective teacher of Black students, he says, "I think it would be hard to isolate it as a racial thing." Although Matthew struggled to give an answer for how to be an effective teacher of Black students, he was able to offer some suggestions. He believes "you need to be non-judgmental…. You just have to be yourself like you would treat any other class or any other students." Black students should be taught "like it's any other student." However, Matthew believes that for Black students "at some point, there's a disconnect with certain teachers." This disconnect can prevent comfort and therefore, stifle success.

As mentioned earlier, Matthew stated that he "make[s] an effort to put in as many labs and activities as possible." However, "not all of them are obviously graded labs." He believes some of these laboratories and activities are what he "thinks kids will like or sort of help understanding." Matthew believes "informal assessments like asking questions and things like that" are important. Additionally, there are times that "instead of doing a test" Matthew will give an "alternative assignment or project." During the unit observed by the researcher, the students were assessed via "take-home projects, tests, labs, and homework." To complete one of the take-home projects, students "had to create a PowerPoint presentation." The diversity of assessments helps to keep the students active and comfortable.

Theme Two: Students Need Clear Expectations, Structure, Encouragement, and Motivation

Matthew believes that expectations and "a certain level of classroom discipline" are important to students' academic success. He explains:

> I think they have to have a understanding of there are sorta rules that have to sorta be upheld and there's consequences if you don't. Uhmm, you know that same thing goes with academic expectations like for homework. What's required? You know I think, ahhh, I think a lot of students respond well to structure. I think that's a big thing. I think you have to have a certain structure in your classrooms. What are you doing at the beginning? Well in our class, they know they have first things first. There's homework check. Like get your homework out. Let's look at it. Let's do it. Then they know we've laid out, they've got a certain lesson for 20 minutes where we're going to introduce our topic or review a topic. Then they know they're going to be going into some sort of activity or laboratory. And then they know they come back and then you know uhh, finish up the lesson back at their desk. So, that kind of structure, if they know what's coming, I think you can avoid a lot of discipline issues, uhmm and sort of, it keeps kids focused. If they know that they don't have to just focus for 90 minutes, like nobody can focus for 90 minutes, like you know it's ridiculous. So if they know that if I can get, you know if I say I want 30 minutes of undivided attention where I want your brain working full capacity, then you can kind of you know work at about 75% while you're doing a little activity and then come back, you know. So if they know that they just have to really, really pay attention and kind of stay with it for 30 minutes or so then it's much easier to, you know, relate to them.

Matthew helps to clarify the daily expected class structure by listing the day's topics and activities on a designated section of the classroom's front whiteboard. He also vocalizes what he

expects to occur during the class period. Throughout the class periods, Matthew keeps the students informed about how much time remains to complete each topic or activity. During note-taking times, Matthew uses extra emphasis for the most important parts of the notes. For example, "This is a key thing you might want to write down and star."

Matthew believes that the Black students in his honors classes are motivated by grades. They "are very conscientious of their GPA." There is "definitely sort of a competitiveness to, you know, to achieve and do well in the class." In the academic-level classes, Matthew believes the students "like to have success…. I think they want to do well. I think they wanna understand stuff." However, "as far as personal motivations, it's hard, you know I can't really say what would personally motivate a student. And I think that's a hard part of a teacher's – I think that's one of the challenges… motivation is a huge problem." Matthew sees parental influence as the biggest motivation for students "across all sort of races and ethnicities." He believes the type of influence parents have depends on "socioeconomic status and things like where parents, um, did they go to school? How do they value education? And things like that." Parents need to have an "understanding of the work that goes in it." When thinking about an exceptionally high achieving Black student, Matthew remembers these thoughts:

> I think they don't necessarily, even those kids that are really high achieving, you find that those parents, they're not the parents that stay on them and hound them. I think they've done it, they've done it so effectively at an early age, kind of instilling that, uhm, you know value; that by the time they get to high school, I think they're soooo, just motivated on their own.

Matthew also believes that "taking advantage of extracurricular opportunities and coming in for extra help" will benefit Black students (and later adds "every student").

Matthew advises his students on various aspects of life in an effort to increase their levels of success. For example, he encourages students to become involved in school activities. He mentions the following about student council:

> You talk about those sorts of things and creating a resume and what they need to do at the school to kind of, sort of beef up their resume a little bit. I use it, I guess, mainly for my job perspective I guess in that sense and getting into colleges and universities. It always looks good getting involved.

Matthew also uses controversial topics to encourage students and to enhance their development. For example, different views held about evolution were discussed.

> We talk about ethical issues, but more from a debate like, you know, the stem cell sort of debate when it sort of arose, evolution when you talk about that sort of debate…. I don't ever disregard the belief of religion or I try to avoid, to make sure that's not going to be insulting anybody and their beliefs…. So you kind of create that delicate balance, I guess, in that sense where you're kind of respectable of all beliefs.

Matthew encourages his students to make good decisions. He shared a personal story with his students in which he had to make a decision. He then disclosed:

> I say you have to weigh the outcomes and if those outcomes, you know sometimes you have to take risks. Sometimes what students, young kids have problems doing is deciding what's a risk worth taking and then what's a risk that's going to obviously backfire and cause severe repercussions? So, I kind of make those general things, you know saying think about the outcome. If it's something you can live with, then you realize it's something that's not going to be that serious, then it's probably worth the risk.

> And if it's something that's maybe going to get you put in jail or in a hospital, it might not be worth the risk.

Theme Three: A Relevant Curriculum and Diverse Assessments are Necessary

Matthew is asked to share how he believes the state-mandated science curriculum is culturally sensitive or applicable to Black students. He does not "see any sort of extra effort to make it culturally sensitive." The textbooks "have the token multicultural photos and things like that, but I don't see any sort of, there's nothing in there that says you need to discuss scientists from all ethnicities." He adds:

> it just says talk about scientific discovery and so they may want to, you know, include things like that; but I personally don't see anything in the standards and look at it and say, you know this is, this is racially equitable for all.

Since Matthew did not use a textbook during the evolution unit, the textbook was not evaluated for its inclusion of "scientists from all ethnicities." When Matthew is asked how he believes the state-mandated science curriculum is culturally insensitive or non-applicable to Black students, he answers that he does not know. However, he mentions that "it could be textbook selection" or "experiential sort of like terminology they use that maybe don't apply to certain cultures."

Matthew has suggestions for what can be done in terms of the science curriculum to increase levels of achievement for Black students. For example:

> Well, I think certain things in your lesson. I think it's important to obviously, to talk about things that are relevant to Black students. For example, you can talk about, uhm, scientists and scientific discoveries that you know that African Americans have made throughout the science fields and I think that's important to show. And it's the same thing obviously with gender, with males and females kinda show female scientists which

> sometimes get overlooked when you kinda look at textbooks and things like that. Uhhmm, but you know make topics interesting.

The researcher did not hear Matthew discuss any Black scientists or specifically discuss their contributions to science. Matthew did, however, attempt to include animals from various parts of the world as examples in his PowerPoint presentations. Additionally, he included pictures of people of various races, ethnicities, and genders in his presentations. Matthew also suggests "having a connection in the classroom with them and things like that." Additionally, the curriculum needs to be "socially or culturally relevant as much as possible or at least including it or being conscientious of it as an instructor might, you know, make a greater connection to the learning." He tries to "incorporate stuff that [he] know[s] about" his students. "For example, I know for kids if they're playing sports or if they're in this club and stuff like that. So, if we talk about things, you know I kind of bring up" something that is related to the activity in which the students are involved. Matthew reveals:

> I probably use more of my personal stories. I don't know a lot of their personal details about, you know, who their brothers or sisters are. I don't live in the same town. Uhm, I know teachers I think live in the same town that kind of get to know the parents a little bit. They've kind of seen the kids or maybe their children have grown up in the same, you know, neighborhood. So my experience has to come pretty much from what I see at school and what clubs and athletics and things they're involved in.

Matthew often uses the biology website "Science is Awesome" to integrate science information from other cultures into his lessons. "We learn how things have been, you know, in different countries, are being discovered and what scientists are doing in different countries." He admits

to being “a little bit biased toward Canada” when integrating information about other cultures into his science lessons. He expounds:

> I think as a Canadian, I’m just, I think my students probably learn more about Canada than they did about, you know, about biology this year. So I always talk about it, uhm, when we talk about, you know, biomes. For example, we talk about Canada and the rest of the world.

To increase levels of achievement for Black students, Matthew suggests that “diverse assessment methods” be used. Students need to have “multiple opportunities to demonstrate understanding... diverse methods and diverse ways to show what they know.” “Alternative like informal assessments” should be options for the students. These assessments may be verbal or written. “It could be a project, a PowerPoint. It could be a video.” Matthew thinks that alternative or informal assessments should be included by teachers “as much as you can and as much as the sort of curriculum allows.”

Matthew recalls issues he had with the assessments of one of his Black male students. He had to be flexible with this student because the student did not have access to a computer or the Internet at home. When Matthew suggested that the student has “access to the library.” The student asked, “Well, how am I supposed to get rides?” At one point, Matthew was wondering if the student legitimately had an issue or if it were a “procrastination and effort” problem. Matthew realized:

> From my experience so far, you know he doesn’t come across as overly slacking. Like, he does put an effort into his work. So I think there was some issues with the transportation and trying to get access to Internet or either there was a problem with it.

The experiences with this student served as reminders for Matthew that students home lives can be very different and can affect how they perform in school. Matthew made adaptations to the requirements for this student's assignments so that high levels of achievement were more possible for him.

Case Two Summary

Matthew believes that successful students are active and experience comfort in many aspects of their schooling. Successful students are provided clear expectations, structure, encouragement, and motivation. The curriculum presented to successful students is relevant to them and they are assessed in multiple ways. Some specific suggestions for helping Black students to achieve high levels of achievement in science that were shared by Matthew can be summarized as:

- Teachers need to plan lessons appropriately and include laboratories and activities as often as possible.
- Teachers should have a good sense of humor, be non-judgmental, and treat everyone the same.
- Teachers need to effectively communicate with students (e.g., performance expectations, behavior expectations, class rules, daily class schedules, etc.).
- Teachers need to be able to relate to students and develop lessons that are relevant to students.
- Teachers need to keep parents informed and recognize the importance of the parents' influence on students.
- Teachers need to use diverse assessment methods and allow students multiple opportunities to demonstrate understanding, sometimes without be graded.

- Students need to respect each other and the teacher.
- Students need to be comfortable asking questions and willing to take advantage of opportunities to get extra help.
- The curriculum needs to include science and scientists from all ethnicities and cultures.

Context for Case Three

Blair (pseudonym) is in her third year of teaching at school one when this study is conducted. She worked as an environmental scientist prior to becoming a teacher. While in graduate school, she was a microbiology teaching assistant. Her second period academic-level biology class was observed by the researcher during a unit on evolution. The class was composed of 12 sophomore students. There were 6 males (2 African American, 1 Asian, and 3 White) and 6 females (1 Latina, 4 White, and 1 Multi-Racial). On observation days, 11 to 12 students were present.

The school in which Blair teaches is located in a rural community. During the 2010-2011 school year the student body was 62% White, 15% Black, 11% "Hispanic," 7% Asian, and 4% Multi-Racial (Department of Education, 2011). Blair's class had the following demographic background: 58.3% White, 16.7% Black, 8.3% "Hispanic," 8.3% Asian, and 8.3% Multi-Racial. Her class percentages for White and Black students were close to the overall school percentages. However, her class percentages for Asian and Multi-Racial students are higher than the overall school percentages. The percentage of "Hispanic" students in her class is lower than the overall school percentage.

Blair was observed for three ninety-minute periods. Quizzes, student notes, activity handouts, video handouts, PowerPoint presentations, a unit test, and a test study guide were

included in the artifacts shared by Blair. Copies of the textbook pages related to the evolution unit were also obtained by the researcher.

Case Three: Blair

When Blair is asked what it means for a student to have a high level of achievement in science, she begins by stating that the "student is putting in effort, trying their best." She continues:

> Not every student in my class I think will achieve at the same level. What I would say though, universally for a high level of achievement, true scientific thought, putting the pieces together, telling the story. Science is very much about the process. Can you tell the story, and put the pieces together, and then use that to come up with your own ideas, original ideas?

She explains, "Achievement, I think, is different for each student." She wants to see that students are "motivated and engaged and putting in effort." She believes that students should be encouraged "to reach the high bar." She wants "to see them go the extra mile." Blair shares her advice for helping Black students to reach the high bar.

