ABSTRACT

GOMILLION, CRYSTALL SHAREE. Racial Identity Development & Perceptions of Scientists of Black College Students in Science and Non-Science Majors. (Under the direction of Eileen R. Carlton Parsons, Ph.D.)

The focus of this research was to evaluate if differences exist in the racial identity profiles and perceptions of scientists held by 48 Black college students majoring in science (n = 17) and non-science (n = 31) fields. The study was conducted at a large, predominantly White university located in the south. All participants completed the Cross Racial Identity Scale (CRIS) and Draw-a-Scientist Test (DAST); measures used to assess six subscales of individuals' racial identity development (RID) and 16 stereotypical conceptions of scientists respectively. Fourteen volunteers also completed one-on-one interviews with the researcher to discuss information that would elucidate their responses to survey instruments. Findings from the CRIS revealed that significant differences did not exist in the science majors' and non-science majors' racial identity profiles. Both groups expressed strongest agreement with views reflected in Internalization Multiculturalist Inclusive (IMCI) and Pre-Encounter Miseducation (PM) subscales. Conversely, the science majors and non-science majors exhibited least agreement with attitudes depicted in Immersion – Emersion Anti-White (IEAW) and Pre-Encounter Self-Hatred (PSH) subscales. Results from the DAST demonstrated that both groups illustrated similar perceptions of scientists as observed by an average of four of the 16 stereotypes expressed in their images.

RACIAL IDENTITY DEVELOPMENT & PERCEPTIONS OF SCIENTISTS OF BLACK COLLEGE STUDENTS IN SCIENCE AND NON-SCIENCE MAJORS

by

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DEDICATION

This dissertation is dedicated to John, a wonderful husband, man, and friend. From the first day I met you, I knew that you were a special person. Your vision is unsurpassed. Over the past few years, your love and encouragement have been driving forces and have helped me overcome difficult obstacles with life and school. At times when I became overwhelmed and distraught, you listened to me vent, encouraged me to persevere, and supported my dreams. Your passion and sense of adventure allowed me to be more carefree and helped me to truly enjoy life and love. I am grateful to you for challenging me to become a better person, woman, and partner.

John, you are truly a man to be honored because of your commitment to God and our relationship. I appreciate you for all of your diligent work and effort. I know that with you our potential is limitless when we rely on God and our love for each other. I love you more with each passing day and am grateful for your devotion. God brought us together as a couple, but we have and will continue to work to develop and nurture our partnership. I eagerly look forward to our future and the many blessings He has in store for you and I. This dissertation is an accomplishment for the both of us.

BIOGRAPHY

Crystall Sharee Travis was born in Omaha, Nebraska on August 26, 1978. She and her three siblings, Stacie, Sharrone, and Clyde, were raised by their mother and extended family members. Though her childhood was difficult and presented a number of challenges, Ms. Travis was able to persist and succeed in her education. Upon completing high school, she attended the University of Nebraska at Omaha as a result of financial support from several academic scholarships. After four years at UNO, she graduated with a Bachelor's of Science in Elementary Education with an emphasis in science.

Following college graduation, Ms. Travis remained in Omaha and taught eighth grade science at her former middle school. She thoroughly enjoyed her time as an educator because of her passion for working with children and interest in teaching science. During her experiences as a teacher, Crystall determined that she would be better prepared to help future generations of children by pursuing advanced degrees in science education. As a result, she relocated to North Carolina where she attended North Carolina State University. Armed with the love and encouragement of family, a determination for success, and the financial support of the Bill Gates Millennium scholarship, Ms. Travis, completed her master's work in science education at NCSU in 2004. For a period of time during graduate school, she also taught sixth grade science and social studies in North Carolina.

In September of 2006, Crystall married her soulmate, John Wesley Gomillion. With his love and patience, she was able to conclude her doctoral work and overcome the dissertation process. Mr. and Mrs. John Gomillion look forward to celebrating at graduation and actively await the wonderful blessings life has in store for their family.

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Exodus 15:2; **"**The Lord is my strength and my song; he has become my salvation. He is my God, and I will praise him, my father's God, and I will exalt him." Without the Lord in my life, I would not have been able to achieve my goals. He has blessed me beyond my imagination.

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CHAPTER ONE

Overview & Problem Statement

African American children are the proxy for what ails American education in general. And so, as we fashion solutions which help African American children, we fashion solutions which help all children.

—Augustus F. Hawkins

Historical Overview of Science in America

Nationally, the scientific enterprise is ever expanding while countries combat in an effort to gain an "edge" over the competition. In American history, such opposition was particularly observed during the 1950's when the United States and Soviet Union battled to be the successor in the race to outer space. Despite the fact that the Soviet Union preceded America in successfully sending the initial animal to space, the United States countered by landing the first man on the moon. Over subsequent years, global competitions such as these revealed the importance of educating citizens to become scientifically knowledgeable and literate. In response, US federal funding was channeled into scientific research and science education to stay abreast of the latest advances and adequately prepare the future workforce to assume roles in the science domain.

Currently, the trend continues; it is ever important for high school graduates to possess competencies in science and general understandings of the scientific enterprise. With contemporary issues concerning the ethics of stem cell research, controversies related to genetically modified foods, threats of bioterrorism, and advancements in biotechnology, it is imperative that students are well-prepared to meet the scientific demands of a progressive society. As such, science educators throughout the country are working to ensure that students are exposed to science through factual, textbook-based learning as well as hands-on, scientific inquiry and discovery.

National reforms in science education outline the provision of advanced science opportunities for "all" Americans; however, a large demographic of the US population continues to receive inferior education and reduced experiences in the science classroom (Atwater, 2000). As a result, Blacks[1] possess a limited presence in science-related courses in K-12 school, majors in college, and careers in the workforce (Atwater, 2000; Seiler, 2001).

Research Questions

Though past science education research has endeavored to evaluate possible factors contributing to the underrepresentation of Blacks in the sciences, limited work has been conducted to explore the role of racial identity development. Therefore, this research study was used as an opportunity to gain insight into Black college students and their social attitudes and to explore the role of such conceptions on their future career plans. The specific research questions which guided this investigation were:

- What are the racial identity profiles of Black college students majoring in science?
- What are the racial identity profiles of Black college students majoring in non-science fields?
- What perceptions of scientists do Black college students majoring in science possess?
- What perceptions of scientists do Black college students majoring in non-science fields possess?

[1] The term Black is used to encompass individuals of African decent (i.e., African American, African, West Indian – Caribbean Black, etc..

The Problem: A Synthesis of the Literature

Blacks in Science & Science Education

In the United States, it is imperative that students acquire quality science knowledge and possess relevant process skills in order to become scientifically literate and competitive in national and global markets (Barlow & Villarejo, 2004). With daily manifestations of environmental and health-related problems, well-informed citizens are needed to advance current practices in science and technology. However, despite reforms in science education which seek to provide all students with relevant content knowledge and attempt to increase the number of people entering science careers, disproportions in the racial demographics of scientists are evident in national statistics.

Data from the 2000 US Census Bureau illustrate that Blacks composed 12.3% of the national population in comparison to Whites[2] who constituted 75.6% (USCB, 2006). Looking at the subset of the American population that accounted for those employed as doctoral scientists[3], statistics from 2001 revealed that of the 656,030 scientists, 2.4% were Black while 80% were Caucasian (National Center for Education Statistic-NCES, 2006). Data such as these reflect the disparities that exist between Black and White students in science education. Studies indicate that as students matriculate through high school and embark on more challenging higher-level science classes, fewer Black students enroll in these courses or their mathematical prerequisites. For example, in 1998, while 77.7% of White students and 72.5% of Black students enrolled in Geometry, 12.1% of White students and 6.6% of Black students registered for calculus (NCES, 2006).

[2] The terms White, Caucasian, and European American are used interchangeable throughout this work.
[3] The title scientist includes those working in science and engineering occupations.

Clearly, differences are evident between the percentages of Black and White high school students pursuing advanced math courses, classes which ultimately determine their ability to register for complex science courses. Unfortunately, the previously stated diverging trends observed at the high school level continue into the college years. Due to fewer exposures to higher-level science content knowledge in senior high, Black students represent a significant portion of the US population inadequately prepared and unable to pursue science majors in college.

The National Science Foundation (NSF) reported that in 2001, of the bachelor's degrees conferred to students in science-related disciplines, 67.7% were awarded to Caucasian graduates while only 8.1% were Black (NSF, 2006). Additionally, in 1998, 5.7% of the master's level science degrees earned were represented by Blacks while 74.6% were conferred to Whites (NSF, 2006). As a result, Blacks are less able to participate in the scientific enterprise, contribute to national competitions with other countries, or work to produce the latest advancements in science, technology, or medicine.

When trends such as these persist throughout the country and are observed at various levels of education, one begins to question why disproportions exist between the percent of Blacks and White Americans endeavoring to pursue science courses, majors, and careers. Why is it that higher percentages of Black pupils are not registering for advanced science courses in high school? What issues prevent Black college students from pursing science-related majors? What factors impact Black individuals' decisions to select careers other than science? Science education researchers seek to find answers to these questions through their investigations. Past studies have purported a number of factors that potentially contribute to

the low presence of Blacks in science: the influence of tracking, teachers, parents, students' self-perception, and students' views of scientists.

Factors Impacting Blacks in Science

Science education literature presents a number of reasons contributing to low percentages of Blacks represented in high school science courses, college majors, and science careers. Several of these elements include the impediment of tracking on minority student matriculation; impact of low teacher expectations, content knowledge, and instructional practices on Black students' views of school; influence of parental views on their children's academic interests; hindrance of stereotypic images of scientists perceived by students; and persistence of negative self-perceptions held by Black students regarding their abilities in science.

Influence of Tracking

Tracking potentially contributes to the failure of Blacks to pursue science (Green, 1999; Winston et al., 2004). Historically, tracking has been a procedure utilized in education to "ability-group" students who test, either using the Intelligence Quotient (IQ) or standardized tests, at the same or similar academic levels (Goodlad & Oakes, 1998; Green, 1999; Luft, 1998; Tate, 2001). As a result, rankings emerge which guide students' progression from kindergarten through twelfth grade and determine the quality of and access to science education received (Gilbert & Yerrick, 2001).

Common models for tracking include three groups arranged in a hierarchy based on ability. The highest level are those students labeled as academically-gifted; these pupils tend to navigate through the educational system without restrictions. Students within this group are often promoted through the college-preparatory academic track and enrolled in honors

and advanced placement courses (Tate, 2001). In their science classrooms, they are exposed to technology and other science equipment. In addition, they are encouraged to complete hands-on, inquiry labs and activities as well as participate in group work and presentations. Upon high school completion, those from the highest track typically pursue college educations at four-year institutions which lead to graduate and advanced degrees. Consequently, these students tend to be the most academically prepared and equipped individuals to pursue careers in the science industry. Research has revealed that the highest track in science is primarily populated by Caucasian and Asian American students (Tucker & Herman, 2002; Tucker et al., 2005).

The second level of the tracking model encompasses those students who are labeled as performing "on grade-level" and are the standard by which their peers are compared (Green, 1999; Tate, 2001). These students are provided with opportunities and resources geared toward the median ability level and are able to navigate through the educational system by proving their abilities and competencies. Following high school graduation, students from this track often either select vocational careers or enroll at two or four year colleges and universities. Depending on the avenue selected by these students and their level of commitment to education, they are still able to position themselves to receive advanced and quality science instruction.

The final, lowest level refers to the students tracked as being academically-inferior to their on grade-level peers (Green, 1999; Luft, 1998; Tate, 2001, 2004). Students in this lowest track are often identified as requiring special needs or being behaviorally-challenged (Neal, McCray, Webb-Johnson, & Bridgest, 2003). They are instructed to seek remediation or retention and are not encouraged to pursue advanced coursework (Luft, 1998; Tate, 2001).

In this track, pupils are restricted to a "back-to-the-basic" curriculum characterized by drills and memorization strategies (Barton, Koch, Contento, & Hagiwara, 2005). For this lowest track, classroom instruction typically utilizes whole-group, lecture-based practices geared toward delivering information and "crowd control" rather than challenging students. In addition, these children typically have educators who are teaching out of their discipline and do not possess adequate science knowledge to successfully prepare students. Unfortunately, lower-track students often have reduced access to science equipment and technology. Finally, the lowest track students' teachers and administrators concern themselves primarily with classroom management and discipline (Griffard & Wandersee, 1999). A large number of students in the lowest academic track drop out of high school or elect to complete their General Educational Development Test (GED); decisions which impact or prevent individuals from obtaining advanced positions in the science, technology, engineering, and mathematics (STEM) fields.

With these systems of tracking implemented in schools, Black students are often relegated to the lowest tracks at rates disproportionate to their White and Asian peers who primarily comprise the highest tracks (Green, 1999; Luft, 1998; Rascoe & Atwater, 2004; Tate, 2001, 2004; Gilbert & Yerrick, 2001). This phenomenon is especially true for Black males who are consistently referred to the lowest academic tracks (Seyfried, 1998). As a result, Blacks receive fewer exposures to advanced sciences and are restricted from future opportunities. Limited experiences in science instruction during students' kindergarten through twelfth-grade years inhibit their admittance into science majors in college and careers in the scientific enterprise (Rascoe & Atwater, 2004). Therefore, the tracking

practices enforced in elementary, middle, and high school outline the diverging levels of college education received and occupational goals realized (Gilbert & Yerrick, 2001).

In addition, tracking often results in the categorization and labeling of students depending on the tracking level with which they are affiliated. As a result, different levels of teacher and administrative expectations for students emerge at the various educational stages delineated by tracking (Gilbert & Yerrick, 2001). For example, the lowest track is often labeled as the "at risk" group and has unfairly become synonymous with minority students. Such stereotyping that has resulted from tracking persists in a number of educators' minds and impacts how they interact with Black students.