Theme One: Encouragement, Motivation, and Clear Expectations are Essential

This theme was very prominent in the data provided by Blair. Because of the extent to which it developed, the researcher divided this theme into categories. Blair's' beliefs about encouragement, motivation and expectations are presented in terms of (a) instructional strategies, (b) classroom environment, and (c) effective relationships.

Instructional strategies. Blair tries "to bring a high energy level to the classroom" as one way of encouraging participation of her students. She will "kinda throw a question out to the class. And then they throw it back to me." However there are times it "can get a little fast-

paced." Blair realizes the faster pace and "strategies for how I call on students and the way that I direct my questioning" can be a problem for some of her students. So, she struggles with "toning it down sometimes to kinda bring in those kids that are really struggling."

Blair believes that it is "essential" for a science teacher to have "a strong background" in science in order to be an effective teacher. "Having a lot of background information is just so, so very helpful." Blair explains:

> I try to, like I said, use the background knowledge, tell stories, uhmm, kinda get'em into it. Personal stories from my field experience also helps out a lot. And, you know, I tell them, I say "OK." That's how I get their attention to kinda come back to me if we're getting off task. "Do you guys want to hear a story?" And they do, they do. And they listen and pay attention.

Her strong background knowledge helps Blair to encourage participation from her students. It also helps her to capture and keep the attention of her students.

Blair believes that "high expectations, inquiry, labs, keeping'em motivated and engaged" are needed for effective science teaching. Her students do a lot of group assignments and laboratories. "Usually when they're in their lab groups, they're assigned different roles as far as recording information or reading instructions versus actually doing the pouring – and the week with the dissections – the cutting or whatever." During group assignments there are times when "they have had to collaborate on some graphic organizer-type creative ways to present information, where they have to come up on how to compile different facts." They also work in groups to manipulate and organize science terms into categories. Blair allows her students "to ask each other questions when we're doing classwork and stuff like that." Her main concerns are that the students are "being productive, showing effort" and "on task." To help clarify the class'

expectations for the day; Blair writes the essential question, class assignments, and homework assignments on a designated area of the whiteboard.

The terms that the students manipulate and organize "are usually almost, most of the terms that are on the word wall or sometimes will take a starting point that's on the word wall and get more specific with it during our activity." Blair feels that the use of the word wall is an effective science teaching strategy. Although the word wall may be thought of as "just kind of old," it "has been invaluable" to Blair and her students.

Giving "lots of verbal feedback and praise" is a necessity for Blair. She offers more details about the type of feedback she likes to offer students:

> personalized feedback to where if I know the student is struggling in a particular area or something like that, you know to say "oh I know you were having a tough time with that. You know, you really nailed it on this quiz or on this test and I know we were working on that." And I try to remember the specific things.

A few examples of Blair's verbal praise heard by the researcher are: "Excellent!" "You nailed it!" "Love it!" She also tries to encourage student participation and effort by offering prizes. For example, "for our EOCT review, we had a review game where they answered questions and accumulated points over four or five days for their ultimate prize. And the ultimate prize could be anything they wanted within reason." There are other times when she gives out candy for students' correct answers. Additionally:

> If I feel like we're in a lull, if they're working hard and taking notes but the eyes are starting to droop and we still have a long way to go, I, you know, Jolly Ranchers for the class. Let's get with it. Uhm, so that kind of reward and positive encouragement as long

> as they're doing what they're supposed to be doing, working with me, I'll you know, try to make it you know – 90 minutes is a long way to go sometimes.

When the students cooperate with her, she does what she can to help them to be successful in her class. She stresses to her students that she wants them to succeed: "I let them know from the very beginning that I'm here for them to succeed. It's not for me to be up here talking at them all day. It's for them to succeed."

Blair also has "an extra thing to kind of keep them motivated and you know keep a positive spin on" on class. It is something she refers to as "GGs."

> Oh, I love my GGs. I love my GGs. The kids love the GGs. They call it the word wall. I'm like, that's not the word wall. That's the GG. So, Bulldoggs spelled with two Gs, you know, it's extra G for extra effort…. I use my double Gs for good grades. That's my good grades wall.

After a test, Blair will post the names of the students with the top three grades per period on the GG Wall. She is normally able to get the tests graded quickly enough to be able to post the names the day after the test.

> So the day after a test, they'll come in and go check. Did I make the wall? And then they know of other people, too. You know, who's always up there? Who, you know, is it special, when it's special for them to get up there. They're like "oh, look, you made the word wall!" They call it the word wall. They got me doing it. "You made the wall! You're up there!"

Because it has such a positive spin, Blair continues to use the GG Wall each school year.

Although the students "know what they're supposed to be doing," there are times that adjustments need to be made in order to keep them on task. When it appears to be an issue with

a particular activity, Blair will "change it up so they can stay on task." Blair discusses her approach to lectures:

> I try not to lecture for too long and have, you know break it up with a little bit of practice or break it up with a little bit of, you know, put the focus back on them and have them do things and change it up and make sure they stay interested that way, with the pieces of paper where they can move things around and manipulate stuff where they're not just writing and answering.

In other words, she wants to prevent monotony. The researcher observed another strategy Blair used to reduce monotony and clarify expectations. During some of her lectures, Blair provides her students a handout that guides them through the note-taking process. The handout for the evolution lectures consisted of a combination of fill-in-the-blank items, incomplete concept maps, incomplete tables, and questions to be answered. The handout clarified what concepts would be covered and what concepts were most important.

Classroom environment. Blair admits that sometimes "there's a fair bit of redirection for staying on task." Of course, there are times when the students' being off-task is a behavior issue rather than an instructional issue. When students are having a behavior issue because of their seating arrangement, Blair will create a new seating chart or make adjustments to group assignments. She confesses that there are also times when she finds herself yelling to students. "Focus! Do what you're supposed to be doing."

Blair knows that students "don't really like to be called out for doing the wrong thing." So, she also incorporates preventative measures in an attempt to keep students on task and to increase their chances of succeeding in her class. She divulges:

> I try to make them feel comfortable. I try not to make them feel judged. I feel like I am, I try to be very accepting of them and everything about them. I ask them questions, like I said about the personal life and then I think they do feel comfortable because then they can, you know, sort of confide in me for certain things or they come to me for certain things. So I feel like I do provide an environment where they feel safe to just sort of be and safe to learn and safe from being judged or criticized harshly and unnecessarily. Uhm so I think that, you know, not doing things that are too rigid or too uncomfortable makes them feel safer and just a little bit more relaxed.

From the beginning, she "is very detailed regarding, uhm, how I expect them to behave in class, the electronics policy, academic dishonesty and all of that" as well as overall "course policies and expectations." She says that "the behavior side" of her syllabus is very detailed." Blair affirms

> They figure out pretty quickly with me, you know, what's gonna fly, what's not gonna fly. And I think that just you know, in front of the class, it's very friendly. I'm very friendly. I, you know, I have the rules. You follow my rules. As long as you do that, we'll be fine.

She stresses to the students "we have a job to get done and let's get it done." Blair also emphasizes to students the "need to know how to show… respect for each other and themselves."

Unfortunately, there are times when neither the preventative measures nor redirecting or moving students solves a behavior problem. For example, if a student makes a "degrading comment," Blair will

> pull the student aside and talk with them if not make a, you know, general speech about, you know, why that's clearly wrong and how they need to, you know – they know how to act and to respect themselves and each other.

Blair will typically contact parents only if "there's something exceptionally good or exceptionally not good." She clarifies that "there's this iParent, Parent Portal, whatever system where they can access Infinite Campus and check all their students' grades… and make sure that they are where they need to be." Blair is, however, likely to contact the coaches of her students who are athletes because she has experienced athletes' responding very well to chastisement from coaches.

> If that doesn't take care of it, then I'll have to write them up and they'll have to go through: see an administrator and talk about why they're not behaving in my class, and you know, sit in ISS [in-school suspension] for a day.

When a student is written up, they lose certain privileges (such as being able to exempt final exams). This is one of the reasons that Blair sees this form of disciplining students as a last resort. She is focused on how to best help her students to be successful.

Effective relationships. Blair states that in order to be an effective teacher of Back students, you need a:

> knowledge of the culture, knowledge of the issues that they're dealing with, and the issues that they're bringing to the table…. I would say a knowledge of the background would be helpful. You know, being part of the community, kinda knowing where the kids are coming from.

Blair encourages her students "to embrace their culture and to use" it. "They should feel proud of their heritage." She "discourage[s] any sort of, uhm, discriminating remarks" in the

classroom. It is also important to Blair that none of her students feel "like outsiders and not like, you know, sort of down on themselves." She shares that "a lot of the talk that goes on in the school can be a little bit racist…. So, I try to prohibit that and, you know, encourage them to, you know, feel confident and feel proud." Blair knows that it is important for these students to "feel that they have someone who cares about them."

Blair realizes she needs to be clear about the expectations of her students. She has learned that it is important to be "conscious of how you're addressing the students and the way they respond back to you." She shares a story about a Black male student she confronted in an aggressive manner. He requested, "Don't come at me like that!" After discussing the issue with him, she realized that her aggressiveness incited defensiveness from him. This lead Blair to realize that she needed "to address him in a very calm way and he responds to it." She recognized that this was a good approach with some of her other students, too. She also shares a story about some of her Black students who are naturally louder than what she once felt was comfortable. One of her Black male students has such a "booming voice" that even when "he talks quietly, it still fills the room." At first, this was very challenging for her. Fortunately, she finally reaches an understanding:

> It's just, he's loud; just naturally and he's not malicious. He's not trying to be disrespectful. He's not trying to be bad, but he is loud. So, I try to be sensitive to that. I try to be sensitive to, you know, the different ways that Black students interact.

Furthermore, she has grasped that "how they're used to interacting with each other, that affects how they perform in class and in a classroom environment." She also mentioned the effectiveness of group work again. Some of her Black students tend to be very social. "If they're happy doing science with their friends, then that's a more positive experience." Once

again, Blair recognizes that what is important is that "they're being productive, showing effort, enthusiasm" and "they're on task." Blair reiterated the importance of "setting ground rules and sticking to them." You must always follow "through with any kind of classroom management routines."

When asked what motivates Black students to learn, she states:

> Same I think as other students which would be getting into college, getting a job. You know, what am I gonna do after high school? Am I gonna make money? What am I going to, you know, how can I take what I'm doing in high school and turn it in to something? How can it help me open doors?

She discusses one of her Black male students who is "very-self motivated." He is very successful in her class, but surprisingly to Blair, is "not nerdy at all." She elaborates: "he's very socially, you know very cool kid socially, but he's very driven academically." She is amused by the fact that, although he is very smart and has very high grades, he always wants to do extra credit when it is offered. Blair shares some more of her ideas about what she believes plays roles in his being self-motivated.

> I would imagine he's probably got some, a pretty decent parent or two at home, seems like. You know, he's fairly well-dressed. He talks about the video games, you know, things that I would associate with coming from a, you know, an okay background, an okay home life. His home life seems alright. Uhm, he's driven, he wants to go to college. He, well he says he wants to become a lawyer. He, you know, he says he's very concerned, just personally about keeping his GPA up and doing well. And he has a goal of, of getting out of high school and, and going to college and pursuing these things.

Blair believes that, in addition to his career goals, his parents play a part in this student's self-motivation.

Theme Two: Curriculum and Assessment Need to be Relevant and Effort is Important

Blair has "no idea" how the state-mandated science curriculum is culturally sensitive to Black students. She "wouldn't even know what to look for to determine whether or not it's culturally sensitive" or "culturally biased against Black students." She does not know what an example of "something that is culturally applicable to Black students" would be. She explains, that she could give some examples "if you were talking about like a history curriculum and, oh, if certain people are overlooked or something like that." She immediately realized, "maybe I just hit on something in the science curriculum." She continues:

> Okay, so maybe that's a good point. We talk about zero Black scientists. All of the scientists, we don't talk about very many scientists, we really don't have time to go into the history of science. Uhm, but none of the scientists we talk about are Black. That could be something, uhm, where we just kind of overlook that. But, aside from that, I don't know what it would look like to be culturally sensitive to Black students.

When the researcher evaluated the textbook pages related to the evolution unit, no Black scientists or Black people were pictured. Blair does have some ideas about how to make the science curriculum applicable to Black students. "Making things more culturally relevant" is one of the keys to increasing the chances for academic success for Black students. She offers this advice:

> In terms of the curriculum, I guess you know, making it relevant. Making it relevant to their culture? Making it relevant to, you know, careers that they want to have. Same as you would make anything relevant to anyone else, you know, try to have them connect

> with it…. How would they use it? How would they use the information in a job? What jobs would they be likely to get? What level of education would they need for this job where they could use this particular information?