Influence of Teachers

Teacher Expectations

A second area which impacts Black children's participation in science is their teachers (Chang & Sue, 2003; Rascoe & Atwater, 2004; Tobin, Roth, & Zimmermann, 2001). Being that Black students are a large demographic in poorer, urban school systems and their teachers are primarily middle-class White women, a cultural disconnect often emerges (Luft, 1998). This mismatch results from low teacher self-efficacy in relation to racial attitudes regarding instructing students from diverse cultural backgrounds. Teacher efficacy is the extent to which educators believe their classroom instruction influences pupil learning regardless of students' home and life circumstances (Tucker et al., 2005). However, teacher self-efficacy is often found to be reduced, especially in urban milieus, because a number of educators feel under prepared to instruct students from culturally diverse backgrounds. Therefore, many White teachers express the need for additional professional development and education to adequately prepare themselves for instructing Black students

(Tucker et al., 2005). When such opportunities are unavailable for educators of Black youth, low teacher expectations and fewer positive interactions with students persist (Seyfried, 1998; Winston et al., 2004).

Teacher expectations are defined as the deductions educators make regarding their students' academic behavior and achievement in relation to what they previous know, or have heard, about the children (Good, 1987; Neal, McCray, Webb-Johnson, & Bridgest, 2003). These inferences can be based on objective measures such as student test scores or subjective means such as teacher gossip, prejudices, or stereotypes (Good, 1987). Research reveals that a number of educators in poorer urban school settings possess low expectations for their Black students and their abilities to be successful in science compared to Caucasian and Asian American pupils (Atwater, 2000; Chang & Sue, 2003; Rascoe & Atwater, 2004; Tucker & Herman, 2002). In addition, teachers tend to express fewer positive interactions with Black students (Tucker et al., 2005). Research has purported that these negative experiences students receive involving their teachers heavily impact their attitudes of and success in school (Neal, McCray, Webb-Johnson, & Bridgest, 2003).

In one study of nine academically gifted Black male participants, Rascoe and Atwater (2004) observed that students perceived instances when educators held minimal expectations for them concerning their academic abilities and found these situations to be additional obstacles to overcome for success. When asked about his science teachers, one student stated that:

> I feel that they don't expect a lot out of me for some reason. I don't really know. I haven't been able to figure that out. They just have a lower expectation of me personally. Like they don't expect as much out of me as maybe the White kid sitting next to me (p. 902).

In contrast, when Black males encountered educators who supported them and held high expectations for their academic success, the young men felt supported and expressed higher levels of confidence in their abilities (Rascoe & Atwater, 2004). Such thoughts are reflected in another participant's statement regarding how his science teacher influenced his academic self-perception and performance, "My physics teacher who really did recognize my ability in class, nominated me to be in some kind of science magazine, some kind of honor. I was really proud of that (p. 897)."

Teacher perceptions are projected onto students and internalized; in some instances, Black pupils perceive that educators expect less from them than other students (Rascoe & Atwater, 2004). In turn, Black children often feel unsupported by their teachers, lose desire to be successful, and turn from scientific pursuits (Luft, 1998). However, research suggests that when educators possess cultural understanding of their students' backgrounds and provide high expectations, academic support, and useful feedback, Black students feel respected in science classrooms and academic performance improves (Boykin, A. & Bailey, C., 2000). Rascoe and Atwater (2004) discovered that Black males who received positive comments and praise from teachers who validated their academic abilities possessed increased pride and motivation to perform well in science.

Teacher Content Knowledge & Instruction

In addition to teacher expectations and views on culture, students felt that their teachers' content knowledge and approaches to instruction influenced how they learned in science class (Songer, Lee, & Kam, 2002; Tate, 2001). In their study, Rascoe and Atwater (2004) posited that students appreciated teachers who implemented a variety of teaching strategies and used methods other than lecture and text-book instruction. In addition, when

students perceived their science teachers as inadequate or unable to successfully educate them, they ignored instruction and taught themselves the material (Rascoe & Atwater, 2004). However, when students viewed educators as exhibiting command of the content and enjoying their job, the pupils had positive experiences in science; they believed their teachers were competent in instructing them. A participant from Rascoe and Atwater's (2004) study remarked:

> But after that, when I knew that my teachers actually knew what they were talking about and enjoyed what they were doing, it was a good relationship because I got to ask them questions and look for help instead of them sending me to someone else to answer my question (p. 899).

Clearly, educators' expectations, content knowledge, and instructional practices have a major impact on Black students' participation and success in school science. Therefore, it is imperative that teachers work to create a classroom environment that is founded on respect so that all students are valued and encouraged to succeed (Seyfried, 1998).

Influence of Parents

A third factor that influences Black students' progress in the sciences is the views held by their parents. Tracking measures and low teacher expectations for Blacks have persisted for several decades in America; therefore, a large body of Black parents have limited science experiences and possess negative connotations surrounding the field (Barton et al., 2001; Fusco, 2001; Fusco & Barton, 2001; Luft, 1998). As a result, a number of Black parents do not feel that they are equipped to adequately support their children in science (Barton et al., 2001).

Other parents in the Black community may not view science as a subject relevant to their daily lives and project pessimistic views of the field onto their children (Barton et al., 2001; Fusco, 2001). While this notion may exist, research suggests that the majority of Black

parents hold views that science is important to life and encourage their children to enter into science and related careers (i.e., medicine, dentistry, and pharmacy) (Barton et al., 2001). However, the problem arises when Black parents are not knowledgeable of the necessary programs and resources available in science and are unable to help their children successfully navigate through the educational system (Fusco, 2001). This is especially true if students have been placed into the lower educational track. In such instances, Black parents may not possess information about or have access to measures that will allow their children to be removed from this situation. Oftentimes, Black parents find that they are powerless in the educational process and are unable to make well-informed decisions on their children's behalf. In such cases, educators, counselors, and administrators often exert their opinions and positions of power onto parents.

Influence of Students' Stereotypical Views of Scientists

A fourth factor that may impact Black students' low participation in science is the stereotypical images of scientists held by students and perpetuated in society. A number of research studies have been conducted to assess the perceptions individuals from various racial and ethnic groups possess regarding scientists (Chambers, 1983; Rubin, Bar, & Cohen, 2003). Countless results from the Draw-a-Scientist Test (DAST), a qualitative instrument developed to evaluate images held regarding scientists, have depicted that students stereotypically draw middle-aged, White men, dressed in lab coats, and wearing goggles (Chambers, 1983; Parsons, 1997; Rubin, Bar, & Cohen, 2003). Participants often refer to Albert Einstein figures (Basu & Barton, 2005) who are represented exploding chemicals in front of a lecture room of students (Chambers, 1983). Stereotypes observed in the drawings have persisted regardless of participants' racial or ethnic background.

When asked about the scientists drawn in their pictures, students often express that the man does not have a personal life, has limited interactions with friends and family, and spends most of his time working (Rubin, Bar, & Cohen, 2003). These images and perceptions held have endured for over 50 years and are evident in students' pictures throughout the world. Consequently, with DAST images revealing the strongly-held stereotypes of scientists, women and members of ethnic minority groups do not view science as a viable career choice; they feel marginalized because of their gender and or race (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Seiler, 2001)

Influence of Students' Academic Self-Perception, Motivation, & Confidence

With the aforementioned contributing factors impacting students' lives and decisions, their resulting academic self-perceptions potentially affect their selection of and success in science as field of study. Academic self-perception includes the attitudes, feelings, and beliefs that students develop regarding their academic abilities and aptitudes (Rascoe & Atwater, 2004). As stated in Rascoe and Atwater (2005), "Students' perceptions are vital because their perceptions regarding the natural world are framed, largely, within the contexts of their empirical experiences in science learning environments (p. 889)." Stake and Mares (2004) exert that students not only need to possess adequate science knowledge and schooling for success, they must also exhibit high levels of academic self-perception and motivation.

Regarding students' self-perceptions in relation to science, research has revealed Black students often become disenchanted with science because they do not feel it is related to their daily lives and situations (Basu & Barton, 2005). In addition, Black students do not "see" themselves in the field; they do not encounter images of people of color contributing to

the scientific enterprise (Atwater, 2000; Brown, 2005; Seiler, 2001). Furthermore, science teachers fail to adequately infuse examples of Black scientists into the daily curriculum outside of Black History Month. As a result, a number of Blacks view science as a field reserved for White males and uninviting to people of color (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Brown, 2006; Luft, 1998; Seiler, 2001). Often, those who decide to pursue science find themselves as one of few or the only person of color in the classroom or career field. Consequently, Blacks discover that they are socially isolated while studying or participating in science (Barlow & Villarejo, 2004). This isolation may cause them to become disengaged from the discipline.

In addition to low representation of Black peers in science courses, Black students often encounter identity issues when electing to participate in science (Brown, 2004, 2005, 2006). Western science is a discipline that respects cultural values indicative of White, middle-class society; therefore, Black students are confronted with decisions to abandon or assimilate their cultural values and practices because they are not appreciated in the field (Atwater, 2000; Brickhouse & Potter, 2001; Brown, 2004; Seiler, 2001). As a result, Black pupils have difficulties negotiating identity and position in science. In their study, Brickhouse and Potter (2001) described the issues surrounding the scientific identity formation of two Black female high school students. In their findings, they observed that despite the differences in the girls' academic backgrounds (one was a more successful student), both young women experienced marginalization, either due to race or gender. The ladies sought participation in a scientific or technology-based community, but felt out of place due to gender and race-related differences. As a result, they were unable to fully integrate into the

science arena and interact with peers from other races and genders (Brickhouse & Potter, 2001).

When images of minority and women scientists are included in the curriculum and cultural differences are valued, Black students are better able to relate to the discipline and visualize it as a viable career pursuit (Parsons, Travis, & Simpson, 2005). However, when such representations are excluded, Black students' perceptions of themselves as scientists are stifled and the avenue of science is not readily explored (Atwater, 2000; Barton et al., 2001; Luft, 1998; Maton, Hrabowski, & Schmitt, 2000; Parsons, Travis, & Simpson, 2005; Russell, 2005; Russell & Atwater, 2004).

Role of Racial Identity in Career Selection

Despite the fact that current literature has presented a number of factors that potentially contribute to the low percentage of Blacks entering the sciences, notions of racial identity development are limited in science education research. Therefore, this work centers on the development of Blacks racial identity and the extent to which students' stages of development influence their academic behaviors (e.g., course selection in K-12 education, determination of college major, and identification of career). As a Black science educator and researcher in America, this study was important to the researcher because it would help shed light on the underrepresentation of Blacks in science. Focusing from literature related to theories of identity development and student-held perceptions of science and scientists, this work reviewed different models of racial identity formation for Blacks and assessed college students' racial identity profiles.

Furthermore, this research examined the views of scientists Black college students' possessed from their sketches using the Draw-a-Scientist Test (DAST) and the Draw-a-Scientist Test

Checklist (DAST-C). The DAST and DAST-C helped determine if Black college students held stereotypical perceptions of scientists and if their views were impacted by their racial identity. Finally, interview information was elicited from participants concerning their personal experiences in science and science education from the aforementioned theoretical framework of racial identity development.

Hypotheses

Hypotheses were proposed for each of the questions guiding the study. Research-based rationales for the purported hypotheses are provided. Regarding the study, the researcher suggested that the racial identity profiles and perceptions of scientists would differ for the Black students majoring in science and those majoring in non-science fields. By using the participants' scores for the quantitative instruments (i.e., Cross Racial Identity Scale, CRIS, and Draw-a-Scientist Test Checklist, DAST-C), data was obtained to identify if differences did exist between the two groups' racial identity profiles and perceptions of scientists. Specific hypotheses outlining the nature of these differences are provided and depicted by the specific questions guiding the study.

What are the racial identity profiles of Black college students majoring in science?

From this study, the researcher expected to observe that the racial identity profiles of Black students majoring in science would exhibit highest agreement with attitudes reflected in the latter stage of the racial identity model measured by the CRIS, Internalization Multiculturalist Inclusive (IMCI) and lowest agreement with attitudes outlined in the early stage of racial identity, Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), and Pre-Encounter Self-Hatred (PSH) (Cross & Vandiver, 2001). The research contended that the IMCI stage of racial identity encompasses individuals who possess an internalized

racial perspective with reference to their Blackness. As a result, these individuals embrace their race and have committed to a course of action regarding their interactions with other Blacks. In addition, people expressing IMCI attitudes are also accepting of individuals from other groups based on different reference points (i.e., gender, race, sexual orientation (Cross, 1991, 1995, 2001). Considering IMCI individuals are open to interactions with members from other racial backgrounds without disregard to their own racial identity, the researcher believed that students who have declared their majors in science were able to embrace their roles in field with limited representation of Blacks.

In addition, the researcher predicted that students majoring in science fields would have less agreement with the Pre-Encounter attitudes measure by the CRIS, Assimilation (PA), Miseducation (PM), and Self-Hatred (PSH) (Cross & Vandiver, 2001). The Pre-Encounter attitudes account for individuals who regard race as a construct of limited importance (Cross, 1971). People with such views often accept the negative stereotypes perpetuated in society about Blacks (e.g., Blacks are academically inferior to Whites) and exhibit views of self-hatred regarding their role as a Black person in America (Cross & Vandiver, 2001). The researcher purported that individuals expressing such Pre-Encounter perceptions would not be inclined to pursue science, a field in which society deems Blacks as unable to be successful. Pre-Encounter students would accept these stereotypes and restrict their selection of science as a college major. Therefore, those who are science majors would express lowest agreement with Pre-Encounter views.

What are the racial identity profiles of Black college students majoring in non-science fields?

In contrast to the racial identity profiles of Black college students majoring in science fields, the researcher hypothesized that participants pursuing non-science fields would

exhibit racial identity profiles in direct opposition. It was purported that the non-science majors would express highest agreement with the Pre-Encounter attitudes (i.e., PA, PM, and PSH) and lowest agreement with the Internalization (i.e., IMCI) views. This rationale stems from the notion that individuals conveying high agreement with Pre-Encounter conceptions often accept negative stereotypes of Blacks (Cross, 1971, 1995, 2001). As such, Black non-science majors may be inclined to believe that they are not intelligent enough to pursue science and refrain from selecting the field as a college major. In addition, participants demonstrating lower agreement with Internalization attitudes would not possess an internalized racial identity or acceptance of their Blackness. In turn, these individuals would not embrace people from other groups based on different reference points (i.e., race, gender, sexual orientation) and would not be disposed to pursue science (Cross & Vandiver, 2001).

What perceptions of scientists do Black students majoring in science possess?

Regarding participants' perceptions of scientists, the researcher also believed that differences would exist between views possessed by science majors and non-science majors. Specifically, it was hypothesized that Black students majoring in science fields would be less apt to draw images of scientists that represented the common stereotypes perpetuated in society (e.g., middle-aged, White male, lab coats, goggles, crazy hair) (Chambers, 1983; Finson, Beaver, & Cramond, 1995). As participants majoring in science encounter and experience the field and individuals representative of the discipline, the researcher believed that the science majors would sketch images that reflected scientists from all racial, ethnic, age, and gender demographics. Therefore, it was hypothesized that out of 16 elements upon which they were evaluated, science majors' scores on their DAST-C assessment of their DAST drawings would represent fewer than 50% of the stereotypes of scientists in

comparison to the non-science majors who would express greater than 50% of the stereotypes of scientists.

What perceptions of scientists do Black students majoring in non-science fields possess?

In contrast to the science majors' perceptions of scientists, the researcher asserted that the non-science majors would be more inclined to express images of scientists indicative of common stereotypes. Since non-science majors are not actively in the field, they would be less likely to encounter individuals from and knowledge of the discipline. As a result, non-science majors would be more disposed to use societal stereotypes as the basis for the sketches. The non-science majors' scores on the DAST-C assessment for their DAST images would be reflect greater than 50% of the 16 stereotypes of scientists in comparison to the science majors' whose scores would demonstrate fewer than 50% of the stereotypes.

CHAPTER TWO

Literature Review

Chapter two is divided into separate parts. Part I outlines a review of literature surrounding a persons' journey during the process of racial identity development (RID). Research is presented detailing the steps of RID regarding White and Black individuals. For this section, the review of literature was conducted through the use of databases for the fields of education (i.e., Education Resources Information Center - ERIC) and psychology (i.e., Psychological Abstracts - PsychInfo). Keywords searched included identity formation, racial identity development, Black racial identity, Black racial identity, White American racial identity, and ethnic identity. A review of relevant literature in the field of racial identity formation and models theorizing RID is provided. Part II details a review of literature describing individuals' perceptions of scientists. Information discussed centers on the Draw-a-Scientist Test (DAST), an assessment tool developed to ascertain peoples' views of scientists and the relation of these perceptions to societal stereotypes. The ERIC database for the field of education was used for the literature search. Statements such as 'perceptions of scientists' and 'Draw-a-Scientist Test' were used for the literature search.

Part One: Racial Identity Development

Identity Formation

Erikson (1968) was one of the principle researchers to study identity formation. In his work, he postulated eight stages through which a person progresses over a lifetime along the pathway to discovering his or her identity. According to Erikson's stages of psychosocial maturity, an individual encounters conflict at each stage of development. He or she must

resolve conflicts through important life events in order for favorable outcomes (virtues) to result.

The first five stages of Erikson's model outline childhood and adolescence. Stage one is Oral-Sensory. This stage marks the period of time from birth until one year of age. An infant in this stage of development is conflicted with issues regarding trust versus mistrust. The significant event that resolves conflict for the infant is feeding. Muscular-Anal is the second stage of the model. In this stage, infants and toddles ranging in age from one to three experience tension between feelings of autonomy and doubt. Resolution for this conflict occurs through the event of toilet training. The third stage, Locomotor, accounts for children ages three to six years who are torn between thoughts of initiative and inadequacy. As children in this stage assert their independence, they are able to progress in their development to stage four, Latency. The period of Latency spans the time from six to 12 years of age. Children at this stage of development experience disparities between their thoughts of industry and inferiority, but conflict is resolved during the process of schooling. Between the ages of 12 and 18, young people experience Adolescence. During this time, youth must negotiate their identity and confusion through peer relationships and interactions with others. These interactions help them to better understand who they are in relation to those around them.

The final three stages in Erikson's model represent the period of adulthood. From age 18 until 40, people experience a time of Young Adulthood. Young adults are conflicted between intimacy and isolation. Erikson postulated that loving relationships help resolve these problems. Between the ages of 40 and 65 years, people experience Middle Adulthood. During this stage of life, tension results between generativity and stagnation and is resolved

by the process of parenting. Finally, from age 65 until death, development has reached maturity. At this time, individuals encounter conflicts between integrity and despair. The only way to resolve this pressure is to look back and accept one's life (Erickson, 1959/1980). Clearly, Erikson's work provides a comprehensive overview of the process of identity and psychosocial development. Unfortunately, his model does not delineate identity development from the perspectives of ethnicity or race.

Adolescent Ethnic Identity Development

In addition to studies on psychosocial development, researchers have also explored how adolescents form their ethnic identity. Phinney (1989) proposed a series of three levels a person progresses through from a time of exploration to a place of committed ethnic identity. The first stage of her model denotes adolescents who possess an unexamined or diffused ethnic identity because they have not been confronted with ethnic identity issues. These individuals often exhibit limited regard for race (Phinney, 1989). Next, some adolescents at the second stage commit to an ethnic identity without personal exploration; they develop their ideas on the basis of ethnic attitudes exhibited by parents. Unfortunately, individuals at this level often accept stereotypes and beliefs held by adults. These young people represent a foreclosed status and have reached a cessation on ethnic awareness because they do not seek new information (Phinney, 1989). When adolescents commit to exploring ethnic issues, they may attain the third stage, achieved identity. At this level, individuals posses ethnic pride, a sense of belonging, and group confidence (Phinney, 1989).

Phinney (1989) postulated that a person's understanding and acceptance of his or her ethnic identity helps to protect him or her from prejudice and discrimination. Though Phinney's model provides relevant information concerning ethnic identity development

during adolescence, it fails to provide explanations for identity formation during adulthood. Therefore, other models explaining identity development have been proposed.

White American Racial Identity Development

Helms (1990) posited a model representing White individuals' racial identity development. The six stages of her model suggest that Caucasians must abandon notions of racism and develop a non-racist identity. Stage one, Contact, encompasses people who exhibit limited respect for race, have few experiences with Black people, and claim a "color-blind" attitude (Helms, 1990). Often, individuals in the contact stage do not analyze societal issues and accept stereotypes perpetuating ideas that Blacks are inferior to Whites. They fail to see that they possess biases and prejudices and do not acknowledge that they are a part of the dominant group in society (Helms, 1990).

During the second stage, Disintegration, White people become conflicted when they are unable to resolve racial or moral dilemmas that appear to be direct opposites (Helms, 1990). For example, one experiences Disintegration when he or she believes that he or she is not racist but does not want his or her son or daughter to marry someone from a minority group. As a result of the dissonance they experience, a person in this stage becomes more aware of his or her Whiteness and battles with choosing between one's own-group identification and humanism (Helms, 1990).

The third stage, Reintegration, results from increased affiliation with the dominant ideology because of societal pressures (Helms, 1990). At this stage, one begins to idealize the White race as being superior and fails to tolerate individuals from minority groups. People remain in this phase until an encounter occurs. If an event transpires that forces someone to re-examine racial and cultural differences, he or she may begin to experience Pseudo-

Independence. At this time, he or she may seek out people from minority groups who he or she deems as "similar" to him or herself (Helms, 1990).

When a person reaches the fifth stage of White racial identity development, Immersion - Emersion, he or she has explored what it means to be a White racial being in America (Helms, 1990). As a result, he or she understands that White privilege exists and seeks to identify instances where he or she has benefited. Consequently, individuals in this stage look for ways to combat racism and oppression of racial and ethnic minority groups (Helms, 1990).

The final stage, Autonomy, is reached when one accepts his or her Whiteness, understands his or her role in perpetuating racism, and strives to abandon his or her White-entitlement (Helms, 1990). This person embraces diversity and is no longer uncomfortable with the realities of race in society. While Helms' model is restricted to White people, other researchers have proposed racial identity models for Blacks.

Black Racial Identity Development

In an effort to better understand the extent to which Black college students' stages of racial identity impact their selection of a major, one must examine the literature. Research from past studies reveals that various models for identity formation and racial identity development (RID) exist (Carter & Helms, 1988; Lockett & Harrell, 2003; Thomas & Speight, 1999; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). The different versions of a Nigrescence model postulated by Cross (1971; 1991; 1995) were selected as the theoretical framework for this study because they provide a comprehensive overview of Black RID. In addition, these models are most appropriate for use with individuals in their

late teens and adult years. Consequently, it is suitable to assess Black college students' stages of RID using this model.

Models of Black RID

Cross' Original Nigrescence Model

For a number of decades, researchers have worked to conceive comprehensive models that account for the journey a person makes along the road to racial identity development. Cross posited his Nigrescence theory which outlined the RID for Blacks (Cross, 1971). Cross (1991) posited that, "Nigrescence is a resocializing experience; it seeks to transform a preexisting identity (a non-Afrocentric identity) into one that is Afrocentric (p. 190)." His Nigrescence model maps the process of racial identity for assimilated, deracinated, deculturalized, or miseducated adults as they become Black-focused or Afrocentrically connected. The original Nigrescence model details five stages through which a person progresses: Pre-Encounter, Encounter, Immersion - Emersion, Internalization, and Internalization - Commitment (Cross, 1995; Helms, 1999; Worrell, William, & Vandiver, 2001).

The Pre-encounter stage of Cross's (1971) model depicts traits for an individual who holds limited salience for race. Often, a person exhibiting Pre-Encounter qualities denies his or her "Blackness" and views the White culture as ideal, seeking to assimilate Caucasian beliefs and values as his or her own (Abrams & Trusty, 2004; Cross, 1995; Tatum, 2004). Cross (1971) proposes that the person will remain in this Pre-encounter stage until a significant, usually racist, event occurs which causes dissonance and prompts a re-evaluation of his or her conceptions of race. After the event, the individual moves to the Encounter stage and displays an increased regard for race. Additionally, the Encounter stage is marked by

decreased denial of oneself as being Black. As a result, a person in the Encounter stage denounces formerly accepted stereotypes held regarding the inferiority of Blacks and is able to negotiate his or her race and worth in society (Cross, 1995; Helms, 1999).

Following one's encounter with a significant event, he or she progresses into the next stage, Immersion - Emersion. During this time, an individual experiences a need to exhibit characteristics which are considered opposite "White" protocols (Abrams & Trusty, 2004; Cross, 1995; Helms, 1999). He or she becomes completely immersed in an "idealized" view of the world of Blackness and searches for instances to learn more about Black history and culture while rejecting those aspects considered White (Tatum, 2004; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). Once the individual acquires information which provides security in his or her own racial group, he or she becomes more objective regarding race. These qualities characterize the Internalization and Internalization - Commitment stages of Nigrescence (Cross, 1995; Tatum, 2004). When a person is able to internalize his or her own race, he or she is able to seek relationships with those from different racial groups while continuing to involve oneself with Black cultural activities and organizations (Cross, 1995; Tatum, 2004). At this level, self-actualization is reached; the acceptance of a positive Black identity (Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001).

Cross' Revised Nigrescence Model

Since its inception, Cross (1991) has revised the Nigrescence model for Black RID. In his revised model, Cross (1991) accounted for varying identity clusters which manifest during the different stages of racial identity development. The new model outlined four stages of Black RID: Pre-Encounter (the identity to be changed), Encounter (point during which person is compelled to change), Immersion - Emersion (vortex of identity change),

and Internalization and Internalization - Commitment (habituation and internalization of the new identity) (Cross, 1991, p. 190).

The Pre-encounter stage of the revised identity model encompasses a number of diverging attitudes and characteristics such as limited racial salience, race neutrality, and anti-Black conceptions. Cross (1991) has referenced these attitudes as low-salience, social-stigma, anti-Black. Those exhibiting low-salience views do not necessarily deny their Black race; however, they do not view race as being a significant factor in their daily lives. For these individuals, their Blackness does not impact their happiness and well-being (Cross, 1991). Those demonstrating social-stigma attitudes may accept the low-salience ideals, but also view race as a dilemma or problem. As Cross (1991) described, "Thus, by default, some significance is attributed to race, not as a proactive force or cultural issue, but as a social stigma that must be negotiated from time to time (p. 191)." Those expressing social stigma conceptions identify their Blackness in relation to social discrimination and oppression rather than Black history and culture. In comparison to low-salience and social-stigma Pre-Encounter attitudes, anti-Black notions are more extreme. Individuals exhibiting anti-Black ideals envision race as an important factor, but in a negative manner. One can liken their views to those of White racists; they loathe other Blacks and do not see them as a people or community with positive potential (Cross, 1991). Additionally, anti-Black attitudes embrace negative stereotypes of Blacks.

Characteristics expressed by the Pre-Encounter population include issues of miseducation, possession of an Eurocentric cultural perspective, problems with spotlight anxiety, approaches to assimilation – integration, and differences in value structures (Cross, 1991). A number of Blacks have been educated to assume a Western cultural and historical

perspective, as such Pre-Encounter Blacks experience degrees of miseducation concerning the impact and significance of Black history. Those expressing anti-Black attitudes may develop self-hatred because of a distorted interpretation of Blacks. In addition, because Pre-Encounter Blacks have often developed a Eurocentric cultural perspective, conceptions of beauty, art, and music are regarded from a White framework. Finally, Pre-Encounter Blacks may also demonstrate a hypersensitivity to racial problems and negative portrayals of Blacks and anxiety about being "too Black" (Cross, 1991). These notions encompass what is termed spotlight anxiety. A third aspect, assimilation – integration, refers to how one approaches society. Pre-Encounter individuals look to Blacks to learn how to assimilate into mainstream arenas, but do not expect change from White America. Finally, people reflecting Pre-Encounter attitudes may exhibit different value structures in comparison to those with a more internalized racial identity. Pre-Encounter individuals have strong memberships with secular, political, and religious organizations, but have low racial salience (Cross, 1991).