Blair shared an example of culturally relevant information that was integrated into her previous unit on genetics. She talked about sickle cell anemia and pointed out its connection to African Americans, West Africans, and malaria resistance. Blair also attempts to integrate into her lessons examples related to "pop culture," sports in which her students are involved, "particular jobs" held by her students, and any other "extracurriculars" in which the students may be involved.

> We use just day-to-day examples. I mean, if something is relevant to what I'm teaching at the time, you know, I'll mention it or it'll kind of turn into a story or a side story and then they'll share stories with me.

She also imparts another needed aspect of the curriculum that will increase its relevance. "I think the one big thing is incorporating technology, getting access to technology." You cannot just rely on the textbook, especially when "they've got smartphones in their pockets."

Questioning the students throughout a lesson is a technique often used by Blair to assess her students' learning and evaluate the lesson. During the evolution unit, she measured the achievement levels "with warm ups, review questions, formative assessment throughout the unit and then summative assessment at the end" in the form of a unit test. Both a quiz and the unit test shared by Blair with the researcher included multiple types of questions. Some of the question types used were: matching, short answer, fill-in-the-blank, multiple choice, and essay. The students also had to label and interpret diagrams and categorize facts (e.g. does it relate to macroevolution or microevolution?). Blair also incorporates laboratories and other activities

throughout the unit. The evolution unit observed by the researcher began with an introductory laboratory that connected the new unit to the previous unit ("tie[d] genetics into evolution"). Blair was able to "refer back to that lab" throughout the unit. The introductory laboratory helped Blair to "clear up some misunderstanding" that arose during the unit. It also provided "a good reference point from where they came in" versus where they were as the unit ended.

Blair shares more details about how she evaluates the effectiveness of her teaching.

> I think you can really see in the student work. When the products of what I'm asking them to do – not just tests and quizzes and stuff like that – but when the products, when they can apply their knowledge and show me.

When the student products exceed her expectations, she sometimes thinks: "Wow! I must've, you now I must've done a good job with that. Because, you know, what they gave to me was so good." She believes she has "done a good job when they show me how well they're getting it."

To maximize opportunities for her Black students to experience success, Blair " give[s] a lot of assignments that are effort reinforcement grades where it's kind of like if you do it, you get the grade. If you don't do it, you don't get it." Although she is always willing to provide students extra help she is even more encouraging when a test is in the near future. "Anytime they need to study big before the test, I say 'Come to me. We'll have a review session.'" She will sometimes encourage her students by giving out candy when they answer questions correctly in class.

It is important to Blair that students are appropriately assessed.

> You have to kinda meet the students where they are and I think there's ways of assessing, you know, what they know in science without also assessing can you do this math problem or can you write a grammatically complete sentence? Or can you read on this

> level?... Tests can be designed so that you're really measuring what they know and not, you know, "Can you do this math problem without a calculator" or whatever it is. And also, you know, performance assessments to see "Okay, this is what you can read and present to me on paper. What can you show me in class? Can you do it?" 'Cause science is definitely a lot about actually being able to do it and apply it. Can you show it to me? And you know, I'm not going to take off a point because you misspelled something or because you forgot a comma or whatever. You know, evaluating the science for truly understanding the concept as opposed to evaluating, you know, things that for whatever reason if you have a group of students that's just not up to speed for whatever reason in math, writing, all that.

For example, some of the graphs included on the unit test that were used to determine answers to some of the test questions did not include numbers, but could be interpreted simply by their shapes. Blair also mentions some other possible biases that may materialize in assessments. For example, "a standardized test question, like an EOCT [End of Course Test]-type question and it's asking about a certain ecosystem that they think you live in." If students are not familiar with that particular type of ecosystem, they may not accurately interpret the question. Therefore, their chances of answering it correctly are lowered.

Theme Three: Teachers Need to Understand That Many Factors Can Impact Students' Success

Blair talks about some hindrances to success she has noticed for some of her Black students. One problem she has witnessed is a "lack of effort." She also feels that some students do not do enough "out-of-class studying." She stresses to her students:

> You will not fail this class for lack of understanding. You will fail it for lack of effort because I am here. I will do for you. I will help you. I will do anything you need me to do, but you have to come to me. You have to, you know, reach out if you're struggling.

Another hindrance she has noticed with some of her Black students is: "when it starts to get complicated, and we really have to start doing some critical thinking, they tended to just shut down a little bit more." Furthermore:

> Where it's a lot of reading and being able to explain and in order to explain you kind of have to write a lot and to really show me that you understand. I would say that was difficult for them.

Blair also mentions Black students who possibly have poor literacy skills that are a hindrance to academic success. She says these issues seem to vary by class because she has Black students in one class who go "above and beyond."

Blair shares some more of her racial and cultural beliefs that are not necessarily related to pedagogy, curriculum, assessment, or evaluation. For example, she knows some people who believe "everyone, you know, has the same opportunity, is allowed the same opportunities to achieve." She does not agree with these people.

> I just don't think that is true, and I don't think that, you know, that problems that occur in one community, "oh, those could occur in any community." Yeah, they could occur in any community, but I think that it's wrong to ignore the fact that in some communities certain things are bigger problems than in others. And so because, I think, that because that is true that certain problems are more common in certain communities than others, then that translates into, yes, race is going to be a factor, you know, in education certainly and in other areas as well.

Blair gives an example more specific to Black students. "If they're coming from poor areas or if they have parents that were, you know, disrupted families; if they're falling behind on basic literacy skills perhaps," this "will affect them throughout their career, uh, their academic career."

Blair thinks that it is important to develop positive relationships with her students.

> I make sure that they're, you know also aside from the academics, doing okay, you know, socially, hanging out. Who, who they're choosing to associate with. You know, we, most of my students are pretty comfortable telling me information, uhm, which you know sometimes is too much. Uhm, but at the same time, I feel like I would rather know and I'm glad that they feel comfortable enough to talk about it. So, you know, we, we kind of aside from academics make sure we have that, a little bit of that social relationship where we know that, you know, make sure that everything is okay. And I think that feeling like that, they feel more comfortable in class and then more comfortable with me as a teacher and learning and, you know, relating with me."

She also states that going "to more games" could help to increase the level of comfort between her and her students. She believes that showing students support in out-of-class activities helps the teacher to develop a positive relationship with the students.

Blair senses that many teachers in her school lack knowledge about best helping Black students to be academically successful. She offers this advice:

> I would say just you know again maybe educating teachers on what they can do to, you know, reach out to parents in a more effective way. Uhm, maybe educate teachers who are not as experienced in dealing with, you know, Black students because they haven't been around it or been exposed to it. What is the best way to kinda get the student back on board? And if there are differences, then we should be educated about how to go

about dealing with these differences. I don't want to assume differences. But I mean I think it's clear that there are, but I would like to be, you know, educated about them. Ok, how do I take these differences that may be a challenge and deal with them effectively?

Case Three Summary

The themes that developed from Blair's beliefs about increasing levels of achievement for Black science students are (a) encouragement, motivation, and clear expectations are essential, (b) curriculum and assessment need to be relevant and effort is important, and (c) teachers need to understand that many factors impact students' success. Blair's advice for helping Black students to reach high levels of achievement can more specifically be summarized as:

- Teachers need to have a strong science background.
- Teachers should have high expectation for students and these expectations should be clear to the students.
- Teachers should provide incentives, motivation, verbal feedback, and praise to students.
- Teachers should vary instructional and assessment techniques. The assessments should be only about science (not math, reading, or grammar).
- Teachers need effective classroom management and routines. (Teachers should seek assistance from coaches.)
- Teachers should recognize and understand cultural differences and biases, as well as promote cultural pride. (Teachers need to be better educated in these areas.)
- Teachers need to be available for students and develop positive relationships with students.
- Students need to be comfortable, motivated, engaged, on task, and productive.
- The curriculum needs to be culturally relevant and incorporate technology.

Context for Case Four

Helen (pseudonym) is a White female who is in her ninth year of teaching at the time of the study. She worked as both a laboratory technician and an environmental technician prior to becoming a teacher. Helen was observed during her second period honors biology class. They were completing a unit on genetics. Many of the students in this class are freshmen who had the ability to skip ninth grade physical science. The class was composed of 22 students. There were 6 males (1 African American and 5 White) and 16 females (2 African American, 13 White, and 1 Multi-racial). On the days the researcher observed this class, there were 20 to 21 students present.

Helen is the only teacher in the study who works at School Two. Like School One, School Two is in a rural community. During the 2010-2011 school year, the student population was approximately 63% White and 15% Black (Department of Education, 2011). The student population also included approximately 3% Multi-Racial, 7% Asian, and 12% "Hispanic" students (Department of Education, 2011). In Helen's class, 81.8% of the students were White. This percentage is substantially higher than the percentage of White students school-wide. The percentage of Black students in Helen's class was 13.6%. This percentage is slightly lower than the overall percentage of Black students in the school. Although there was only one Multi-Racial student in Helen's class, the percentage for Multi-Racial students in her class was 4.5% and is higher than the overall school percentage. There were no students in Helen's class who classified themselves as Asian or "Hispanic."

Helen was observed for three ninety-minute classes. Artifacts shared by Helen include a PowerPoint presentation, laboratory activity, guided reading handout, quiz, test review guide,

video handout, and student notes. The researcher also obtained copies of the textbook pages that coincide with the genetics unit.

Case Four: Helen

Although the researcher often found it difficult to get Helen to talk, she was able to get her to discuss some of her beliefs about teaching. When Helen is asked to describe what indicates that a student has a high level of achievement in science, she provides the following answer.

> A high level of achievement would be, I think it's like the critical thinking skills. Not just being able to regurgitate information, but I like the kids who, if I'm doing notes, they can kind of put everything together and then they'll ask questions where I know they're putting all the different parts together and trying to figure it out.

Helen shares her beliefs about how to best help Black students to reach high levels of achievement in science.

Theme One: Effective Teachers Use Varied, Meaningful Instruction and Assessment and are Caring, Encouraging, and Fair

> Helen believes that being caring is a necessity for effective science teachers.
>
> If they are caring about their students and try to get them involved in learning and not in just being the sole or being the center of attention as the teacher, but trying to get the kids to focus, put the focus more on them and what they are doing.

An effective teacher will also allow students to "do and show me things rather than just answer questions." She adds, "I mean, a lot of times we test them and sometimes they don't do well on a test but it doesn't necessarily show what they know." Helen thinks that students' performances on tests are not always good indicators of what the students know. It is possible that "they're

just having a bad day or they read the question wrong, something like that." For this reason, Helen provides opportunities for her students to explain their understandings to her. She explains:

> If we asked open-ended questions where they could explain, kids, even though they hate doing those; they tend to kind of, they do better on those. Because they're, it's not just a right or wrong answer. They can explain why they're thinking a certain way. Um, and I think that's a issue that we have with our standardized testing is that either it's right or it's wrong. Sometimes they'll interpret a question completely different than what the question is actually asking for.

Helen believes that questions can be interpreted differently by different students. Being able to explain, rather than being expected to give a specific answer, helps students to overcome interpretation problems. Therefore, the students' chances for high levels of achievement are increased. Helen's test did include open-ended questions.

Helen uses a variety of instructional strategies. "Almost every day they have at least some type of group project or partner project that they would work on." Some examples of the group project are "making a poster" or visiting different laboratory stations. The laboratory stations typically consist of some type of activity (e.g. creating Punnett squares, putting pictures of meiosis phases in order, working on a pedigree, etc.) along with questions to be answered by the students. Helen has established routines for laboratory work.

> Usually I will have everything set up at their lab station already. Uhm, and then if it's something we have to share, like if we're looking at pond water or something like that, then I will put it on a cart or on the front table. And so, they know one person from each group, uhm, comes and gets it when, at the time that they need it.

Students also regularly have “more independent work.” For instance, worksheets are usually completed individually.

When Helen is asked what kinds of instructional strategies she recommends for helping to increase levels of achievement for Black students, she says to have “them do artwork and like drawings and stuff; kind of make it more of a visual process.” She adds that she includes “lots of pictures and videos” in her daily lessons. Helen believes that Black students sometimes “need a more structured environment.” Her Black students tend “to be more social.” Because they are more social, Helen believes that Black students benefit from working in groups. However, she finds that there are times that they “get off topic.” She states, “It’s difficult to manage keeping them focused and on topic when they’re working in groups.” For this reason, even when the students are working in groups, they often need structure in order to remain on task.