As found in the original model, the Encounter stage occurs when an individual is confronted with an unpleasant event which prompts him or her to re-evaluate previously held beliefs regarding race (Lockett & Harrell, 2003; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001; Worrell, William, & Vandiver, 2001). The Encounter stage is marked by two aspects, experiencing the event and personalizing it. When people experience the event and dissonance occurs, individuals must determine their course of action. Some individuals will have an encounter episode, will not be effected by it, and will continue in the Pre-Encounter direction. In contrast, others will experience the event, become traumatized by it, and re-evaluate their original conceptions of race and their willing assimilation into White society (Cross, 1991). Cross (1991) indicated that when the later occurs, "The Pre-Encounter person

is dying; the Black American, or "Afrocentric" person, is beginning to emerge (p. 201)." Consequently, re-evaluation of one's attitudes following an encounter event often leads to Immersion - Emersion.

The third stage of Cross's (1991) revised Nigrescence model was found to be one of the most prominent stages of Black RID. Cross (1991) commented that this stage, "…represents the vortex of psychological nigrescence (p. 201-202)." At this level of RID, a person has decided to commit to change often resulting in an affinity for symbols their new identity as indicated by hairstyles, flags, national colors, jargon, etc. The Immersion – Emersion stage represents a period of dichotomy during which individuals simultaneously demonize and reject Whites while glorifying and praising Blacks. This stage outlines two phases, Immersion and Emersion. The Immersion phase of the third stage depicts people who engross themselves into the Black world. They seek to join organizations, attend seminars, and read literature related to Blacks. After individuals' emotions and actions level off, they enter the Emersion phase and may seek to develop a substantive understanding of and commitment to their Black race. Such progression leads them closer to an internalized identity (Cross, 1991).

One must note that several negative outcomes may result during the third stage of RID. Individuals may experience regression, fixation, or "dropping out" as they transition their racial identity (Cross, 1991). When people experience a racial identity process that is negative and disappointing, they may elect to reject their Blackness. As a result, they may regress toward their former identity as expressed in their Pre-Encounter conceptions. In addition to regression, there are people who experience fixation during stage three. Fixation involves those who concentrate on their hated for White people. These attitudes may

manifest themselves in their future interactions with others. Those newly immersed in their Black RID often fixate on the rejection of Whites. Finally, instances of dropping out are also observed. Dropping out refers to people electing not to be involved in Black affairs. While dropping out does not regress back to Pre-Encounter convictions, it does involve two different aspects: those who view the race problem as insuperable and may elect to participate at a later date or those who become depressed and express no identity, anomie (Cross, 1991). Despite the markers of transition and conflict observed at the Immersion – Emersion stage, individuals who progress toward and personalize their Black racial identity reach Internalization.

Regarding Internalization, Cross (1991) commented, "For the 'settled' convert, the new identity gives high salience to Blackness, with the degree of salience determined by ideological considerations (p. 210)." As a result, three varying ideologies were defined: Nationalism, Biculturalism, and Multiculturalism (Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). Nationalists express solely a concern for race regarding their approach to life. Biculturalists embrace at least two aspects (e.g., race, gender, religious, sexual orientation) while multiculturalists encompass several areas of salience. Ultimately, an internalized racial identity functions in people's lives on three levels: 1) protection against psychological insults that result in a racist society; 2) membership and affiliation with others; and 3) foundation for interactions with others (Cross, 1991).

The final stage, Internalization - Commitment, indicates those individuals who sustain their interest in developing their Black identity and commitment to helping others. This commitment occurs over an extended period and in some cases over a lifetime. While the

Internalization – Commitment stage does not differ psychologically from the Internalization stage, the commitment to and duration of nigrescence is highlighted.

Recycling & Afrocentricity

Originally, Cross (1971; 1991) postulated that nigrescence occurred once in life and involved the completion of four or five stages. However, work by Parham and Helms (1985) has noted that recycling may result. If individuals complete the cycle during an early stage in life (i.e., adolescence or early adulthood) they may recycle through the process at later junctures in life (e.g., middle age) or as a result of life events (e.g., marriage). However, these authors posited that it is unlikely that individuals would recycle back to the Pre-Encounter stage. Additional life circumstances would present themselves as new encounters in people's lives (Cross, 1991; Parham & Helms, 1985).

Though the term Afrocentricity has developed a number of definitions over time, for the study of racial identity development, Cross (1991) delimits its characteristics to the exploration of the significance and application of African-based views on such factors as art, history, politics, economics, psychology, and social problems. In his work, Afrocentricity is sometimes used synonymously with Internalization attitudes and approaches to life.

Parham & Helms' Racial Identity Model

Stemming from Cross's work with the Nigrescence model, Parham and Helms (1985) continued the research for Black racial identity development. In their definition, the authors noted that racial identity is based on an individual's ideals and involvement in sharing a common racial heritage with a particular reference group. Therefore, RID determines the relationship a person expresses relative to Black culture or the majority culture (Moreland & Leach, 2001). From their work, Parham and Helms (1985) postulated identity attitude

"statuses", parallel to Cross's, which characterize Black RID: Pre-encounter, Encounter, Immersion-Emersion, and Internalization (Helms, 1990; Moreland & Leach, 2001; Parham & Helms, 1985; Vinson & Neimeyer, 2000). The term status was used to reflect the dynamic nature of RID as opposed to the term stage which denotes definable markers in time (Helms, 1990; Parham & Helms, 1985).

An individual in the Pre-Encounter status of RID exhibits ideals that the White worldview is dominant and correct and denounces the Black worldview (Moreland & Leach, 2001). The Encounter status represents a person who experiences either a personal or social event which is upsetting and challenges his or her perceptions of identity. Following this encounter, the person moves to the Immersion - Emersion status which prompts the individual to develop his or her pride in being Black and also results in the minimizing of White culture. Finally, the Internalization status reflects the view of a person who values his or her own racial group and culture while also accommodating diversity (Helms, 1990; Moreland & Leach, 2001; Vinson & Neimeyer, 2000).

Multidimensional Model of Racial Identity

The latest model of Black racial identity development is the Multidimensional Model of Racial Identity (MMRI). This theory was developed using the interactions of social psychology literature focused on self-esteem and identity constructs, various models of Black racial identity, and behavior and group affiliation (Seller, Rowley, Chavous, Shelton, & Smith, 1997). The MMRI views race as one of many identities Blacks exhibit (Rowley, Chavous, & Cooke, 2003). Specifically, the MMRI examines Blacks' viewpoints concerning the importance of race in how they categorize themselves and the meanings they attach to affiliation in a racial group (Seller, Rowley, Chavous, Shelton, & Smith, 1997). Four

dimensions which detail the importance and meaning of race in Black self-concept where identified for the MMRI: identity salience; the centrality of identity; the ideology associated with identity; and the regard in which an individual holds Black people.

Salience describes the degree to which race is prominent in a person's self-concept at a given point in time. Salience is dynamic in nature because it can depend on situations and their context. An example of salience could be a solitary Black person in an environment fueled by White racial aggression (Cokley & Helm, 2001). At such time, race is likely to be of high salience to the person. Centrality details the constancy and importance of race being central to one's self-concept. While salience is variable due to situations, centrality is normative (Seller, Rowley, Chavous, Shelton, & Smith, 1997). The incorporation of centrality in the model denotes that hierarchies exist in a person's identity constructs and the extent to which they are prominent in one's definition of self.

Ideology refers to the attitudes, thoughts, and perspectives an individual possesses regarding how members of a racial group should behave. According to Sellers, et al (1997), there are four categories of ideologies: 1) naturalists who focus on the uniqueness of being of African descent, 2) oppressed minorities who connect commonalities between Blacks and other oppressed groups, 3) assimilationists who emphasize the similarities between Blacks and American society in general, and 4) humanists who recognize the commonalities between all humans. The final dimension of MMRI is regard. Regard refers to the manner in which a person looks upon or feels about oneself; it is a personal judgment of his or her race. The regard dimension is composed of public and private components. Public regard is defined as the perception one has about how others view, either positively or negatively,

Blacks while private regard describes the extent to which a person feels positive or negative about him or herself being Black (Seller, Rowley, Chavous, Shelton, & Smith, 1997). While various models exist describing the progression a person makes along the journey of developing his or her racial identity, the concept of RID has also been linked to different elements of one's life. Such aspects include moral development, family experiences, racial socialization, and self-esteem (Carter & Helms, 1988; Collins & Lightsey, 2001; Hagrow, 2001; Lockett & Harrell, 2003; Miller, 1999; Moreland & Leach, 2001; Scott, 2003; Tatum, 2004; Thomas & Speight, 1999; Vinson & Neimeyer, 2000; Wilson & Constantine, 1999). These areas of research provide possible insight into relationships which may exist concerning Black college students' racial identity and selection of college major. It is important to note that researchers have not correlated specific chronological ages to correspond with different stages of RID models (Cross, 1971, 1991, 1995; Helms, 1990). However, Helms (1990) purports that adolescence tends to represent the period during which individuals develop cognitive maturity and are better able to think critically and abstractly; therefore, they may be more apt to possess racial awareness or race-consciousness.

Impact of RID on Various Factors

Black RID & Race

Throughout American history, a variety of terms have been used to label individuals based on racial group membership. For those whose interests are evaluated in this research, terms such as African, African American, Afro-American, Black American, Black, person and or people of color, Negro, and Colored have been used (Thompson & Akbar, 2003). In their work Thompson and Akbar (2003) evaluated the extent to which Blacks understood and

defined the racial label to which they identified and how the method used to define racial labels related to racial identity and attitudes.

In their study, Thompson and Akbar (2003) studied 319 individuals (131 males and 188 females) ranging in age from 18 to 82 years (mean = 33.28 years). The researchers used a survey to obtain demographic data, information related to racial experiences, racial term preference, and definition of racial categories. Demographic data revealed that 86% of the participants grew up in a metropolitan area of a large Midwestern city while 14% were from two small rural towns within the same state. Mean income for the sample was $22,638 and mean education reported was 14.22 years. The males in the study were found to be significantly older than the females, $F(1, 317) = 5.02$, $p = .03$ and reported significantly higher incomes, $F(1, 317) = 12.91$, $p = .0001$. No differences were observed in level of education attainment for males and females. On the demographic questionnaire, participants were able to identify their preferred racial identity label as: American, Negro and or colored, multi-racial, African, Black, Black American, Black and or African American, and African American.

To assess racial identity salience, the researchers used the Identity Salience Scale, a five-item instrument with item anchors ranging from (0) *not very important* to(3) *very important*, and scales ranging from 0-15. The Black Multidimensional Racial Identity Scale was used to evaluate participants' racial identity attitudes. Finally, respondents were asked to provide a written statement addressing how the believed individuals were assigned to racial categories. Their responses were assessed for biological basis (e.g., genes, skin color, and physical attributes), ancestry (i.e., ancestry from Africa), history and or heritage of

oppression or slavery, cultural aspects (e.g., life experience, music, literature), or the denial of the existence of race.

Findings from this study revealed that 45.9% of the participants identified racial categories based on biological and physical factors. Examples of their descriptions included, "Any person with 1% of Black blood" and "Color in skin, coarse hair, big, strong features (p. 83)." Of the participants, 22.8% identified ancestry as the basis of racial categories. Individuals who declared that categorizations were based on ancestry commented that labels are given to, "Those whose ancestors were transported from Africa to America unlawfully, coerced, or voluntarily and gave rise to subsequent generations" and "Any Black person in America because they are descendents of Africans from Africa (p. 83)." For the remaining participants, 15.3% did not provide a description for the basis of racial categorization, 7.2% described heritage, 6.3% discussed culture, and 2.5% denied the existence of race.

Regarding participants' preferences for terms used to identify themselves, 35.1% selected the category African American, 17.9% were comfortable with African or Black, 16.3% preferred Black American, 8.2% affiliated with the term Black, 7.2% declared that they were purely American, and 3.4% described themselves as colored, Negro, multiracial, or African.. One participant remarked about the process that led to identification with being African American:

> I've grow to embrace the term African American because it gives me something to identify with. Growing up it didn't matter if I was called black or whatever because I never sensed any racial tension growing up in my 50/50 Black/White neighborhood and school It wasn't until I attended a predominately white school and until I started interviewing for jobs that I felt like I was in a sea or ocean by myself (p. 84).

In contrast, another participant responded that, "I prefer Asiatic" (referring to the seven continents being combined together prior to separation) (p. 84). No significant gender

differences for term preference were found, but a significant effect was observed for rural and urban residency. Findings indicated that rural participants were less likely than urban individuals to report a desire to be called African American.

Finally, Thompson and Akbar (2003) found that the basis for participants' racial categorization was not related to their racial identity salience or psychological, physical, or sociopolitical racial identity attitudes while an association was observed between cultural racial identity attitudes. They also identified that the term African American was highly associated with racial identity salience scores.

RID & Moral development

Moreland and Leach (2001) conducted a study which evaluated the impact of one's racial identity on his or her moral reasoning and decision-making. Moral development refers to the extent to which a person's actions are "good" or "right" in a society (Moreland & Leach, 2001). In their work, Moreland and Leach (2001) outlined levels of moral development: Pre-conventional morality, Conventional morality, and Post-conventional morality. Pre-conventional morality describes one's view of morality as an external referent to self; the person chooses to follow rules which are beneficial to him or her. Conventional morality details an individual who incorporates attitudes shared by a community of people. Finally, Post-conventional morality stresses that a person seeks to uphold the social beliefs, rights, and values of society (Moreland & Leach, 2001).

To determine if a link exists between one's moral development and Helms' statues for RID, Moreland and Leach (2001) studied 197 Black undergraduate and graduate participants. The Racial Identity Attitude Scale for Blacks (RIAS-B) was administered to determine racial identity attitudes reflective of the five RID statuses. Also, participants

completed the Defining Issues Text (DIT) which measures decision-making based on moral dilemma scenarios. From this study, results revealed that students exhibiting qualities of the Pre-encounter status were negatively correlated to moral development; those with higher scores for Pre-encounter items were viewed to be less able to produce moral reasoning thereby expressing Pre-conventional moral development. The rationale for this finding was that those in the Pre-encounter stage hold White standards in high regard and chose not to disrupt the status quo with their decision-making. An additional finding from the study exposed that a significant positive correlation existed between those expressing views indicative of the RID stage of Internalization and Post-conventional moral development. As such, participants at the Internalization status were more inclined to make justified moral and complex decisions. From these studies, the researchers concluded that relationships exist between Black racial identity development and moral development. As a result, one can gleam that further elements of Blacks' lives may be impacted by their level of RID.

RID & Family Experiences

Studies have also been conducted to identify connections between Black racial identity development and family experiences. Tatum (2004) interviewed 18 Black college students who grew up in predominately White neighborhoods. The findings from her study revealed that of the 18 families represented, various approaches were made by parents to address race in their families. These frames included race-conscious, race-neutral, class-conscious, and race-avoidant approaches. The frameworks parents used to rear their children resulted in the participants expressing sentiments reflective of Cross's Nigrescence model (Cross, 1991; Tatum, 2004).

In her findings, Tatum (2004) noted that one participant, identified as Janice, raised in a class-conscious and or race-avoidant home expressed attitudes related to the Pre-Encounter stage of RID. Janice grew up in a neighborhood with mostly White children. Her parents had limited contact with extended family members and did not expose her to a Black social network. As a result, she possessed limited salience for race; an attitude reflected in the earlier stages of RID. Janice noted that, "I didn't really see my Blackness in high school at all. I mean I was aware of how I was treated differently… [But I would say] 'we don't see color here. Everyone is friends and they treat me the same (p. 121)." As expected in the model for racial identity development, this participant experienced a significant episode which moved her into the Encounter and subsequent stages. Upon graduating high school and attending a predominately White university, Janice expressed, "Being treated like an Affirmative Action case and having bottles and epithets hurled at her from a passing car" (p. 122). As a result, she re-evaluated her conceptions of race and sought to identify with her Black culture.

Additionally, Tatum (2004) identified a participant who possessed attitudes reflective of the Immersion - Emersions stage. This participant, identified as Karen, grew up in a family that was race-conscious. She and her family lived in a predominately White neighborhood where she recalled that there were only two or three other Black children at her school. Though her experiences in high school mimicked those of Janice, Karen totally immersed herself into Black culture in college. She noted, "I've done a fair amount of work in African American literature, especially women's literature" (p. 124). Karen expressed these experiences in college resulting from her progression from the Encounter stage into the

Immersion - Emersion level. While this study exposed links between RID and family experiences with race, additional work assessed RID and racial socialization.

RID & Racial Socialization

In addition to research on the influence of RID on family experiences, racial identity has also been linked to Black parents' approaches to racially socializing their children. In contrast to the approaches parents use to address or avoid issues of race with their children, researchers purport that racial socialization is the procedure by which youth and their parents engage in decision-making regarding their cultural heritage and ability to maneuver through a racially aware society (Scott, 2003). In past studies, researchers have determined that the process is not the same for all Black parents and have identified three parental orientations that impact their interactions with children during racial socialization: mainstream, minority, and Black cultural (Miller, 1999; Scott, 2003; Thornton, 1997). When preparing their children for the racial difficulties and issues in society, parents who exhibit a mainstream framework emphasize self-confidence, personal self-esteem, competence, and hard work rather than race. In contrast, parents who assume a minority-based orientation are more inclined to stress the importance of race in America and the obstacles their children are likely to encounter due to their racial and ethnic heritage. Finally, those parents how exhibit a Black cultural perspective seek to instill racial pride in their children by focusing on the history and accomplishments of Blacks (Scott, 2003; Thornton, 1997).

In his study of 71 (37 female and 34 male) Black adolescents who were 10^{th}, 11^{th}, and 12^{th} grade students at a small, private, and religious-oriented high school in the south, Scott (2003) explored the extent to which racial identity and racial socialization impacted Black youths' ability to cope with discrimination. Using the Daily Life Experiences survey (DLE-

R), a 20-item, five-point, Likert-type scale, he assessed the extent to which youth encountered "micro aggressions" in their daily lives based on race or racism. Such micro aggressions based on race included being followed in public locations, being refused services, and being ignored. Responses for the DLE-R ranged from (0) *never* to (4) *all the time.* Additionally, Scott (2003) utilized the Racism Experiences Stress Scale (EXP-STR), a 17-item, five-point, Likert-type scale to evaluate the impact of racism on the stress in one's life. Response choices for this scale varied from (0) *no stress* to (4) *extremely stressful*. For the instruments, higher scores signify more frequent discriminatory experiences and distress respectively.

Participants in the study also completed the Multidimensional Inventory of Black Identity (MIBI) and the Racism-Related Socialization Influences Scale, The MIBI is a 65-item, seven-point, Likert-type inventory that measures three domains: centrality, ideology, and regard. The researcher only used the Racial Centrality scale for this study. This scale consists of 10 items that assess the degree of importance respondents place on being Black as central to their self-conceptions and identities. The Racism-Related Socialization Influences Scale is a 9-item, five-point, Likert-type survey used to evaluate the frequency and content of the racism-related messages one receives from family and adults. Responses for the instrument range from (1) *not at all* to (5) *extremely.* Finally, participants completed the Self-Report Coping Scale which assesses the use of approach and avoidance strategies in response to daily stressors. This instrument is a 34-item, five-point Likert-type scale from (1) *never* to (5) *always*. Two subscales for the Self-Report Coping Scale include Seeking Social Support and Self-Reliance and or Problem Solving.

Using one-way ANOVA to examine the relationship of demographic variables to perceived discriminatory experiences, discrimination distress, racial identity, and racial socialization, data revealed only one significant finding between gender and racial centrality, $F(1, 69) = 4.22$, $p = 0.04$. Male participants found race as being more central to their racial identity and self-conception than females. In addition, racial identity and racial socialization were related to the participants' ability to handle discriminatory experiences. The extent of racial centrality to self-conception and identity was unrelated to approach and avoidance strategies; however, the receipt of racial socializations messages from family was related to the use of the approach coping strategy, but not the avoidance method. Though this study did not find significant relationships between racial identity as expressed through racial centrality, the results did indicate that it is highly important for Black parents and family members to racially socialize adolescents so that their children will be more equipped to handle and cope with discriminatory encounters and experiences (Scott, 2003).

RID & Self-Esteem

Research has also observed that relationships exist between an individual's stage of racial identity development and his or her self-esteem. Collins and Lightsey (2001) conducted a study which provided evidence to confirm this relationship. A sample of 70 Black women completed quantitative instruments that allowed for the application of statistical models to detect relationships between variables (i.e., racial identity attitude, self-esteem, and self-efficacy). Participants completed one measure for each variable: Racial Identity Attitude Scale (RIAS), Rosenberg Self-Esteem Scale, and Generalized Self-Efficacy Scale.

A series of regression analyses described the statistical relationship between racial identity attitudes, self-esteem, and self-efficacy. Analyses depicted that internalization attitudes measured by the RIAS were a significant predictor of self-esteem and self-efficacy. In addition, regression models illustrated the extent to which racial identity attitudes accounted for variance in self-esteem. The variances in self-esteem explained by stages in RID were: Pre-encounter (R^2 = .10), Emersion (R^2 = .14), Internalization (R^2 =.14). These statistics describe that the stages of RID respectively account for 10%, 14%, and 14% of variance in the self-esteem scores at the corresponding stages. These values were significant at $p < .01$, $p < .001$, and $p < .001$ respectively. Though this work presented a number of interesting findings, the authors did not observe significant variance in self-esteem for the Encounter stage of RID.

Findings from the aforementioned studies illustrate the impact one's racial identity development has on his or her moral development, family experiences, racial socialization, and self-esteem. Furthermore, such research provides support that racial identity development may impact other areas of Blacks' lives, one aspect being Black college students' selection of college major. From previous research, it can be theorized that one's stage of RID may impact his or her decisions regarding the selection of science as a college major. Depending on one's views of the world, he or she may perceive science as a field limited to Caucasian individuals and fail to pursue it as a viable career pathway. This researcher contends that such views are expressed by college students exhibiting traits indicative of the Pre-Encounter stage while Blacks in the Internalization stage denounce that science is limited to White people and pursue it as a college major.

Blacks, College Majors, & Career Selection

Considering the fact that society requires scientific advances and relies heavily on a knowledgeable and skilled workforce, future scientists and researchers are needed to allow the Unites States to remain progressive in areas regarding biotechnology, healthcare, and space travel. Consequently, it is important to ensure that Blacks are well-equipped with the appropriate information and necessary abilities required to acquire jobs in the science industry.

Typically speaking, one's career decisions are determined by his or her college major and degree obtained (Bamberger, 1987; Duru & Mingat, 1979; Montmarquette, Cannings, & Mahseredjian, 2001). Therefore, it is important to analyze literature related to factors impacting the selection of college majors and pursuit of careers. Duru and Mingat (1979) proposed that individuals determine their college studies based on an exchange the economic return projected for a field in comparison to risks of failure. Bamberger (1987) contends that college students select a major by accounting for the possibility that they might be unsuccessful in one field of study, change to another, and fail there as well. Therefore, individuals' choices of college major may be dynamic. As a result, students often pursue endeavors where they believe they will be most successful (Montmarquette, Cannings, & Mahseredjian, 2001).

Regarding Black students, issues related to gender and race also factor into decisions regarding the selection of one's college major and future career (Fadigan & Hammrich, 2004; Jayaratne, Thomas, & Trautmann, 2003; Lewis & Collins, 2001). Black women may not view certain academic areas or career choices as accessible to them because of gender roles and stereotypes outlined in society (Fadigan & Hammrich, 2004). If fields are deemed too

masculine or inappropriate for women, they are less inclined to pursue them as career options. Despite the fact that minority women may have an interest and exhibit success in science, they may select a different field of study because perceived discomfort may result from thoughts of entering a White male dominated field (Jayaratne, Thomas, & Trautmann, 2003). However, women are more inclined to make selections based on the perceived relevance and value particular fields have to their lives (Fadigan & Hammrich, 2004).

Lewis and Collins (2001) found that Black college students' decisions to pursue science-related careers were highly connected to their perception that the field would be supportive of their personal goals. If students believe their college major or career choice would conflict with or negatively impact their personal relationships and goals, they were less likely to endeavor into science fields. In addition, participants in this study viewed college coursework as a reflection of the nature of science and potential future careers. Therefore, if students disliked particular courses they were likely to change their majors to prevent working in similar careers (Lewis & Collins, 2001).

Maton, Hrabowski, and Schmitt (2000) proposed other factors to explain why Black college students fail to persist in college science majors. They contend that the majority of Black families earn lower incomes than Caucasian families causing difficulties to arise when deciding to send children to college; it is often challenging or impossible for large percentages of Black families to finance their students' higher education. Therefore, a number of Black students obtain jobs during their college years to help reduce costs. Unfortunately, studies reveal that employment during college is negatively associated with persistence in school and degree completion (Maton, Hrabowski, & Schmitt, 2000). A second factor proposed to explain the lower numbers of Blacks in science majors is an inadequate

academic background. In comparison to Caucasian students, Black freshman tend to have insufficient Scholastic Aptitude Test scores (SAT), lower high school grade point averages (GPAs), and limited participation in advanced science and math courses in high school (Maton, Hrabowski, & Schmitt, 2000). As a result of the aforementioned factors, Blacks are less likely to pursue science fields in college.

Classification of Minority Groups

When discussing the academic achievement of Black students, it is important to recognize literature surrounding the existence of minorities in American. One limitation to the Cross Nigrescence model as a theoretical framework is that it treats individuals who are African American (i.e., people of African decent but born and raised in America) and Black (i.e., individuals of African decent but born and raised in other areas – Africa and Caribbean) as synonymous in their racial identity development. Such factors must be addressed when generalizing findings regarding Black racial identity development. To account for these assumptions, the work of Ogbu (1986) is summarized. In his research, Ogbu (1986) outlined a rationale that accounts for the academic differences observed between ethnic minority groups in the United States. He posited a classification system which encompasses what he defined as autonomous, immigrant, and castelike minorities and their existence in society and matriculation through the American school system.

According to Ogbu (1986), autonomous minorities represent such individuals as the Amish, Jews, and Mormons. While these groups' status as minority is numeric in comparison to other ethnic and religious populations, the autonomous minorities are not completely subordinate, politically or economically, to the dominate group. Additionally, autonomous minorities typically stem from cultures which promote and appreciate success in school

achievement (Ogbu, 1986). Immigrant minorities encompass such groups as the Chinese, Filipinos, Japanese, and Koreans residing in the United States. Individuals representative of immigrant minorities volunteer to relocate to America in search of economic, political, and social improvements for self and or family. As a result, those from this population are usually successful in school (Ogbu, 1986).

Castelike minorities include those people who entered into America involuntarily and often permanently. Castelike minorities include Black Americans, American Indians, Mexican Americans, Native Hawaiians, and Puerto Ricans. Affiliation with a castelike minority group is attained at birth and observed throughout lifetime. In America, castelike minorities are treated as subordinate to Whites and often experience inequities surrounding politics, economics, and social concerns. Additionally, children from castelike minority groups often receive an inferior education and exhibit disparities in achievement in comparison to White pupils (Ogbu, 1986). The result of such differences between the three types of minority groups manifests when racial stratification impacts education, specifically regarding testing practices and outcomes. those of the castelike minority groups tend to perform poorly in comparison to the other minority groups (Ogbu, 1986). Such classification of minority individuals in America will factor into the researcher's analysis of Black college students' racial identity development in subsequent chapters.

Though the aforementioned research on racial identity development and classification of minorities in America helps to provide a rationale for the disproportionate representation of Blacks compared to Whites in science majors in college and science-focused fields, it was also important to examine research regarding individuals' views concerning scientists.