Helen keeps the students on task by “walking around the room, seeing if they need help.” There was a time the researcher observed a Black male student who reluctantly raised his hand for help, but was not noticed by Helen. This student was not assertive in seeking the help he needed. There are times when students ask for help that Helen concludes other students may be better able than her to assist the student who needs help. “I’ll put them with someone else who is better at teaching or, you know, thinks that they can teach it to another student. Sometimes they learn better from another student than from me.” Additionally, she thinks it is sometimes valuable for students to reach a level of frustration that they work through on their own. Helen shares, “I think I jump in too quickly to help them instead of having them be frustrated and try to figure it out on their own.”

Helen’s instruction is guided by the state-mandated science curriculum. When Helen is asked if the state-mandated science curriculum is applicable or culturally sensitive to Black

students, she initially responds, “I have no idea.” After giving the question some more thought, she answers:

> The curriculum itself, I don’t think is; but you can put into it, like there’s areas, like the genetics unit, where you can put things into it that would make it more applicable to different races. But it, I don’t think the curriculum itself guides teachers in a specific direction.

The researcher found no information or pictures applicable to Black students in the textbook pages that were used with the genetics unit. The PowerPoint presentation shared by Helen with the researcher included pictures of many different animals and only three people. All three people pictured were White. Helen next reveals, “I guess make it so that it is meaningful to them somehow.” You should “bring up their own personal experiences.” For example, she discusses “the different diseases that for whatever reasons affect certain ethnicities more than others.” She also “would like to focus more on anatomy-type stuff because that’s interesting to them and they; it’s something that’s actually useful, they can learn and apply it to later in life.” However, Helen points out:

> Everybody is held accountable for teaching the same things and you can’t just focus on one area that you like. So everybody is held accountable for that and as far as colleges are concerned, there’s kind of a similar rigor within all the high schools. That these are the things that colleges expect that you have already learned.

Although Helen appreciates the accountability aspect of the state-mandated curriculum, she does not like that she is somewhat limited in covering topics that are more meaningful to her students. Her students often ask, “Why do I need to know this?” There are times Helen believes the answer to this question is, “You don’t really need to know this.” Depending on the career goals

of some of her students, Helen does not see how some concepts connect to the knowledge the students need for those careers.

Helen tries "to treat everybody fairly," so she "hope[s] it comes off that I treat everyone fairly." She also encourages her students to be "nice to other or… polite and use their manners as best as they can." If students misbehave, her first step in trying to correct the problem is "just talking to them individually." However, she sometimes needs to go a step farther. "Occasionally, I have to ask them to go out into the hallway and then talk to them out there." Helen believes that her "overall body language" is often enough to prevent or correct behavior issues. For example, if the students detect that she sighs or takes a deep breath, they interpret it as a warning. Several times, the researcher witnessed Helen correcting students by saying, "Focus!" When a student started singing, Helen shook her head and said, "No, no, no!"

Helen does not distinguish between her students based on race. "I kind of do everything the same for everybody. Uhm, you know I kind of pick the kids who are having trouble. I do what I can to help them." She continues, "I think if they have a good relationship with the teacher, uhm, that helps them want to learn. Like, sometimes if a teacher, if they just don't get along, they'll just not want to work for that teacher." Helen believes that it is imperative for teachers to show students that they care about them. She shares more details: "show like I care that you graduate. I care that you do well. Um, not just 'This is my job,' but 'I personally have an interest in what happens with you.'" Helen believes that a caring teacher must sometimes support students in non-classroom environments. Helen also reveals that she likes to support the extracurricular activities of her students.

> There are a couple in that class who play basketball, so I went to two of their basketball games, a soccer game, things like that. Some of my older students that have jobs around

here, like if I see them, I'll say "hi" you know at Wendy's or Zaxby's or wherever they work.

She is a sponsor of the Habitat for Humanity club, "so I try to get them to join that." Providing support in these ways helps to develop a good relationship with the students.

Helen assessed the genetics unit observed by the researcher in two main ways. There was a "test at the end of the unit." Furthermore, the students had to "solve a murder mystery using a pedigree." Helen's genetics test did include multiple types of questions (e.g., multiple choice, matching, drawings, and short answer). The students had to use many skills and concepts learned during the unit in order to solve the mystery. Throughout her lessons, Helen asks the students questions that help them to recall information previously covered and to make connections between concepts.

Helen has each student's name on a card in a jar. She will often pick a card out of the jar to determine which student will answer a question. There are times when a correct answer will earn the student a piece of candy. This is typically the case when reviewing for a test. She also puts "stickers on their tests if they get an A." She explains that the stickers are a great way to motivate the students. Even though "they're in high school,… they get so excited about a sticker."

Theme Two: Parent Support is Important

Helen believes that it is important to keep parents informed. "I try to stay in touch with parents." She will "email parents usually a few days in advance before a test so that they know that a test is coming up." She will also contact parents by email or phone if the student's "grade drops below a 75… and let them know the grade before it gets to a failing grade." Helen also likes to contact parents for positive things, "especially for kids who usually aren't doing well and

then they do something good." She notes that calling parents when students are doing well "is a big motivator for them."

There are multiple times that Helen stresses the importance of "getting parents involved." She believes that "parents are a big influence." She adds, "The ones whose parents push them hard are the ones who really work hard." She further elaborates:

> For most people, like parent involvement and if their parents are, not pushing them, but just really stressing that education is important and it, I don't think parents fully realize how much influence they have over their kids. Their kids, they think they're not listening, but they are. And so, I think as teachers, if the kid doesn't have that at home, we kind of have to work twice as hard to make them feel like someone cares.

She shares some thoughts about one of her highly successful Black female students. Helen believes that the main reason this student works so hard is because of the influence her parents have on her.

> Her parents basically, she's never, like there hasn't been any other option for her other than "You are going to college, so you need to do what you need to do to get there." And they've been supportive of that and she's really self-motivated as well.

In addition to being very supportive of their daughter, these parents are also very visible to and supportive of the school staff.

> They, like to honors night, and things, uhm programs like that, yeah they would come. And for AP night when they had to sign contracts and yes. So yes, they are at the school for different programs and things like that.

Helen feels that having involved and supportive parents greatly increases the chances for Black students to have high levels of achievement in science.

Theme Three: Certain Mentalities Can Be Hindrances to Success

There were racial and cultural philosophies that Helen shared that were not directly connected to instructional strategies, curriculum, assessment, or evaluation. For example, she notices that students "have friends of different races and such, but they usually are identifying, uhm, more with their own race." Her students seem to have friends of difference races. However, they seem to spend most of their time with the friends of their same race. Helen wonders how this mentality affects students socially and academically. She also questions the role of "preconceived notions about students" that even the best-intentioned teachers might hold. Although the teachers' intentions are good, are their thoughts preventing them from being more effective?

Finally, Helen reflects on a popular way of thinking that she feels is negatively impacting her Black students.

> Sometimes I think it's, especially where we are like in a rural area, it's kind of the culture, the accepted culture that it's okay not to do well. It's okay not to graduate from high school. I mean, this county has never had a graduation rate higher than 80% ever and I think it's the influence of parents and siblings that it's accepted not to be able to do well because there's other things that they can do.

This frame of mind really bothers Helen. She admits that her desire to help change this mentality and therefore, to help motivate her Black students to have higher expectations was her incentive to participate in this study. She is hoping for answers. How can she help her Black students to realize and strive for all of the possibilities that are not readily visible in their small community? She wants these students to recognize that they do not have to struggle the way many of their family members are struggling. There are options that can lead them to a "better life."

Case Four Summary

Helen's beliefs about increasing the levels of achievement for Black science students developed into the themes; (a) effective teachers use varied, meaningful instruction and assessment and are caring, encouraging, and fair; (b) parent support is important; and (c) certain mentalities can be hindrances to success. The detailed tips Helen has shared for increasing the chances that Black students attain high levels of achievement in science can be summarized as:

- Teachers need to be caring, focused on students, and treat everyone fairly.
- Teachers need to develop positive relationships with students and increase their awareness of life's possibilities.
- Teachers need to use a variety of instructional strategies and assessments and need to provide a structured environment.
- Teachers need to allow students to teach each other when the teacher is having difficulty helping a student understand something.
- Teachers need to keep parents informed and take advantage of their involvement and support.
- Students need to be polite and well-mannered.
- Students need to have positive mentalities about life.

Cross-Case Analysis

Jonathan is a veteran, Black, male teacher who is very experienced. He is confident in his ability to meet the needs of, not just his Black students, but all of his students. Through his many years of experience, Jonathan has developed strategies that he believes help to increase the levels of achievement for his Black students. Helen is also a veteran teacher, but does not have as much experience as Jonathan. She is a White female who is still looking for answers for meeting the needs of her Black students. Matthew, a White male, and Blair, a White female, are

in the early years of their careers. It seems as if Matthew has not detected any differences or additional needs with his Black students. Perhaps Matthew is satisfied with the levels of achievement reached by his Black students because they have been honors-level students. Unlike Matthew, Blair teaches general-level students. Blair is confident that she is figuring out how to meet the needs of some her Black students, but would like to be better informed. She is hoping to develop more strategies to increase levels of achievement for her Black students. All of the participants are able to offer suggestions for increasing the levels of achievement in science for Black students. Jonathan, Matthew, Blair, and Helen do share some philosophies related to increasing the levels of achievement in science for Black students. Of course, they also hold some distinct beliefs. These similarities and differences can be summarized by using the following categories: teacher characteristics, student characteristics, classroom environment, and curriculum characteristics.

Teacher Characteristics

Jonathan, Matthew, Blair, and Helen share some beliefs about the kinds of science teachers who are more likely to be able to increase the levels of achievement for Black students. They all agree that the type of relationship the teacher establishes with students is vital. They agree that when the relationship between the teacher and the students is positive, the student is more likely to do well in the teacher's class. Jonathan suggests that the teacher be available and familiar with the cultures of the students to increase the chances of developing a positive relationship with the students. Jonathan, like Matthew, also believes that it is helpful if the teacher also guides students in developing life skills. Matthew recommends that teachers have a sense of humor and share personal stories so that they seem more human and personable. Sleeter and Cornbleth (2011) concur that outstanding teachers demonstrate a sense of humor. Jonathan,

Matthew, and Blair were observed using humor in their lessons. Blair believes that a more positive relationship with students can be developed if the teacher is knowledgeable about the culture, background, and possible issues of the students. She also believes that the teacher needs to be a part of the community. Blair and Helen advise teachers to support students' out-of-class activities, such as athletic events. Additionally, Helen stresses that teachers show the students that they care about each student and their successes. Researchers such as Noddings (2001), Irvine (2003), and Sleeter and Cornbleth (2011) agree that caring is a very important quality for teachers. Davis (2012) adds that students "may not care about what you are teaching until you demonstrate that you care about them" (p. 112). The researcher did observe the teachers demonstrating that they cared about their students. One way all of these teachers displayed caring was by allowing students to have snacks and drinks in class. The teachers' attending the out-of-class activities can show their students that they care and can help to better establish a sense of community. One way Jonathan demonstrated caring about one of his Black students was by not allowing him to give up on an assignment the student did not feel capable of doing. Matthew's willingness to alter the requirements for his Black student's out-of-class assignment that required Internet access was one way he showed caring. Helen's concern for what she perceives to be low career aspirations for many of her Black students is an example of her caring for her Black students.

The most obvious similarity across all four cases involves philosophies about parents. All four of the teachers value the support and involvement of their students' parents. Cartledge and Lo (2006) explain that "the term *parent involvement* means different things to different people" (p. 196). Jonathan points out that teachers sometimes make false assumptions about parents by thinking that the parents are not willing to be involved. Cartledge and Lo (2006) tell

us that most parents do the best they know to do at the time. It is often a case of ineffective communication. It is important for the teachers and parents to effectively communicate how they can best support each other in helping students to achieve (Cartledge & Lo, 2006). Matthew and Helen use email to aide them in keeping parents informed about both negative and positive things. However, they do not mention making any accommodations for the parents who do not use email. Blair shares that she would like for teachers to be better educated to effectively communicate with parents. Although Blair realizes the importance of parents' support, she rarely communicates with the parents of her students. She expects the parents of her students to go to the school's online parent portal to check their children's grades. Like Matthew and Helen, Blair does not mention any accommodations made for parents who do not have computer or Internet access. Neither Matthew, Helen, nor Blair seems to realize that some parents may not be involved because of time constraints created by their need to work multiple jobs. Unfortunately, the researcher did not ascertain what kinds of things the teachers did for Black students who did not seem to have supportive parents.