Part II: Perceptions of Scientists

A number of research studies have been conducted in science education to discover individuals' perceptions of scientists. Studies have revealed that prior to the twentieth century, a multitude of images (both visual and verbal) were discussed by participants to represent scientists (Chambers, 1983; Schibeci & Sorensen, 1983). Depictions varied with regard to the scientists' characteristics as illustrated by physical attributes (i.e., madman, eccentric, and fashionable), selected profession (e.g., professors, chemists, and magicians), and chosen work setting (i.e., in the laboratory or outside in nature). However, the diversity of such images of scientists were not observed during the 1950's and subsequent decades (Barman, 1999; Chambers, 1983; Finson, Beaver, & Cramond, 1995; Mason, Kahle, & Gardner, 1991; Rosenthal, 1993). Chambers (1983) described the views of scientists represented in the twentieth century as "cleaned up" and "standardized" and he attributed this change in perceptions due to media influences. Over the years, studies have been performed to better understand individuals' images of scientists.

In 1957, Mead and Metraux evaluated American high school students to assess their perceptions of scientists in relation to this new, standard image. From their research, Mead and Metraux (1957) observed that on average, students portrayed a scientist as a man, who wore a lab coat, and worked in the laboratory. This man was middle-aged and wore glasses. In addition he had a beard and was surrounded by lab equipment (e.g., test tubes, Bunsen burners, and flasks). The scientist was often depicted with phrases over his head such as, "I've found it", and he possessed dangerous secrets about his work (Mead & Metraux, 1957). Consistent with the new image observed by Mead and Metraux, Basalla (1976) identified instances when individuals represented similar characteristics of scientists. Additionally, he

noted that alternative images, such as Frankenstein and Jekyll and Hyde, emerged in individuals' perceptions. Finally, research during this time exposed that standard images of scientists such as these were drawn by children, adolescents, college students, adults, and scientists working in the discipline (Basalla, 1976).

Chambers (1983) conducted 11 years of research (1996-1977) to evaluate the age during which children conceptualized their perceptions of scientists; work which ultimately resulted in the Draw-a-Scientist Test (DAST). The DAST was administered to 4,807 students, kindergarten through fifth grade, by their classroom teachers. Participants were located in Quebec, Ontario, Texas, Oklahoma, Connecticut, New York, and Vermont. The students were instructed to "draw a picture of a scientist." For a control measure, 912 of the participants were asked to "draw a person" prior to completing the DAST. Before evaluating the illustrations, the researcher identified and described seven elements reflective of the "standard image" of a scientist. The seven factors included the presence of: a lab coat, eyeglasses, facial growth of hair, symbols of research, symbols of knowledge, technology, and relevant captions. Students' images were analyzed based on these aspects and scored from one to seven to quantify the presence of the standard image.

Results from his study revealed that almost none of the standard images were present in the kindergarten and first grade students' pictures. Most students at the second grade level exhibited at least two elements in their drawings. Trends such as these continued for subsequent grade levels. Ultimately, Chambers (1983) observed that fifth graders' images depicted three or four factors related to the standard image of scientists. He also evaluated a small sample of adults which revealed that four or five elements were illustrated in their DAST drawings. Chambers (1983) concluded that the average number of elements

representative of the standard perception of scientist increased with grade level. Additionally, he identified that conceptions of scientists which aligned with the standard image described by Mead and Matraux (1957) appeared during the second and third year of education.

Other researchers have built upon the work by Mead and Matraux (1957) and Chambers (1983). Schibeci and Sorensen (1983) examined the DAST to determine if it was an efficient and reliable measure to assess elementary school pupils' perceptions of scientists. Using the strategies outlined by Chambers (1983), students completed drawings reflective of their views of scientists. The researchers used two coders to analyze the illustrations based on the seven elements of standard images. The reliability coefficient calculated for the two coders was 0.86 ($p < 0.01$) (Schibeci & Sorensen, 1983). Findings from their study were consistent with those discussed by Chambers (1983); the average number of indicators represented increased with grade level. Moreover, this study also recognized validity issues with the DAST. Schibeci and Sorensen (1983) established that interview data was needed to validate the instrument and accurately assess the extent to which the drawings reflected participants' perceptions of scientists.

In another study, Rosenthal (1993) used the Draw-a-Scientist Test to evaluate and compare views of scientists held by college students majoring in liberal studies ($n = 76$; 95% of whom planned to become elementary teachers) with those of science (biology) majors ($n = 90$). Though Rosenthal observed that the dominate image of scientists were White males, wearing eyeglasses and lab coats, and working in a lab setting with chemical equipment, she identified that 41% more liberal studies majors than science majors depicted such images reflective of the standard elements. She rationalized that the science majors studied the

discipline, had more contact with scientists, and were more apt to represent variety in their images (Rosenthal, 1993).

To improve objectivity, inter-rater reliability, and understanding of individuals' perceptions of scientists as measured by the Draw-a-Scientist Test, Finson, Beaver, and Cramond (1995), developed and field-tested the Draw-a-Scientist Test Checklist (DAST-C). A total of 47 eighth grade students participated in the study for instrument development. Treatment students (n = 24) participated in a career-oriented interdisciplinary program for science. They were exposed to a number of activities, faculty members, and projects pertaining to the discipline. Students in the control group (n = 23) participated in their typical eighth grade science curriculum.

The DAST-C outlined the stereotypes identified in research by Mead and Metraux (1957) and Chambers (1983). Authors of the DAST-C included the seven elements noted by Chambers as well as additional measures. After revisions, they added eight alternative images for scientists. Alternative images included elements such as gender (which was usually depicted as male), Caucasian (few drawings represented non-White individuals), indications of danger, presence of light bulbs, mythical stereotypes (e.g., Frankenstein, Mad and or Crazed), indications of secrecy (e.g., signs or warnings, "Private", "Keep Out"), scientist working indoors, and middle-aged or elderly scientist. Finson, Beaver, and Cramond (1995) also added the open comments section, though it was not included in the scoring of the instrument, which allowed scorers to make remarks such as the scientists' dress, facial expression, and type of work. Scoring of DAST drawings using the DAST-C allowed researchers to check off from the list the number of stereotypical elements present in illustrations. One could add the number of checkmarks to obtain a total score for the image;

the higher the score, the more stereotypical the representation (Finson, Beaver, & Cramond, 1995).

Using ANOVA measures on the final form of the DAST-C, inter-rater reliability ranged from 0.94 to 0.98 for analysis of 10 treatment group pre-test and 10 post-test drawings. Findings revealed no significant differences in pre-testing and post-testing for the control group and no significant differences between the control group and treatment group on their pre-test scores. However, differences were observed between the pre-test and post-test for the treatment group. To elucidate these findings for the treatment group, individual structured interviews were conducted to ascertain students' perceptions of scientists. Results from interviews indicated no significant difference between interview information and DAST-C scores. Overall, Finson, Beaver, and Cramond (1995) found that pre-test scores for the treatment group indicated a higher percentage of stereotypical elements of scientists while post-test scores showed fewer stereotypes. The participants' exposure to different aspects of the science field reduced the number of stereotypical conceptions of scientists.

Over the years, research was also conducted to assess the perceptions of scientists depicted by students from diverse racial backgrounds. In an effort to better understand the underrepresentation of Black females in science, Parsons (1997) conducted a study that evaluated this demographic's views of scientists. The author interviewed a sample of 20 participants for approximately 45 minutes. During the interviews, students completed the Draw-a-Scientist Test and were asked questions relating to their sketches upon completion of the instrument. Analysis of verbatim interview responses revealed that 55% of the participants illustrated their scientist as a White male, 20% as Black male, 10% as Black female, and 5% as White female. In addition, Parsons (1997) identified that the differences in

the participants' drawings for the White and Black scientists aligned with dominant (Caucasian) cultural ethos and Black cultural ethos respectively (Boykin, 1983).

Parsons (1997) argued that a Black students' representation of a scientist as a Black person may have indicated their internalization of the nine dimensions of Black cultural ethos: spirituality, harmony, movement, verve, affect, communalism, expressive individualism, orality, and social perspective of time (Boykin, 1983, 1986). Acceptance of such views conflict with ideas expressed in dominant cultural ethos; aspects which are perpetuated in school science and the scientific enterprise. Conflict between the cultural ethos of Blacks and that of stereotypical scientists (i.e, White males) may prohibit Black females from entering the profession.

In addition to Parsons (1997) work on Black females, Fung (2002), completed a study evaluate the perceptions of scientists held by another population of minority students, 675 Hong Kong Chinese students. The classroom teachers presented the participants with a piece of paper and requested for them to draw an image in response to the instruction: How does a scientist appear to you? Try to draw one in the rectangular box below. (If you like, you may draw two). Fung's (2002) method diverged from Chamber's (1983) original application of the DAST by instructing students to draw scientists as they viewed them and allowed the participants to illustrate more than one image. Findings from the research revealed that despite students' ability to complete multiple drawings of scientists, only 2% of the participants illustrated two images; all of which represented one male and one female.

Consistent with data obtained from earlier work, Fung's (2002) study also identified that the number of standard elements present in images of scientists drawn by Hong Kong Chinese students increased with grade level. In addition, secondary students illustrated three

or more stereotypical elements of scientists (Fung, 2002). Rubin, Bar, and Cohen (2003) expressed similar findings in their study of perceptions of scientists held by Hebrew and Arabic-speaking pre-service teachers in Israel. Images of a White male scientist working in a laboratory were depicted in the participants' drawings (Rubin, Bar, & Cohen, 2003).

Finson (2003) conducted additional research to identify the perceptions of scientists exhibited by students of different races. From his sample of 191 students, 30 were Caucasian, 67 were Native American, and 94 were Black. He assumed that the DAST-C was equally valid for use with individuals other than rural, middle class Whites. Therefore, Finson (2003) hypothesized that no significant differences would be observed in the perceptions of scientists held by the students. Results from analysis of variance (ANOVA) measures revealed that no significant differences in DAST-C scores existed for the three groups ($F = 0.22$, $p < .80$) (Finson, 2003). The three populations of students illustrated drawings that included an average of 4.64 stereotypic elements of scientists. Finson attributed these findings to the prevalence of stereotypic images of scientists perpetuated by the media (e.g., movies, television, newspapers, and comic books). Results such as these depict the persistence of societal stereotypes of scientists regardless of participants' geographic location and racial orientation.

Literature from searches related to racial identity development and perceptions of scientists help provide a foundation upon which to base the present research study. In order to address the research questions surrounding Black college students RID and views of scientist on selection of science and non-science fields as a major, the aforementioned theoretical and conceptual frameworks were necessary.

CHAPTER THREE

Methodology

Chapter three focuses on the methods used to conduct the research study. Information pertaining to and a rationale supporting the sample of participants selected, the instrumentation used for data collection, and processes for data analysis are also contained in this chapter.

Participant Eligibility

Gall, Gall, and Borg (2003) describe the selection of participants as, "The process of selecting a sample from a defined population with the intent that the sample accurately represents that population (p. 167)." Sampling strategies used in this study allowed for quantitative and qualitative measures to be utilized. This study involved a purposeful sample and specifically sought to address issues related to Black college students and their decisions to pursue science as a college major and future career. Considering, Blacks are underrepresented in the field and research is limited regarding their participation in science, this study did not include college students who are non-Black. In addition a restriction on participants' race, individuals who participated in the study were also required to possess a minimum grade point average (GPA) of 3.0 on a 4.0 scale for eligibility. This GPA standard was set to account for stereotypes that Blacks are smart enough to participate in science.

University Demographics

This study involved Black students majoring in various programs located at a large, predominantly White university located in the southern region. Demographic information for the institution was collected regarding the student population and programs offered. Focusing on science disciplines, the institution offers degrees in various science and related academic

programs. Students may select majors in science fields such as biology, chemistry, geology, environmental science, and physics. In addition, individuals may enroll in science-related majors in health sciences such as biomedical science, nursing, medicine, and dentistry.

The university represents a diverse student body. For 2006, of the 43,422 students enrolled, 11.3% were Black, 11.0% Hispanic, and 5.4% Asian. Regarding gender, 39.8% of the student population is male and 60.1% is female. In addition, 78.3% of the students were classified as undergraduates, 12.8% Graduate I (those seeking a Masters or EdS), 4.5% Graduate II (those seeking a Ph.D.), 1.1% medical professional, and 3.3% non-degree seeking.

Participants

Using a purposeful sample of 48 volunteers, the study involved Black[4] students. The participants were divided into two groups for comparison: science majors and non-science majors. The science majors' group consisted of 17 participants (one male and 16 female) with an average age of 20.6 years and an average GPA of 3.32 on a 4.0 scale. Students majoring in science declared their areas of study as biomedical science (65%), chemistry (11%), chemical engineering (6%), exercise science (6%), biology (6%), and pre-medicine (6%). The non-science majors' group was composed of 31 participants (eight males and 23 females) with an average age of 21.7 years with an average GPA of 3.18 on a 4.0 scale. Individuals in this group selected their college majors as education (16%), business (13%), mass communications (10%), political science (10%), accounting (10%), psychology (7%), criminology (6%), social work (6%), creative writing and or history (3%), interdisciplinary social sciences (3%), English (3%), audiology (3%), marketing (3%), management

[4] For this study, the term Black encompassed individuals who reported their race as African, African American, Black, West Indian - Caribbean Black, Hispanic Black, and Mixed.

information systems (3%), and undecided (3%). Additional information regarding the participants is provided in Table 1.

Table 1

Characteristics of participants (n=48)

	% of Sample
Gender	
Female	77
Male	19
Age	
<19	10
19	10
20	27
21	17
22	8
>22	23
Academic Class Standing	
Freshman	8
Sophomore	8
Junior	40
Senior	23
Undeclared	25
Ethnic Self-Designation	
African	15
African American	44
Black	10
West Indian - Caribbean Black	23
Hispanic Black	2
Mixed	4
Other	0
Socioeconomic Standing	
Poor	4
Lower Class	0
Working Class	35
Middle Class	44
Upper Middle Class	10

Table 1 (continued)

Upper Class	0
Wealthy	2
Primary Community	
Rural	8
Urban	31
Suburban	54
Other (ghetto)	2

For this study, participants were recruited using a variety of methods including researcher contact (i.e., via telephone and email) with student organizations on campus and solicitation of participants at common campus locations (i.e., library and student union). When contacting organizations over the telephone, the principal investigator introduced herself, explained her request for participation in a graduate research project, described the study (i.e., social attitudes of Black students and impact on college major), and requested to be placed on the organization's agenda for a future meeting. Permission was granted to recruit participants at two organizational meetings. One organization was a program developed for the support of minority students majoring in the pre-professional fields such as medicine, nursing, dentistry, and engineering. Members of this organization represented various racial groups including students of Black descent. The second organization was a group formed specifically for the needs and support of Black students and their concerns during college. This program was open to students from all majors.

Participants were also recruited for the study by solicitation in common areas on campus (e.g., library, student union, individual colleges). To recruit individuals face-to-face, the principal investigator introduced herself, explained a summary of her graduate research study, and requested participation. Individuals were informed that participation was

completely voluntary and they could terminate their commitment at any time. Students who volunteered to participate in the study completed all portions of the research on campus, either at the university library or immediately following an organization meeting.

Upon agreeing to participate in the study, each student was given a consent letter which the principal investigator reviewed with them. In addition, each person was provided with a quantitative survey (the Cross Racial Identity Scale - CRIS) and qualitative survey (the Draw-a-Scientist Test - DAST). For completion of the survey instruments and to ensure anonymity, subjects were assigned a number by which they were referenced. This number was written on all of the materials corresponding to the participant.

The Cross Racial Identity Scale (CRIS) is a 40-item quantitative instrument on a Likert-type scale used to assess individuals' racial identity development (RID). Participants' responses can be averaged to produced six scores reflective of six social attitudes: Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), Pre-Encounter Self-Hatred (PSH), Immersion – Emersion Anti-White (IEAW), Internalization Afrocentricity (IA), and Internalization Multiculturalist Inclusive (IMCI) (Cross & Vandiver, 2001). The subscale receiving the highest score indicated the strongest social attitude for the respondents. The CRIS was scored according to the developers' protocols. This instrument required approximately 20 minutes to complete. Refer to Appendix A for a copy of the CRIS instrument. Appendix B identifies the item numbers composing each of the six subscales.

The Draw-a-Scientist Test was also used in this study. The DAST is an instrument that aims to assess participants' perceptions of scientists. For the DAST, participants received a piece of unlined white paper with the following phrase written at the top: "Draw a picture that represents your image of a scientist." Subjects were provided with a 24-pack of colored

pencils which they could use to enhance their sketches. The time requirement for the DAST was a minimum of 20 minutes. The DAST drawings were evaluated according to the protocols outlined in the Draw-a-Scientist Test Checklist (DAST-C). The DAST-C provides an outline of 15 stereotypical elements of scientists and an additional section for open comments. Researchers mark one checkmark for each element present in an illustration. Marks are summed to obtain a DAST-C score. The greater the number of marks denoted by the DAST-C, the more stereotypes observed in the depiction of a scientist. Refer to Appendix C for a copy of the DAST-C.

After completion of the two instruments, participants were asked if they were willing to continue in the study with a one-on-one interview with the principal investigator. For subjects who agreed to participate, the principal investigator collected contact information and scheduled times to interview them about their racial identity development and social attitudes based on the CRIS, perceptions of scientists based on the DAST, and selection of a college major. The principal investigator used an interview guide to conduct the semi-structured interviews. Refer to Appendix D for a copy of the interview guide. In addition, interviews were audio-taped and transcribed for data analysis. For individuals who decided not to participate in an interview, they were thanked for their time for completing the surveys. All students who agreed to participate in any part of the study were informed that their names were entered into a raffle to win one of four $25 gift certificates to a bookstore located on campus. Table 2 provides information regarding each of the interview participants.

Table 2

Information for Interview Participants[5]

Science Majors	
Jennifer	Female; African American; 20 year-old junior; chemistry major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Edith	Female; African; 21-year-old senior; biomedical science major; had a 3.26 Grade Point Average; grew up in a mostly White, suburban neighborhood; did not belong to any ethnic organizations
Stacey	Female; African American; 21-year old senior; chemistry major; had a 3.3 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Stefanie	Female; African American; 20 year-old junior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Roni	Female; African American; 21 year-old senior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mixed race, urban neighborhood; belonged to one ethnic organization
Pamela	Female; African; 19 year-old junior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations
Angie	Female; African American; 21 year-old senior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mostly Black, rural neighborhood; belonged to two ethnic organizations
Allison	Female; Black; 20 year-old junior; exercise science major; had a 3.1 Grade Point Average; grew up in a mixed race, rural neighborhood; belonged to two ethnic organizations
Non-Science Majors	
Lola	Female; African; 31 year-old junior; English major; had a 3.4 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations

[5] The names presented in this work are pseudonyms to protect participants.

Table 2 (continued)

Lily	Female; African-Caribbean American; 22 year-old senior; creative writing major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Wesley	Male; African American; 23 year-old senior; criminology major; had a 3.0 Grade Point Average; grew up in a mostly Black, urban neighborhood (ghetto); belonged to two ethnic organizations
Kimberly	Female; African American; 20 year-old psychology major; had a 3.4 Grade Point Average; grew up in a mostly Black, suburban neighborhood; belonged to one ethnic organization
Jane	Female; West Indian-Caribbean Black; 22 year-old; started the study as an early childhood education major, but changed to a biomedical science major; had a 3.0 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to one ethnic organization
Kayla	Female; African American; 20 year-old; psychology major; had a 3.8 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations

Data Collection

Cross Racial Identity Scale (CRIS)

Quantitative research seeks to describe characteristics of a sample of individuals or phenomena (Bogdan & Bilken, 1998; Gall, Gall, & Borg, 2003). Specifically, descriptive research involves using statistical measures to detail what is occurring at a particular point in time (Gall, Gall, & Borg, 2003). To assess this, most descriptive research studies involve the use of questionnaires or survey instruments to elicit information related to opinions, attitudes, and practices. For this study, data collection included the use of the Cross Racial Identity Scale (CRIS) to ascertain Black participants' stages of racial identity development. The use of the CRIS provided answers to the following research questions: What are the racial identity

profiles of Black college students majoring in science? What are the racial identity profiles of Black college students majoring in non-science fields?

Development of the CRIS

The Cross Racial Identity Scale was developed over a period of five years using five independent samples. Across multiple samples of participants, data were collected from over 1000 students from two universities located in the northeastern region of the United States. The majority of participants in the sample were female undergraduates from middle class backgrounds. They also reflected a mean age of 21 years with a standard deviation of 3.66.

In the first phase of item development, team members composed 250 items that reflected six nigrescence identities: Pre-Encounter (Assimilation and Self-Hatred), Immersion - Emersion (Intense Black Involvement and Anti-White), and Internalization (Black Nationalist and Multiculturalist) (Cross & Vandiver, 2001). Over the course of development, the 250 items were reduced to 126. This new version of the instrument was evaluated for construct validity by 45 experts in the field. Twenty experts returned the instrument after assessing the extent to which each item in the scale reflected one of the constructs outlined in the racial identity model. For inclusion in the survey, items we selected if they had a mean rating of at least six on a 10-point scale; 75% of the raters identified items as a representation of a particular RID construct and fewer than 25% rated them as reflecting multiple constructs (Cross & Vandiver, 2001).

In addition, the CRIS was divided into two sections. The first requests demographic information such as gender, age, and socioeconomic status. The second section consists of the six CRIS subscale items. The original version of the CRIS consisted of 57 items over the six subscales, while the current version is composed of 40 items on a 7-point Likert scale. These 40 items were delineated into six subscales consisting of five items each with 10

comments included as fillers. The fillers were used to provide distance between items reflecting the same subscale (Cross & Vandiver, 2001).

The convergent and divergent validity were examined using the scores from the final CRIS sample (n = 336 students attending a predominately White university in the northeast). In addition, the factor structure was confirmed using factor analytic procedures.

Properties of the CRIS

Regarding reliability of the CRIS, Cronbach's Alpha was used to provide reliability estimates and standardized coefficients from confirmatory factor analysis. From the different measures used, the reliability estimates ranged from .78 to .90 where $p < .001$ (Cross & Vandiver, 2001). These findings report that the instrument reliably assessed each of the six subscales as a score of .70 is the threshold for reliability.

The six factor loadings used for analysis include: Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), Pre-Encounter Self-Hatred (PSH), Immersion -Emersion Anti-White (IEAW), Internalization Afrocentricity (IA), and Internalization Multiculturalist Inclusive (IMCI). Using a sample of 279 students, exploratory factor analysis revealed six independent factors (*Mdn* intercorrelation = |.08|) indicative of the CRIS subscales with no cross-loadings above |.33|. Regarding confirmatory factor analysis, a 30-item version of CRIS was used.

The covariance matrix was examined using maximum-likelihood estimation and the Satorra - Bentler chi-square was applied to generate robust standard errors. From these measures, data revealed that factor intercorrelations varied from |.06| to |.46| (*Mdn* = |.16|) with only two of the 15 correlations above |.30|. Confirmatory analysis expressed that IEAW

was positively correlated with IA (r = .46) and negatively correlated with IMCI (r = -.40), where $p < .001$.

Relationships between the CRIS and Balanced Inventory of Desirable Responding (BIDR) were examined to demonstrate that the scores from the CRIS were not a reflection of social desirability. Bivariate correlations showed that none of the CRIS subscales had correlations above |.23| with the BIRD subscales, indicating that CRIS scores are not impacted by social desirability (Cross & Vandiver, 2001).

Administration of CRIS

The developers of the CRIS suggest that using the term racial identity in the name of an instrument may result in biased responding (Cross & Vandiver, 2001; Helms, 1990). As such, they have labeled the instrument as the Cross Social Attitude Scale. Consequently, when describing this instrument to participants, the researcher used this identifier. The CRIS is appropriate to administer either individually or in groups. It requires 20 minutes to complete with a readability index of 6.7 on the Flesch - Kincade formula.

Draw-a-Scientist Test (DAST)

Following completion of the CRIS, the Draw-a-Scientist Test (DAST) was used to assess Black college students' perceptions of scientists. This instrument provided participants with the opportunity to individually sketch an image of a scientist. It allowed the researcher to observe instances when the images drawn correlated with stereotypic perceptions perpetuated in society and reported in science education research (Chambers, 1983; Finson, Beaver, & Cramond, 1995; Parsons, 1997). To complete this assessment, participants were given a blank, unlined piece of white paper and were provided with the direction to "Draw a picture that represents your image of a scientist." In addition, participants had access to a 24-

pack of colored pencils and were allowed to enhance their drawings. Use of the DAST allowed for the following research questions to be studied: What perceptions of scientists do Black students majoring in science posses? What perceptions of scientists do Black students majoring in non-science fields possess?

Data Analysis

Cross Racial Identity Scale (CRIS)

Considering the CRIS includes 10 filler questions, 30 of the 40 items make up the six subscales which are composed of five items each. As a result, the CRIS produces six subscale scores that are not able to be collectively summed for interpretation (Cross & Vandiver, 2001). Rather, a profile is generated expressing individuals' strength of agreement with each of the racial identity subscales. For comparison or statistical computations, scores can either be tabulated by totaling the items over all five questions making up the subscale and obtaining scores from five to 35 on each subscale (i.e., 1 + 2 + 3 + 4 + 5 = 15) or the sum for each subscale can be divided five (the number of items composing each subscale) (i.e., 15 / 5 = 3) (Cross & Vandiver, 2001). The researcher used both methods for calculating and reporting scores. Raw scores for each question were used to compute statistical applications using SPSS software. Reliability coefficients and Cronbach's alpha were calculated. Average scores were used to determine the degree of agreement we racial identity attitudes were expressed by individuals from specific reference group orientations (i.e., African American, Black, Hispanic American, West Indian – Caribbean Black).

Draw-a-Scientist Test Checklist (DAST-C)

To analyze participants' DAST drawings, the Draw-a-Scientist Test Checklist (DAST-C). This instrument allows a researcher to identify elements in the images related to 15 common stereotypes referenced in literature (Finson, Beaver, & Cramond, 1995). This

researcher also included the open comments section, section 16, in the analysis of participants' drawings. For evaluation of the drawings, a greater number of items marked on the checklist denotes possession of more stereotypic views of scientists (Finson, Beaver, & Cramond, 1995). Information gathered from the DAST and DAST-C provided a basis for understanding Black college students' perceptions of scientists, their ability and or inability to "see" themselves as scientists.

Participant Interviews

In qualitative research, interviews are used to, "…collect data about phenomena that are not directly observable: inner experience, opinions, values, interests, and the like (Gall, Gall, Borg, 2003, p. 222)." As such, interviews were conducted for this study using a semi-structured format with an interview guide. Interview questions were validated by other researchers to help ensure that inquires reflected the information needed to obtain information concerning racial identity and perceptions of scientists. From the sample of participants who completed the CRIS (n = 48), individuals were asked to volunteer for a one-on-one interview. One interview was conducted with 14 volunteers. Interviews ranged from 20 to 60 minutes and averaged about 35 minutes in length.

Interviews began with a discussion of the participants' illustrations from the Draw-a-Scientist Test as a lead in to topics related to experiences in kindergarten through twelfth grade science, decisions on selecting science as a college major, and ideas for future career goals. In addition, interviews were used to gather information regarding participants' race-related experiences growing up and how these experiences impacted the development of their racial identity stages. Each interview was audio-taped and transcribed verbatim. Transcriptions were analyzed for themes in participants' responses relating to racial identity and perceptions of scientists. Segments related to racial identity were coded by themes outlined by each of the six

CRIS subscales: Pre-Encounter Assimilation, Pre-Encounter Miseducation, Pre-Encounter Self-Hatred, Immersion – Emersion Anti-White, Internalization Afrocentricity, and Internalization Multiculturalist Inclusive. Segments of transcripts pertaining to perceptions of scientists were coded according to themes represented by each of the stereotypical elements depicting scientists.

To validate the information collected from the interviews, verbal member checking was used to ensure that information reported accurately reflected the participants' perspectives. Member-checking occurred following the interview as a summation of what information was obtained. The researcher verbally reviewed the information with the participants and provided them with the opportunity to correct any misunderstandings.