Jonathan, Matthew, Blair, and Helen all believe that teachers should have clear expectations and be encouraging. Students are most successful when teachers' expectations are clear and their actions help the students to meet the expectations (Ladson-Billings, 1994; Sleeter & Cornbleth, 2011). Once again there are some similarities and differences in how Jonathan, Matthew, Blair, and Helen believe the clear expectations and encouragement can be provided. All of the teachers in this study believe that it is important to be very clear with the students about what is expected in terms of behavior and how to complete assignments. Jonathan states that it is important to believe in your students' abilities to perform well in your class. He thinks that if you don't believe that students can do well, you will teach them in a way that will result in

their not doing well. The students may internalize the teacher's belief which may lead to a self-fulfilling prophecy of failure (Groulx, 2001; Powell, 1990). Tell (2001) asserts that good teachers nurture the moral, spiritual, civic, and social development of their students. All of the teachers attempt to help prepare their students for life outside of school. For example, Matthew encourages students to get involved in activities that will help to build their resumes. Furthermore, Matthew models the decision-making process in an effort to influence how his students make decisions. Blair points out that teachers also need to be aware of their students' expectations for them, such as how the students prefer to be approached.

Jonathan and Blair mention some distinct characteristics teachers should possess that help them to increase levels of achievement for Black students. Jonathan is the most veteran teacher in this study and has developed a deeper understanding than the other participants about both teaching and the educational system as a whole. Jonathan believes that teachers need to evaluate themselves and the system. These beliefs are probably a result of Jonathan being a Black male who has had negative experiences due to a system he has viewed as unfair to him. When students' levels of achievement are low, it is important that teachers think about what roles the teachers or the system is playing in this lack of achievement. What changes can be made in order to give the students better chances for increased levels of achievement? Blair has had some of her Black students grow resistant to completing assignments and she struggles with how to help them. She indicates that she believes that many of the teachers in her school fail to meet the needs of their Black students. She believes that teachers need to be better equipped to positively impact students whose cultures are different from their own. Many researchers believe this to be true (Atwater, 1993; Banks, 1994; Bryan & Atwater, 2002; Darling-Hammond, 2002; Gay, 2002; Irvine, 2003; Ladson-Billings, 1994). Blair is early in her career and sees

herself as a work in progress. She believes that the more informed teachers are about the cultural backgrounds of their students, the better the teachers are able to interact with the students and connect the curriculum to them. She also considers herself to be a work in progress in this area. Blair has a strong background in science and believes that all science teachers must have strong science backgrounds to be effective teachers. Of course, there are many researchers who hold this belief as well (Arends, 2004, National Research Council, 1996; Trowbridge, Bybee, & Powell, 2000).

Student Characteristics

The four teachers participating in this study agree that most Black students with higher levels of achievement have some common characteristics. These students are typically self-motivated, willing to seek help when needed, and have supportive parents. The teachers shared some possible sources of the motivation. Jonathan feels that some of the students simply want to do good things and better themselves. Matthew agrees that the students want to do well and are motivated by good grades. Blair believes that the students are motivated by a desire to go to college or to get a good job. Helen feels that many of her Black students need new sources of motivation. Her students seem to be limited by their aspirations. Her Black students do not seem to aspire beyond the local minimum-wage type jobs, and therefore are not concerned about doing well in her class. Helen thinks that her students are not aware of the possibilities that exist outside of their community and need to be exposed to what she believes is a better life. She struggles with what she can do to increase their awareness of other possibilities. If Helen is still struggling with motivating her Black students in this way after nine years of teaching, what might this mean for those teachers with much less teaching experience?

As mentioned earlier, all of the teachers in this study believe that parent involvement and support are important for helping Black students to achieve higher levels of achievement. The teachers in this study believe that the parents are often the primary influence for the students' motivation. Jonathan describes some characteristics of parents of students who usually have higher levels of achievement. The parents set high standards for their children, are well-informed, available, and visible; but, are not harassing. Matthew and Helen add that these parents stress to and instill in their children the importance of education. These parents begin settling for no less than the best from their children when their children are young.

The teachers in this study also share that their Black students with higher levels of achievement are willing to seek help when it is needed. Matthew encourages his students to come in for extra help and to text him. Blair encourages her students to attend review sessions. Jonathan, Matthew, Blair, and Helen walk around their classrooms so that it is convenient for their students to seek their assistance. There were times, of course, when the teachers simply offered their help. Unfortunately, there were also times when opportunities to help students were not taken. For example, there was a time the researcher observed a Black male student in Helen's class who appeared to need help. It would have been beneficial to him if he or Helen would have been more assertive.

Classroom Environment

Davis (2012) proposes that "students need classrooms where there is a strong sense of community" (p.112). Jonathan, Matthew, Blair, and Helen attempt to create this type of classroom because they all believe that the students need to feel comfortable in the classroom in order to have higher levels of achievement. Once again, clear expectations are important. All of the teachers use the whiteboards to provide information about daily schedules and upcoming

assessments. The teachers also tend to keep students notified about expected time allotments for each item on the day's agenda. Jonathan and Blair mention that they often assign students roles during group activities and clarify the responsibilities for each role. This did occur during the researcher's observations of Blair, but not during the researcher's observations of Jonathan. The teachers believe that when students know what is expected, they are able to be more comfortable and more successful.

Effective classroom management is a salient component of a comfortable classroom environment. Rules and expectations must be clear. The teachers should circulate the room. Jonathan believes it is important to give attention to each student. Matthew and Helen express the value of students understanding the nonverbal cues given by the teacher. Although understanding the nonverbal cues of students is also important to establishing a comfortable classroom, it was not discussed by any of the teachers in this study. Blair stresses the need for verbal praise. All of the teachers were observed giving verbal praise to their students during instruction time and during the times the students were working.

Jonathan, Matthew, Blair, and Helen share some other aspects of a comfortable classroom environment. The students respect the teacher and each other. Helen points out that the students do not work well for teachers with whom they are not comfortable. The Black male student in Helen's class who appeared to need help, yet never received any help, may not have been comfortable with Helen. This may be the reason he was not more assertive. Jonathan and Matthew discuss an environment in which the students are comfortable asking and answering questions. Blair adds that the students should feel comfortable sharing stories. The researcher did observe Black students asking questions, answering questions, and sharing stories in Jonathan, Matthew, and Blair's classes. None of the teachers in this study mention the need for

the teacher to respect the students. However, these teachers did demonstrate respect for their students when the researcher was observing in their classrooms. Also, these teachers do imply that the teachers need to respect their students. For example, in most cases, the students need to respect the teacher in order to be comfortable with the teacher.

Instruction, Curriculum, and Assessment Characteristics

All four teachers who participated in this study are the types of teachers described by Arends (1994) who have a "repertoire of best teaching practices" (p. 9). They believe that multiple instructional and assessment strategies are necessary for maximizing students' levels of achievement. They all agree that laboratories and activities need to be among these strategies. Additionally, they all incorporate group work. Sleeter and Cornbleth (2011) "use the terms *engaging* or *engagement* to refer to active student involvement that is 'minds-on,' not simply hands-on. Students are not merely listening or watching or completing a rote drill and practice worksheet" (p. 5). Jonathan, Matthew, Blair, and Helen use instructional strategies that they believe provide their students with opportunities to be cognitively engaged. Moreover, Jonathan thinks that science teachers should integrate other subjects such as mathematics, language arts, and social studies rather than just emphasize science to increase students' levels of achievement. There were times during the researcher's observations that Jonathan integrated other subjects into the science lessons.

Jonathan, Matthew, Blair, and Helen believe that the science curriculum needs to be culturally relevant to the students to maximize the chances for higher levels of achievement. Real-life, day-to-day examples applicable to the various cultures represented in the classroom should be integrated into the curriculum. A connection should be made between the newly-introduced concepts and the previously-introduced concepts. The Black students need to see

Black scientists and their contributions to science. Jonathan states that this allows Black students to know that science is for them. Neither Jonathan nor Matthew used the textbook during the units they were observed by the researcher. However, the PowerPoint presentations used by Jonathan and Matthew do include pictures of people of various races, ethnicities, and genders. Matthew also uses examples of animals from various parts of the world. The textbook pages shared by Blair and Helen did not include any Black scientists or their scientific contributions, nor did they include pictures of Black people doing science. Jonathan also feels that it is important to solicit the opinions of the students during the lessons as a way of making the science culturally relevant to them. He does this during class discussions and through classwork and assessment questions. Matthew uses specific websites to locate science findings that are culturally relevant to the students. Blair pushes the use of technology (such as when students have smartphones in class). She also remembers to make connections to things she knows about her students, such as activities in which they are involved. Additionally, Blair and Helen mention discussing a genetic disease that is more prevalent in African Americans. Unfortunately, some researchers see this type of curriculum addition as problematic because "when differences between racial groups are attributed to biology the potential for reinforcing social inequality becomes stronger" (Donovan, 2014, p.462). Helen tries to find videos that are culturally relevant to her students. So, all of the teachers in this study are attempting to create a more culturally coherent curriculum for their students.

All of the teachers in this study use oral questions, quizzes, and tests for assessing their students. However, they all realize that the students must also be assessed in other ways. They all believe that multiple types of questions should be included in the assessments. Evidence is presented by the teachers to show that they not only hold these beliefs, but also use them in their

classrooms. Jonathan and Helen favor open-ended questions and having discussions with the students. Matthew is partial to projects and non-graded laboratories. Helen also uses projects and believes art-related assignments work well with her Black students. Jonathan and Blair had students who were enrolled in general level classes, while Matthew and Helen's students were in honors level classes. Blair emphasizes one of her practices related to some of her general-level students. She focuses on assessing just the science knowledge and not penalizing students who may have weaknesses such as with grammar or mathematics. Jonathan also sees where weaknesses in other subjects can cause a problem with achievement in science; however, he believes that science should incorporate an overall educational experience.

Jonathan gives a distinct curriculum-related suggestion for increasing levels of achievement for Black science students. Students need to have a strong science background. He believes that exposure to science needs to begin at an early age. The science curriculum should always include scientists of all races and of both genders to increase the relevance to all students.

CHAPTER 5

DISCUSSION AND IMPLICATIONS

The purpose of this study was to determine from experienced science teachers their pedagogical philosophies and what they believe can be done to increase levels of achievement for Black students in science. The teachers were interviewed and observed. The teachers also provided artifacts for the units observed by the researcher and completed demographic questionnaires. The use of critical race theory as the theoretical framework enabled race to be at the forefront of this study. This study was guided by the following research questions:

1. What kinds of pedagogical philosophies related to instructional strategies, curriculum, assessment, and evaluation do science teachers hold?
2. What kinds of pedagogical philosophies related to race do science teachers hold?
3. How do teachers negotiate their philosophies surrounding race to create their science curricula, instructional strategies, and kinds of assessments used?

This chapter includes a discussion and implications. The discussion is an interpretation of the findings in terms of theory and previous research. The implications include suggestions for future studies related to Black students in high school science courses.

Discussion

All four of the teachers who participated in this study were identified by administrators and co-workers as science teachers who have exhibited a desire to help increase the levels of achievement for Black students and have been effective in doing so. During the unit in which

the participants were observed by the researcher, each participant had Black students the participants described as having high levels of achievement for that unit. Jonathan, Matthew, Blair, and Helen shared with the researcher their overall pedagogical philosophies, their pedagogical philosophies related to race, and how these philosophies shape what they do in their classrooms.

Overall Pedagogical Philosophies

The participants' overall pedagogical philosophies are important aspects of what they believe will help to increase levels of achievement for Black science students. These philosophies dictate what the participants believe science teachers need to do in order to be effective and guide the participants' starting points for helping their Black students to do well in their classes.

Jonathan believes that effective teachers are fair, unbiased, and mobile. He also believes that these teachers should have high expectations for students, use real-life examples in lessons, encourage students to think, solicit the opinions of students, integrate students' opinions into the lessons, and use a variety of instructional strategies and assessments. Additionally, he believes that these teachers effectively communicate with students and parents and establish non-threatening classroom environments. Jonathan believes that students' abilities to think have been stifled. He blames this stifling of thinking on the overuse of multiple choice questions and rubrics. This is an aspect of Jonathan's pedagogical philosophy that could be an interesting area for further research.

Matthew's overall pedagogical philosophy stresses planning lessons appropriately, incorporating laboratories and activities, keeping students actively engaged, allowing group work, sharing personal stories, and having clear expectations for students about behavior and

assignments. Matthew believes that the teacher should be an effective communicator who is easygoing, humorous, and accessible. Matthew believes that an effective teacher establishes a safe classroom environment where students respect each other, respect the teacher, and are comfortable asking questions. Effective teachers provide alternative assignments and assessments and help prepare students for life. Matthew believes that effective teachers keep parents informed. However, he mainly relies on using email to contact parents. He does not seem to realize that this is not an effective way to communicate with some parents. The researcher is reminded of Matthew's Black male student who does not have Internet access at home. Does Matthew keep parents in this type of situation informed?

An important aspect of Blair's pedagogical philosophy relates to the teacher's science background. Blair believes that a science teacher must have a strong science background in order to be an effective teacher. Additionally, effective teachers have high expectations for their students, share stories, and provide lots of encouragement, feedback, and praise. Blair believes that effective teachers establish a safe classroom environment where expectations and rules are clear. Students are kept engaged and on task. The teacher incorporates laboratories, activities, group work, and varied assessments. Blair also believes that teachers need to convey to students that they want the students to succeed.

Being caring is one aspect of Helen's pedagogical philosophy. She believes that effective teachers need to show students that they care about the students' doing well and that they have personal interests in what happens to the students. Helen believes that effective teachers allow students to "do and show" rather than simply answer questions on paper. Effective teachers walk around the room to assist students, realize when it's better to allow students to teach each other,

establish routines, and keep parents informed. Helen actually mentions calling parents – for both problems and good news – in addition to sending emails.

Race Philosophies

In addition to their overall pedagogical philosophies, the participants had philosophies that were more specific to Black students. The researcher was surprised by Jonathan's first statement associated with his pedagogical philosophy related to Black students. Although he is a veteran teacher who is Black, he states that teachers should be the same with everybody. The researcher initially interpreted this to mean that Jonathan did not believe that any Black students needed any adaptations. He appeared to exhibit the colorblindness discussed by Villalpando (2003) and Omi and Winant (1994). A lack of awareness of a student's race by a teacher will likely result in a curriculum that is less relevant to the student. When Jonathan stated that Black students can do what everybody else can do, the researcher interpreted this to be in agreement with his belief that teachers should have high expectations for their students. As more of Jonathan's pedagogical philosophy related to race was revealed, the researcher discovered that he was not totally oblivious to the roles that race can play in the education of students. For example, Jonathan believes that no one instructional strategy exists that works for all students. He believes that teachers need to try different things, adapt to the reading skills of the students, use real-life examples, integrate other subjects into the science, and incorporate science related to different races, cultures, and genders when creating lessons for his students. Jonathan believes that Black students need to see Blacks doing science in order to see science as something for them. The curriculum should always be tailored to the target population (Cartledge & Lo, 2006). The students also need to see a more diverse school staff to feel more comfortable in the school environment. Another important aspect of Jonathan's pedagogical philosophy related to race is

his belief that teachers need to evaluate themselves and the system. Teachers especially need to evaluate themselves in regards to stereotypes and prejudices they may hold. Teachers' actions may be shaped by negative beliefs which negatively affect the achievement of their Black students. Dysconscious racism (King, 1991) may also be a result when these stereotypes and prejudices are not confronted. Jonathan believes that there are aspects of the entire system of schooling that are harming Black students. He believes that some of these aspects set up Black students for failure. For example, Jonathan is displeased with the low percentage of Black students in Honors and Advanced Placement classes and the high percentage of Black students in Special Education classes. He also finds it problematic that many Black students are placed in Special Education classes at an early age and often remain in these classes longer than he believes is necessary. Jonathan has also noticed that some Black students allow peer pressure to prevent them from doing well. These students may associate excelling academically with being White and do not want to be accused of acting White (Fordham & Ogbu, 1996; Irvine, 2003). Jonathan reiterates his belief that parents have a crucial role in the levels of achievement for Black students. The parents of many of his successful Black students have been supportive of Jonathan as their children's teacher and have pushed their children to do well. Jonathan teaches classes that tend to have more Black students, therefore it is particularly important for his pedagogical philosophy related to race to be expanded and effectively implemented.

Matthew's pedagogical philosophy related to race is based on treating everyone the same. He adds that the teacher must be non-judgmental and create opportunities for success. Unfortunately, his lack of acknowledging the roles of race in students' schooling remains prevalent as more aspects of his pedagogical philosophy related to race are revealed. He does, however, mention that lessons should be socially or culturally relevant and that diverse

assessment methods should be used. He also believes that the teacher needs to establish a positive connection to Black students to increase the chances that the student will have high levels of achievement. The researcher believes that there are two main reasons that Matthew does not believe that race may have an effect on a student's education. First, Matthew teaches Honors-level classes that tend to have a much higher percentage of White students than Black students. Additionally, it is likely that the Black students in these high school classes have already figured out the keys to succeeding in their classes regardless of the circumstances. Second, Matthew is early in his career and has spent time teaching in other countries prior to teaching in the United States. He may not have had contact with many Black students who have not already figured out the keys to succeeding in their classes regardless of the circumstances.

Although Blair is a relatively new teacher, she has recognized the importance of tailoring her lessons to the students in her class. Perhaps Blair is more aware of the role race can play in a student's education, because she teaches Academic-level classes that tend to have a higher percentage of Black (and Latino) students. Blair initially reveals an aspect of her pedagogical philosophy related to race when she shares that teachers need knowledge of the cultures and backgrounds of their students. This knowledge about students should include knowing how to best approach and interact with Black students. Parts of Blair's pedagogical philosophy related to race have aspects of culturally relevant teaching (Irvine, 2003): she believes that teachers need to be a part of the community and encourages students to embrace and have pride in their cultures. Blair also believes that it is important for teachers to discourage students from making any discriminating remarks and should integrate knowledge about students' cultures into science lessons. Blair also believes that teachers need to integrate technology and everyday examples into the lessons. Blair believes that Black students are motivated by getting into college, getting

a job, and making money. Blair shares a negative aspect of her pedagogical philosophy about Black students. She believes that some Black students perform poorly in her class simply due to a lack of effort or a resistance to critical thinking. Blair does not consider that the students may be shutting down due to something she may or may not be doing and that she could possibly combat the problem if she determines what the issue really is. Blair believes that Black students tend to be more social and therefore benefit from working in groups. Blair is aware that not all students have access to the same opportunities and that this may affect how students perform in school.

Like Jonathan and Matthew's philosophies, Helen's pedagogical philosophy is based on the premise of doing the same things for all students. Although Helen has been teaching for a longer period of time than Matthew and Blair, she has not yet truly developed a pedagogical philosophy that incorporates the races of her students. However, she does state that the curriculum should be applicable to different races. Helen also believes that the curriculum should integrate the personal experiences of and be meaningful to her students. Helen believes that effective teachers establish good relationships with, show that they care about, and do what they can to help their students. Helen mentions that she sometimes thinks that because Black students tend to be more social, they sometimes do not stay on task during group-work time. Therefore, she believes Black students sometimes need more structure. Helen may be blinded by her White privilege with her lack of understanding what she perceives as low expectations for life after high school for some of her Black students. She talks about her Black students not setting goals beyond what they see in their community. However, she does not seem to consider exposing them to other things. This lack of understanding on Helen's part may also be manifested in negative ways in her classroom and negatively affect the kind of relationship she is

able to develop with her Black students. Furthermore, it may negatively affect the levels of achievement for the Black students in her class.

How Race Affects Pedagogy

The participants' race philosophies have been summarized. Now, how are these philosophies manifested in participants' pedagogies? Jonathan shows his high expectations for his Black students by pushing them and by not allowing them to give up when their work becomes challenging for them. Jonathan makes attempts to integrate various races, cultures, genders, and ages into his lessons. He wants all of his students to be able to connect to the science and feel that science is for them. In this sense, he does do the same thing for everybody. He is tailoring his curriculum to his target audience. Jonathan asks oral questions and provides assignments that push students to think and share their opinions. Jonathan respects his students and insists that they respect him and each other. He promotes the Golden Rule of treating others as you want to be treated. When his students do not do well on an assignment, Jonathan evaluates himself as a teacher and a person to determine what changes may need to be made. He makes an effort to get to know his students and learn about their cultures. There are times when Black students Jonathan does not even teach make requests to talk to him. He makes time to grant their requests. Jonathan can see the difference he makes in the lives of the students in his school. He is proud of this, yet he continues to strive to improve. He also feels valued and motivated to continue his career.

Matthew does share personal stories with his students and tries to make aspects of his lessons applicable to everyday life. He even uses the Internet to integrate science information from various parts of the world. Matthew is sensitive to his students' feelings and tries to avoid insulting his students or their beliefs. He suggests that it might be helpful to discuss Black

scientists and their contributions to science, but there is no evidence that this is done. Hopefully, as Matthew continues to develop as a teacher, he will realize the importance of tailoring his lessons to all of the specific students in his classes and will follow the steps needed in order to create this type of curriculum.

Blair experienced an example of what Irvine (2003) refers to as a "lack of cultural synchronization" when she approached a Black student in a way that did not work well for him. This initiated her efforts to learn how to best approach her students. Blair tries to learn about her students through conversations with them and through information her students share during class. Blair incorporates things she learns about her students into science lessons. She also incorporates into the lessons information related to the current everyday lives of the students in general. To help improve the grades for her students she perceives as exhibiting a lack of effort, Blair grades some assignments based solely on effort. The researcher did not determine if the students know this prior to attempting the assignments or if Blair shares the information after grading them. Knowing in advance that an assignment will be graded on effort can affect what type of effort the students put forth. As long as her students remain on task, they are allowed to work in groups for some assignments. Blair believes working in groups caters to the social nature of some of her Black students. Additionally, Blair sometimes adapts assessments so that students are not penalized for non-science weaknesses they may possess. Blair desires to be further educated about how to best meet the needs of all of her students. Hopefully this desire, along with the pertinent actions, will continue as Blair advances in her teaching career. This will be very important if she continues to teach the classes that tend to have a larger percentage of Black and Latino students.

Implications for Further Research

The original goal of this study was to solicit participants from schools that had reputations for high levels of achievement in science for Black students and learn secrets to high levels of achievement from those teachers. When access to those schools was denied, the study had to be adjusted. Although the schools in this study had Black students who reached high levels of achievement, these schools were not the kind that would have the reputation as the best schools for Black students to reach high levels of achievement in science. Fortunately, the science teachers who participated in this study were viewed as successful in the eyes of their co-workers. Furthermore, all of the teachers shared stories about Black students they saw as having high levels of achievement in science and were able to provide valuable information. The researcher believes that even more valuable information could be attained through access to teachers in the schools with the reputations for high levels of science achievement for Black students. To what do they contribute the high levels of achievement for their Black science students?

The indicators for high levels of achievement were individually defined by the participants in this study. If "high levels of achievement" could somehow be quantified, a more in-depth comparison of the teachers' roles could be presented. What is a good way to quantify high levels of achievement? More information could also be attained by comparing science teachers with Black students on the lower end of the achievement scale to those with Black students on the higher end of the achievement scale.

If the researcher repeated this same study, she would want to determine a different way to evaluate the artifacts. Although the artifact evaluation instrument used did provide some information about the curriculum, it is better used for the curriculum as a whole. It was too

broad for an excerpt of the curriculum. The absence of some of the items on the instrument did not mean that these indicators were not met by the participants. These things simply did not appear in the particular unit observed by the researcher. An instrument that was more closely matched to the research questions may have been more helpful.

One of the findings of this study is the importance of parental involvement and support for Black science students to attain high levels of achievement. What can teachers do to aide parents in best supporting their children? There are times that teachers just assume that parents are not involved in or supportive of their child's education. This is often not the case. It is sometimes ineffective communication between the parents and teachers. For example, a teacher may suggest that a parent help their child by going over homework with the child. The parent's idea of "going over homework" might not match the teacher's idea. As a result, the teacher may not see any changes with the student's progress and assume the parent did not follow the advice. The teacher may then decide to no longer solicit the parent's help. The parent may then begin to believe the teacher is unwilling to cooperate. There are also parents who want to help their children but simply do not have the skills or knowledge to help their children. How can teachers help these parents to help their children? A study specifically about the support and involvement of the parents of Black students from different social classes would be helpful. What specific things do the parents of the Black students with high levels of achievement do? What kinds of things do they believe to be detrimental and therefore avoid doing? Additionally, what can the teachers do when their efforts to gain the support and involvement of parents fail? What can be done in the situations where the parents lack the skills and knowledge needed to help their children? The answers to these and many more questions related to increasing levels of

achievement of Black science students can provide a clearer picture for making progress with this endeavor.

REFERENCES

AAAS. (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press.

Adams, P. E., & Krockover, G. H. (1997). Beginning science teacher cognition and its origins in the preservice secondary science teacher program. *Journal of Research in Science Teaching, 34*(6), 633-653.

Allen-Sommerville, L. (1996). Capitalizing on diversity: Strategies for customizing your curriculum to meet the needs of all students. *The Science Teacher, 63*(2), 20-23.

The American Heritage College Dictionary (3rd ed.). (1993). Boston, MA: Houghton Mifflin Company.

Angelo, T. A. (1999). Doing assessment as if learning matters most. *AAHE Bulletin, 51*(9), 3-6.

Arends, R. I. (1994). *Learning to teach* (3rd ed.). New York, NY: McGraw-Hill, Inc.

Atwater, M. M. (1993). Multicultural science education: Assumptions and alternative views. *The Science Teacher, 60*(3), 33-37.

Atwater, M. M. (2003). A theoretical framework for including culture, race, and gender in science education. In R. Reviere (Ed.), *Race, Gender, and Science: Women in the Curriculum: Selected Topics* (pp. 12-24). Baltimore, MD: Institute for Teaching and Research on Women.

Banks, C. A. M., & Banks, J. A. (1995). Equity pedagogy: An essential component of multicultural education. *Theory into Practice, 34*(3), 152-158.

Banks, J. A. (1994). *Multiethnic education: Theory and practice* (3rd ed.). Needham Heights, MA: Allyn and Bacon.

Banks, J. A. (1998). The lives and values of researchers: Implications for educating citizens in a multicultural society. *Educational Researcher, 27*(7), 4-17.

Barba, R. H. (1998). *Science in the multicultural classroom: A guide to teaching and learning (2nd ed.)*. Needham Heights, MA: Allyn & Bacon.

Barton, A. C. (2000). Crafting multicultural science education with preservice teachers through service-learning. *Journal of Curriculum Studies, 32*(6), 797-820.

Beyer, L. E. (2001). The value of critical perspectives in teacher education. *Journal of Teacher Education, 52*(2), 151-163.

Bigelow, B. (1994). Getting off the track: Stories from an untracked classroom. In B. Bigelow, L. Christensen, S. Karp, B. Miner & B. Peterson (Eds.), *Rethinking Our Classrooms: Teaching for Equity and Justice* (pp. 58-65). Milwaukee, WI: Rethinking Schools, Ltd.

Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan, 80*(2), 133-144,146-148.

Blank, R. K. (2002). Using surveys of enacted curriculum to advance evaluation of instruction in relation to standards. *Peabody Journal of Education, 77*(4), 86-121.

Boston, C. (2002). The concept of formative assessment [Electronic Version]. *Practical Assessment, Research & Evaluation, 8*, 1-5. Retrieved November 8, 2006, from http://PAREonline.net/getvn.asp?v=8&n=9

Boyd, W. L. (1978). The changing politics of curriculum policy-making for American schools. *Review of Educational Research, 48*(4), 577-628.

Boykin, A. W., & Noguera, P. (2011). *Creating the opportunity to learn: Moving from research to practice to close the achievement gap.* Alexandria, VA: ASCD.

Brooker, P. (1999). *A Concise Glossary of Cultural Theory*. London, United Kingdom: Arnold.

Bryan, L. A., & Atwater, M. M. (2002). Teacher beliefs and cultural models: A challenge for science teacher preparation programs. *Science Education, 86*(6), 821-839.

Bybee, R. W. (1991). Science-technology-society in science curriculum: The policy-practice gap. *Theory into Practice, 30*(4), 294-302.

Cartledge, G., & Lo, Y. (2006). *Teaching urban learners: Culturally responsive strategies for developing academic and behavioral competence*. Chicago, IL: Research Press.

Cavalli-Sforza, L. L., & Cavalli-Sforza, F. (1995). *The great human diasporas: The history of diversity and human evolution*. Reading, MA: Addison-Wesley.

Clark, J. V. (Ed.). (2014). *Closing the achievement gap from an international perspective: Transforming STEM for effective education*. Dordrecht, Netherlands: Springer.

Cochran-Smith, M. (1995). Color blindness and basket making are not the answers: Confronting the dilemmas of race, culture, and language diversity in teacher education. *American Educational Research Journal, 32*(3), 493-522.

Cochran-Smith, M. (2004). *Walking the road: Race, diversity, and social justice in teacher education*. New York, NY: Teachers College Press.

Cole, R. W. (1995). *Educating everybody's children: Diverse teaching strategies for diverse learners. What research and practice say about improving achievement.* Alexandria, VA: Association for Supervision and Curriculum Development.

Cooper, C. C. (1986). Strategies to assure certification and retention of Black teachers. *The Journal of Negro Education, 55*(1), 46-55.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage Publications, Inc.

Cross, B. E. (1995). The case for a culturally coherent curriculum. In J. A. Beane (Ed.), *Toward a coherent curriculum* (pp. 71-86). Alexandria, VA: Association for Supervision and Curriculum Development.

Cuban, L. (1995). The hidden variable: How organizations influence teacher responses to secondary science curriculum reform. *Theory into Practice, 34*(1), 4-11.

Darling-Hammond, L. (2002). Educating a profession for equitable practice. In L. Darling-Hammond, J. French & S. P. Garcia-Lopez (Eds.), *Learning to teach for social justice* (pp. 201-212). New York, NY: Teachers College Press.

Davis, B. M. (2012). How to teach students who don't look like you: Culturally responsive teaching strategies (2nd ed.). Thousand Oaks, CA: Corwin.

Davis, K. S. (2003). "Change is hard": What science teachers are telling us about reform and teacher learning of innovative practices. *Science Education, 87*, 3-30.

Dee, T. S. (2004). Teachers, race, and student achievement in a randomized experiment. *The Review of Economics and Statistics, 86*(1), 195-210.

Delgado , R. (Ed.) (1995). *Critical race theory: The cutting edge*. Philadelphia, PA: Temple University Press.

Delgado, R., & Stefancic, J. (2001). *Critical race theory: An introduction*. New York: New York University Press.

Department of Education (2011). *2010-2011 Report Card* [Data file]. Retrieved from http://doe.org (The information in this reference was shortened in an effort to protect the privacy of the study participants.)

Donovan, B.M. (2014). Playing with fire? The impact of the hidden curriculum in school genetics on essentialist conceptions of race. *Journal of Research in Science Teaching, 51,* 462-496.

Eisner, E. W. (1985). *The educational imagination: On the design and evaluation of school programs*. New York, NY: Macmillan.

Eisner, E. W. (1993). Invitational conference on the hidden consequences of a national curriculum. *Educational Researcher, 22*(7), 38-39.

Feistritzer, C.E. (2011). *Profile of teachers in the U.S. 2011*. Retrieved from National Center for Education Information website: http://ncei.com/Profile_Teachers_US_2011.pdf

Fordham, S., & Ogbu, J. U. (1996). Black students' school success: Coping with the "burden of 'acting White'". *The Urban Review, 18*(3), 176-206.

Foster, M. (1990). The politics of race: Through the eyes of African-American teachers. *Journal of Education, 172*(3), 123-141.

Freeman, E. (2005). No child left behind and the denigration of race. *Equity & Excellence in Education, 38,* 190-199.

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice*. New York, NY: Teachers College Press.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106-116.

Gillette, M. D. (1996). Resistance and rethinking: White student teachers in predominately African-American schools. In F. A. Rios (Ed.), *Teacher thinking in cultural contexts* (pp. 104-128). Albany, NY: State University of New York Press.

Gordon, D. (1984). The image of science, technological consciousness, and the hidden curriculum. *Curriculum Inquiry, 14*(4), 367-400.

Grant, C. A., & Ladson-Billings, G. (Eds.). (1997). *Dictionary of multicultural education*. Phoenix, AZ: The Oryx Press.

Groulx, J. G. (2001). Changing preservice teacher perceptions of minority schools. *Urban Education, 36*(1), 60-92.

Hewson, P. W., Kahle, J. B., Scantlebury, K., & Davies, D. (2001). Equitable science education in urban middle schools: Do reform efforts make a difference? *Journal of Research in Science Teaching, 38*(10), 1130-1144.

Hitchcock, G., & Hughes, D. (1995). *Research and the teacher: A qualitative introdcution to scholl-based reserach* (2nd ed.). New York, NY: Routledge.

Howard, T. C. (2010). *Why race and culture matter in schools: Closing the achievement gap in America's classrooms*. New York, NY: Teachers College Press.

Irvine, J. J. (1988). An analysis of the problem of the disappearing Black educators. *The Elementary School Journal, 88*(5), 503-513.

Irvine, J. J. (2003). *Educating teachers for diversity: Seeing with a cultural eye*. New York, NY: Teachers College Press.

Johns, J.R. (2011). Abriendo Caminos: A professional learning community for teachers. In C.E. Sleeter & C. Cornbleth (Eds.), *Teaching with vision: Culturally responsive teaching in standards-based classrooms* (pp. 129-141). New York, NY: Teachers College Press.

Joseph, P. B. (2000). Conceptualizing curriculum. In P. B. Joseph, S. L. Bravmann, M. A. Windschitl, E. R. Mikel & N. S. Green (Eds.), *Cultures of curriculum* (pp. 1-14). Mahwah, NJ: L. Erlbaum Associates.

Kagan, D. M. (1992). Implications of research on teacher belief. *Educational Psychologist, 27*(1), 65-90.

Kalra, R. M. (1989). *Meaningful intercations with culturally different students*. New Dehli, India: Commonwealth Publishers.

King, J. E. (1991). Dysconscious racism: Ideology, identity, and miseducation of teachers. *The Journal of Negro Education, 60*(2), 133-146.

King, J. E., Hollins, E. R., & Hayman, W. C. (Eds.). (1997). *Preparing teachers for cultural diversity*. New York, NY: Teachers College Press.

Kleinsmith, L. J. (1993). Racial bias in science education. In D. Schoem, L. Frankel, X. Zuniga & E. A. Lewis (Eds.), *Multicultural teaching in the university* (pp. 180-190). Westport, CT: Praeger Publishers.

Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers of African American children*. San Francisco, CA: Jossey-Bass.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-491.

Ladson-Billings, G. (1999). Preparing teachers for diverse student populations: A critical race theory perspective. *Review of Research in Education, 24*, 211-247.

Ladson-Billings, G. (2001). *Crossing over to Canaan: The journey of new teachers in diverse classrooms*. San Francisco, CA: Jossey-Bass Inc.

Ladson-Billings, G. (2005). Is the team all right? Diversity and teacher education. *Journal of Teacher Education, 56*(3), 229-234.

Ladson-Billings, G., & Donnor, J. (2005). The moral activist role of critical race theory scholarship. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed., pp. 279-301). Thousand Oaks, CA: Sage Publications.

Ladson-Billings, G., & Tate, W. F. (1995). Toward a critical race theory of education. *Teachers College Record, 97*(1), 47-68.

Levine, D. (1994). Forging curriculum reform throughout a district. In B. Bigelow, L. Christensen, S. Karp, B. Miner & B. Peterson (Eds.), *Rethinking Our Classrooms: Teaching for Equity and Justice* (pp. 168-170). Milwaukee, WI: Rethinking Schools, Ltd.

Loewen, J. W. (1995). *Lies my teacher told me: Everything your American history textbook got wrong*. New York, NY: Simon & Schuster.

Luft, J. A. (1998). Multicultural science education: An overview. *Journal of Science Teacher Education, 9*(2), 103-122.

Lynn, M. (1999). Toward a critical race pedagogy: A research note. *Urban Education, 33*(5), 606-626.

MacDonald, R. E., & Healy, S. D. (1999). *A handbook for beginning teachers* (2nd ed.). New York, NY: Addison Wesley Longman, Inc.

Matthews, J. (2002). International education and internationalism are not the same as globalization: Emerging issues for secondary schools. *Journal of Studies in International Education, 6*(4), 369-390.

McKinley, J. (2010). *Raising Black students' achievement through culturally responsive teaching.* Alexandria, VA: ASCD.

Miles, M. B., & Huberman, A. M. (1994). *An expanded sourcebook: Qualitative data analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Miller, D. C., & Salkind, N. J. (2002). *Handbook of research design and social measurement* (6th ed.). Thousand Oaks, CA: Sage Publications, Inc.

Moin, L. J., Dorfield, J. K., & Schunn, C. D. (2005). Where can we find future K-12 science math teachers? A search by academic year, discipline, and academic performance level. *Science Education, 89*, 980-1006.

National Center for Education Statistics. (2012a) *Enrollment and percentage distribution of enrollment in public elementary and secondary schools, by race/ethnicity and region: Selected years, fall 1995 through fall 2021*. Retrieved from https://nces.ed.gov/programs/digest/d12/tables/ dt12_044.asp

National Center for Education Statistics. (2012b). *Percentage of public school teachers of grades 9 through 12, by field of main teaching assignment and selected demographic and educational characteristics: 2011-12*. Retrieved from http://nces.ed.gov/programs/digest/d13/tables/dt13_209.50.asp

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

Nieto, S. (2000). *Affirming diversity: The sociopolitical context of multicultural education (*3rd ed.*)*. New York, NY: Addison Wesley Longman, Inc.

Noddings, N. (2001). The caring teacher. In V. Richardson (Ed.), *Handbook of Research on Teaching* (4th ed.). Washington, DC: American Educational Research Association.

Omi, M., & Winant, H. (1994). *Racial formation in the United States: From the1960s to the 1990s* (2nd ed.). New York, NY: Routledge.

Peterson, B. (1994). Teaching for social justice: One teacher's journey. In B. Bigelow, L. Christensen, S. Karp, B. Miner & B. Peterson (Eds.), *Rethinking Our Classrooms: Teaching for Equity and Justice* (pp. 30-38). Milwaukee, WI: Rethinking Schools, Ltd.

Powell, L. (1990). Factors associated with the underrepresentation of African Americans in mathematics and science. *The Journal of Negro Education, 59*(3), 292-298.

Rascoe, B., & Atwater, M. M. (2005). Black males' self-perceptions of academic ability and gifted potential in advanced science classes. *Journal of Research in Science Teaching, 42*(8), 888-911.

Russell, M. L., & Atwater, M. M. (2005). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominately white institution. *Journal of Research in Science Teaching, 42*(6), 691-715.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans*. New York, NY: Oxford University Press.

Saldana, J. (2009). *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage Publications, Inc.

Shepard, L. A. (2000). The role of assessment in a learning culture. *Educational Researcher, 29*(7), 4-14.

Simmons, P. E., Brunkhorst, H., Lunetta, V., Penick, J., Peterson, J., Pietrucha, B., et al. (2005). Developing a research agenda in science education. *Journal of Science Education and Technology, 14*(2), 239-252.

Sleeter, C. E., & Bernal, D. D. (2004). Critical pedagogy, critical race theory, and antiracist education: Implications for multicultural education. In J. A. Banks & C. A. Banks (Eds.), *Handbook of Research on Multicultural Education* (2nd ed., pp. 240-258). San Francisco: Jossey-Bass.

Sleeter, C.E., & Cornbleth, C. (Eds.). (2011). *Teaching with vision: Culturally responsive teaching in standards-based classrooms.* New York, NY: Teachers College Press.

Smith-Maddox, R., & Solorzano, D. G. (2002). Using critical race theory, Paulo Freire's problem-posing method, and case study research to confront race and racism in education. *Qualitative Inquiry, 8*(1), 66-84.

Stake, R. E. (2006). *Multiple case study analysis*. New York, NY: The Guilford Press.

Sternberg, R. J., Grigorenko, E. L., & Kidd, K. K. (2005). Intelligence, race, and genetics. *American Psychologist, 60*(1), 46-59.

Stevenson, H. W., Chen, C., & Uttal, D. H. (1990). Beliefs and achievement: A study of Black, White, and Hispanic children. *Child Development, 61*(2), 508-523.

Strizek, G. A., Pittsonberger, J. L., Riordan, K. E., Lyter, D. M., & Orlofsky, G. F. (2006). *Characteristics of schools, districts, teachers, principals, and school libraries in the United States: 2003-2004 Schools and staffing survey (NCES 2006-313)*: Washington, DC: U. S. Government Printing Office.

Tate, W. F. (1997). Critical race theory and education: History, theory, and implications. *Review of Research in Education, 22*, 195-247.

Tatum, B. D. (1997). *Why are all the Black kids sitting together in the Cafeteria?: And other conversations about race*. New York, NY: Basic Books.

Teel, K.M., & Obidah, J.E. (2008). *Building racial and cultural competence in the classroom: Strategies from urban educators*. New York, NY: Teachers College Press.

Tell, C. (2001). Appreciating good teaching: A conversation with Lee Shulman. *Educational Leadership, 58*(5), 6-11.

Toolin, R. E. (2003). Learning what it takes to teach science: High school students as science teachers for middle school students. *Journal of Science Education and Technology, 12*(4), 457-469.

Trowbridge, L. W., Bybee, R. W., & Powell, J. C. (2000). *Teaching secondary school science: Strategies for developing scientific literacy* (7th ed.). Upper Saddle River, NJ: Prentice-Hall, Inc.

U.S. Census Bureau (2012). *State and county QuickFacts*. Retrieved from http://quickfacts.census.gov (This website address was shortened in an effort to protect the privacy of the study participants.)

Villalpando, O. (2003). Self-segregation or self-preservation? A critical race theory and Latina/o critical theory analysis of a study of Chicana/o college students. *International Journal of Qualitative Studies in Education, 16*(5), 619-646.

Watson, D., Charner-Laird, M., Kirkpatrick, C. L., Szczesiul, S. A., & Gordon, P. J. (2006). Effective teaching/effective urban teaching: Grappling with definitions, grappling with difference. *Journal of Teacher Education, 57*(4), 395-409.

Weiss, I. R. (2001). *Report of the National Survey of Science and Mathematics Education*. Chapel Hill, NC: Horizon Research, Inc.

Willinsky, J. (1998). The obscured and present meaning of race in science education. In D. A. Roberts & L. Ostman (Eds.), *Problems of meaning in science curriculum* (pp. 73-85). New York, NY: Teachers College Press.

Zerai, A. (2000). Agents of knowledge and action: Selected Africana scholars and their contributions to the understanding of race, class and gender intersectionality. *Cultural Dynamics, 12*(2), 182-222.

APPENDIX A

Science Teaching Standards of the National Science Education Standards

TEACHING STANDARD A:
Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- Develop a framework of yearlong and short-term goals for students.
- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.
- Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.
- Work together as colleagues within and across disciplines and grade levels.

TEACHING STANDARD B:
Teachers of science guide and facilitate learning. In doing this, teachers

- Focus and support inquiries while interacting with students.
- Orchestrate discourse among students about scientific ideas.
- Challenge students to accept and share responsibility for their own learning.
- Recognize and respond to student diversity and encourage all students to participate fully in science learning.
- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

TEACHING STANDARD C:
Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers

- Use multiple methods and systematically gather data about student understanding and ability.
- Analyze assessment data to guide teaching.
- Guide students in self-assessment.
- Use student data, observations of teaching, and interactions with colleagues to reflect on and improve teaching practice.
- Use student data, observations of teaching, and interactions with colleagues to report student achievement and opportunities to learn to students, teachers, parents, policy makers, and the general public.

TEACHING STANDARD D:
Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers

- Structure the time available so that students are able to engage in extended investigations.
- Create a setting for student work that is flexible and supportive of science inquiry.
- Ensure a safe working environment.
- Make the available science tools, materials, media, and technological resources accessible to students.
- Identify and use resources outside the school.
- Engage students in designing the learning environment.

TEACHING STANDARD E:
Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

- Display and demand respect for the diverse ideas, skills, and experiences of all students.
- Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.
- Nurture collaboration among students.
- Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.
- Model and emphasize the skills, attitudes, and values of scientific inquiry.

TEACHING STANDARD F:
Teachers of science actively participate in the ongoing planning and development of the school science program. In doing this, teachers

- Plan and develop the school science program.
- Participate in decisions concerning the allocation of time and other resources to the science program.
- Participate fully in planning and implementing professional growth and development strategies for themselves and their colleagues.

APPENDIX B

Demographic Questionnaire

Name

Race/ethnicity

Degree(s)

Area(s) of certification

Route to certification (traditional 4-yr teacher education program, MAT, alternative preparation, provisional)

Name and location of undergraduate/ graduate institutions

Description of undergraduate institute (private or public; rural, urban, or suburban; student demographics; highest degree offered)

Previous employment

Number of years of teaching experience prior to this school year

List and describe the science courses you are teaching this school year

List and describe other science courses you have taught

Hometown

Description of hometown (rural, urban, or suburban; population demographics)

High school you attended

Description of high school (private or public, student demographics; grades included)

Influential courses you have taken

APPENDIX C

Interview Protocol

Why did you pursue a career in science teaching?

What does it mean for a student to have a high level of achievement in science?

What makes a science teacher effective?

In what ways do you consider yourself to be an effective science teacher?

Explain how you know when you are an effective science teacher?

In what ways or areas are you less effective in your science teaching?

What characteristics do you think a teacher should possess in order to be an effective teacher of Black students?

What do you believe motivates Black students to learn?

On what do you base these beliefs?

What do you believe to be some of the reasons Black students perform poorly or fail in science classes?

What can be done to increase the levels of achievement in science for Black students?

What are the positives and negatives of using a state mandated science curriculum?

In what ways is the state mandated science curriculum culturally sensitive or applicable to Black students?

In what ways is the state mandated science curriculum culturally insensitive or non-applicable to Black students?

What can be done to increase the levels of achievement for Black students in science in terms of science curricula?

What can be done to increase the levels of achievement for Black students in science in terms of instructional strategies and classroom management?

What can be done to increase the levels of achievement for Black students in science in terms of assessment and evaluation?

APPENDIX D

Classroom Observation Instrument

Teacher: _____ Class: _____

Date: _____ Time: _____

What does the teacher do or say?

To integrate the personal lives of students

To assess prior knowledge

To connect “new” knowledge to “old” knowledge

To demonstrate his/her disposition

To praise, encourage, motivate, reward, or build self esteem of students

To express expectations

To promote “safe” environment

To promote social justice

To instill community pride

To address multiple learning styles and wide range of instructional levels

To monitor progress and adjust instruction

To capture and hold students’ attention

To promote thinking

To integrate various cultures

Other interactions with students:

What do the students do?

Types of interactions with teacher

Types of interactions with each other

What is displayed in the classroom?

How is the classroom arranged?

What are the demographics of the class? (this will be verified in interview)

Does teacher seem knowledgeable?

Does the teacher guide students through the thinking process?

Does the teacher help students develop study skills?

Does teacher use memory aids (such as diagrams, mnemonics, graphs, illustrations, charts, etc.)?

Is the teacher organized?

Are the lesson's objectives clear to the students?

Is time managed effectively?

What kinds of resources are used by the teacher?

Other pertinent evidence

APPENDIX E

Artifact Evaluation Instrument

	Evidence in Artifact?
Men AND women do science. @ #	
People of all ages engage in science. @ #	
People from various backgrounds and cultures engage in science. @ #	
Men AND women have made and continue to make important contributions to science. @ #	
People from all cultures have made and continue to make important contributions to science. @ #	
Until recently, the contributions of women and racial minorities were disregarded or credited to men (who were usually of European descent). This was partially due to restrictions on the education and employment opportunities of women and racial minorities. @	
Modern science is based on traditions of thought that came together in Europe about 500 years ago, but the early Egyptian, Greek, Chinese, Hindu, and Arabic cultures are responsible for many scientific and mathematical ideas and technological inventions. @	
Science content should be adapted to meet the interests, knowledge, understanding, abilities, and experiences of students. @ #	
The interests, knowledge, understanding, abilities, experiences, beliefs, moods, and expectations of students affect how ideas are interpreted and perceived and determine if they are believed. @ #	
Recognize, respect, and respond to student diversity in ideas, skills, experiences, etc. #	
Materials should be devoid of stereotypes, assumptions that reflect the perspectives or experiences of a particular group, language that might be offensive to a particular group, and other features that might distract students from the intended task. @ #	
Science education should address the prevalence and fallacy of stereotypes. @	
Science is a part of society. #	
"Scientists are linked to other scientists worldwide both personally and through international scientific organizations." @ (p. 177)	
Science is a group enterprise. @ #	

Some organizations have an unstated purpose of excluding certain categories of people from activities. @	
Government's attempts at bringing about social changes are not always successful. @	
Major historical conflicts may be valuable to study but only in relation to current episodes that are meaningful to students. @	
Social change often promotes conflict due to competition for power, status, ideas, and resources. @	

LEGEND

$\surd^{+}$	Well done
$\surd$	Done
$\surd^{-}$	Poorly done
X	Not found
@	From *Benchmarks*
#	From *NSES*