Potential Risks

There are no physical, financial, social, or legal risks associated with the procedures outlined in this study. Considering the study addressed racial identity development and social attitudes; individuals may have had difficulty reporting about past experiences. However, this information was important because it provided insight into potential factors that inhibit or prevent Blacks from pursuing science. Therefore, participants were notified that they did not need to talk about anything that is too personal to them during the interview. Additionally, the principal investigator ensured to inform the subjects that participation in the study was voluntary and reporting was entirely confidential; Pseudonyms would be used during reporting. Subjects also had the opportunity to refuse to answer interview questions they deemed unpleasant. Finally, subjects were informed that they did not need to report information from the first section that they deemed as too personal or sensitive. During the course of the study, none of the subjects withdrew from participation.

Recording & Storing of Data

Data from the Draw-a-Scientist Test (DAST) was recorded on the unlined white paper given to each participant. The assessment of the drawing from the DAST was recorded on the Draw-a-Scientist Test Checklist (DAST-C). One DAST-C was used for each participant. Data from the Cross Racial Identity Scale was recorded on the paper and pencil instrument. One was used for each participant. Interview tapes were reviewed and transcribed. All data was stored at the principal investigator's residence and locked in a file cabinet.

CHAPTER FOUR

Findings & Implications

The information presented in this chapter is organized into three parts. Part I includes the findings and analyses pertaining to the Cross Racial Identity Scale (CRIS). The data from the CRIS are summarized and discussed in relation to the two groups of participants, science majors and non-science majors. Part II describes the findings and analyses relating to the Draw-a-Scientist Test (DAST) and Draw-a-Scientist Test Checklist (DAST-C). The DAST and DAST-C findings are also delineated by group, science majors and non-science majors. Part III includes the discussion of the findings, limitations to this work, recommendations for future research, and implications from this study for the field of science education.

Part I: Findings Pertaining to Cross Racial Identity Scale (CRIS)

The Cross Racial Identity Scale (CRIS) was the survey used to ascertain the science majors' and non-science majors' racial identity attitudes. This instrument allowed the researcher to obtain specific information to answer the following research questions: What are the racial identity profiles of Black college students majoring in science? What are the racial identity profiles of Black college students majoring in non-science fields? To information for such questions, the researcher analyzed participants' scores for the Cross Racial Identity Scale (CRIS) as well as their responses during one-on-one interviews with 14 of the 48 CRIS respondents. Information obtained from the CRIS provided a profile for the participants as it pertained to their racial identity attitudes. The interview findings illuminated the actual manifestation of the profiles.

For the CRIS survey instrument, participants were asked to reply to questions divided into two sections. Section one elicited demographic information while section two asked

participants to respond to 40 comments, 30 of which reflected the six racial identity subscales outlined in the Cross Nigrescence Theory. The remaining 10 comments were filler items used to space the subscale statements. The six subscales assessed included: Pre-Encounter Assimilation (PM; holds limited salience for race), Pre-Encounter Miseducation (PM; accepts common negative stereotypes of Blacks), Pre-Encounter Self-Hatred (PSH; feels inferior because of their Black race), Immersion - Emersion Anti-White (IEAW; denounces aspects of society related to Caucasians), Internalization Afrocentricity (IA; approaches life from an Afrocentric perspective), and Internalization Multiculturalist Inclusive (IMCI; possesses a realized Black racial identity and embrace those from other reference groups). One should note that the majority of the sample was represented by female participants; therefore, findings may not be generalizable to males.

Using a 7-point, Likert-type scale which evaluates attitudes ranging from (1) *strongly disagree* to (7) *strongly agree*, respondents indicated their level of agreement with each of the comments. The resulting scores for each subscale provided a basis for determining the participant's CRIS racial identity profiles. Participants' surveys were divided into two groups for comparison, science majors and non-science majors. Descriptive and inferential statistical computations were used to compare the two groups and the SPSS software was used to analyze the data. For all tests completed, the confidence interval was set at 95% where $p < .05$ unless otherwise indicated.

When analyzing the data for the CRIS survey, descriptive statistics were first calculated. Figures 1 through 6 represent the frequency distributions of the science majors' ($n = 17$) and non-science majors' ($n = 31$) scores for each CRIS subscale. Scores were rounded for comparison between groups.

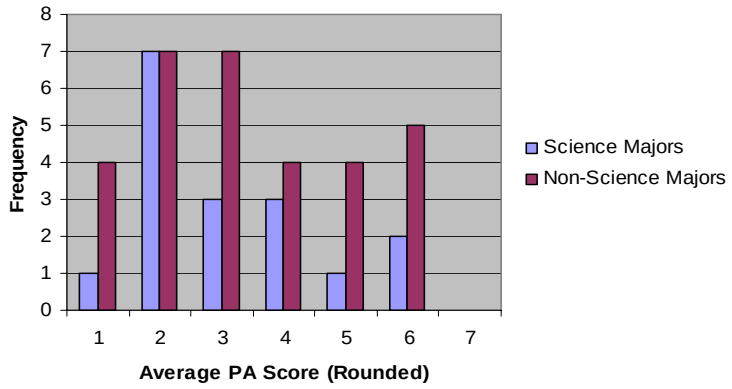

Figure 1. Distribution of scores for PA subscale

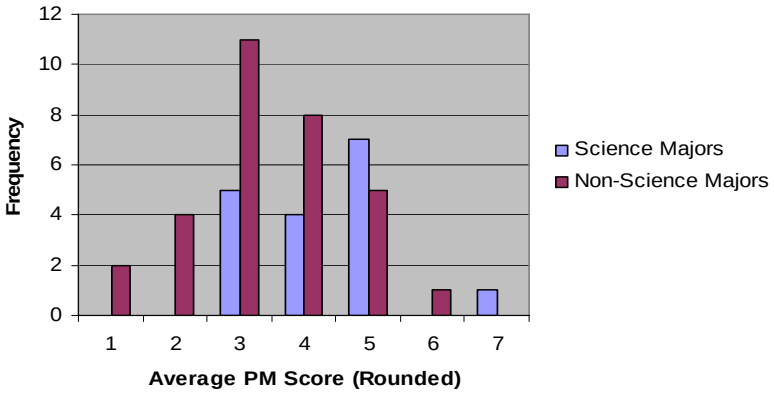

Figure 2. Distribution of scores for PM subscale

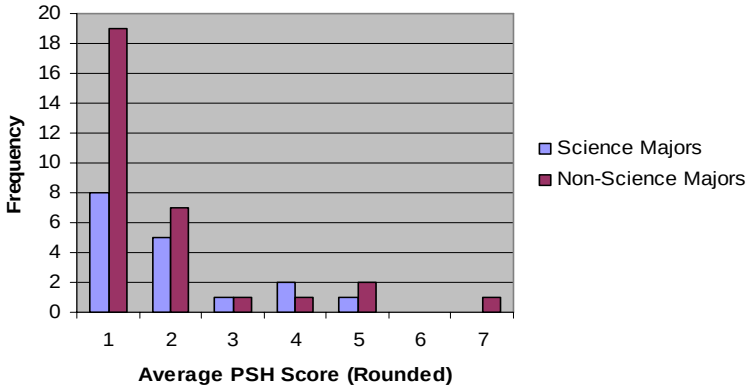

Figure 3. Distribution of scores for PSH subscale

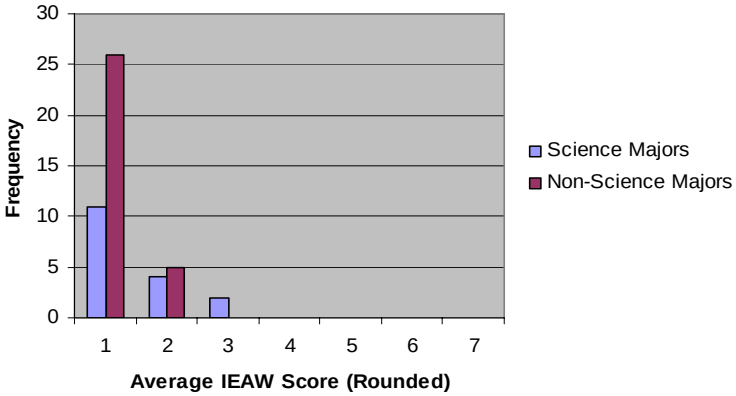

Figure 4. Distribution of scores for IEAW subscale

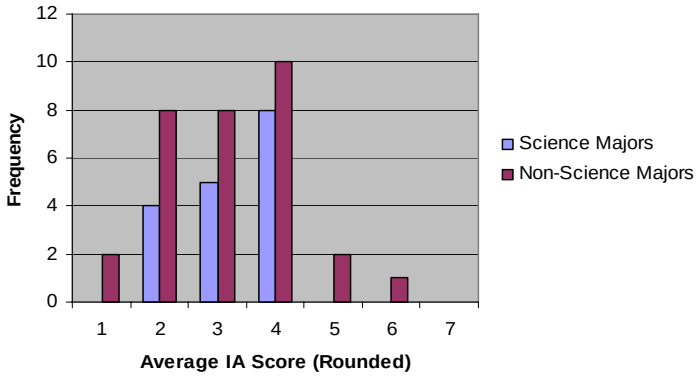

Figure 5. Distribution of scores for IA subscale

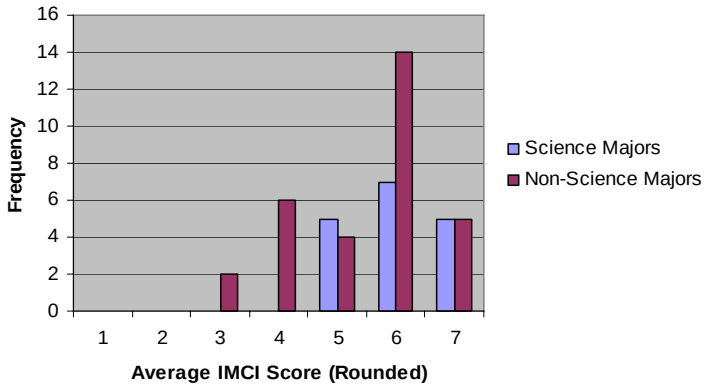

Figure 6. Distribution of scores for IMCI subscale

Analysis of the distribution of scores for the science majors and non-science majors exposed similar patterns in responses between the groups. With regard to the distribution of Pre-Encounter Assimilation (PA) attitudes as illustrated in Figure 1, seven science majors replied that they "disagree" while seven non-science majors expressed that they "disagree" and "somewhat" disagree with views encompassed by this subscale. No participants from either group commented that they "strongly agree" with the PA ideals. Figure 2 depicts the distribution of scores for the Pre-Encounter Miseducation (PM) subscale. Data signify that seven science majors indicated that they "somewhat agree" and 11 non-science majors expressed that they "somewhat disagree" with the conceptions supporting the PM views. The distribution of scores represented in Figure 3 highlights that the majority of participants from both groups, eight science majors and 19 non-science majors, commented that they "strongly disagree" with the Pre-Encounter Self-Hatred (PSH) attitudes. No participants from either group remarked that they "agree" with the PSH views.

Figure 4 illustrates that the distribution of scores for both the science majors and non-science majors expressed that the highest number of students, 11 science majors and 26 non-

science majors, said that they "strongly disagree" with Immersion - Emersion Anti-White (IEAW) beliefs. None of the science majors or non-science majors indicated any agreement with the IEAW attitudes. Figure 5 portrays that most of the science majors (eight) and non-science majors (10) commented that they "neither agree nor disagree" with ideas expressed by the Internalization Afrocentricity (IA) subscale. None of the participants indicated that they "strongly agree" with the IA views. Finally, distribution of Internalization Multiculturalist Inclusive scores (IMCI) (see Figure 6) disclosed that seven science majors and 14 non-science majors commented that they "agree" with attitudes indicative of the IMCI subscale. No participants responded that they disagreed with IMCI thoughts.

In addition to evaluating the frequency distribution of scores for each of the CRIS subscales between science majors and non-science majors, frequency distributions were also analyzed for the groups based on academic standing of the participants. From the science majors group, 17 participants completed the CRIS but 15 identified their academic class standing; therefore only those individuals who reported the classification were including in the analysis. The science majors group consisted of six seniors, seven juniors, and two freshmen. None of the participants in the science-majors groups declared that they were sophomores. Figures 7 through 12 depict the frequency distributions for the science majors' average scores for each of the six CRIS subscales based on academic classification. Of the 31 non-science majors, 20 participants reported their academic class standing. This group included seven seniors, eight juniors, four sophomores, and two freshmen. The scores for the non-science majors who did not indicate their classification were not included in the reporting of frequency distribution. Figures 13 through 18 illustrate the distributions of the

non-science majors CRIS scores for each of the subscales. All scores were rounded to the nearest whole number for comparison.

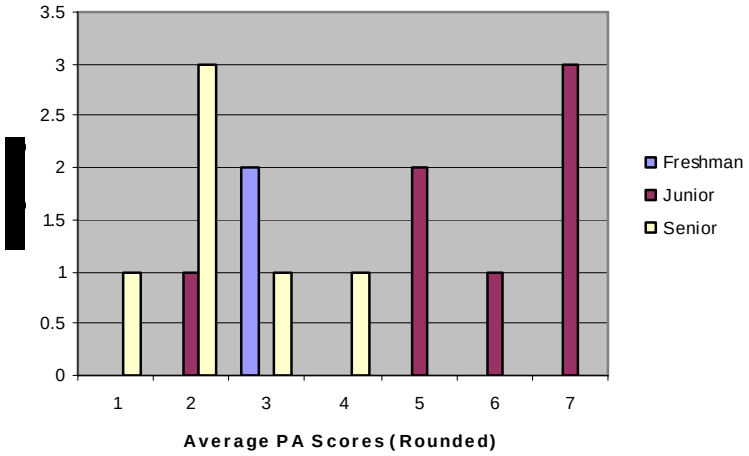

Figure 7. Distribution of science majors' average CRIS (PA) scores by class standing

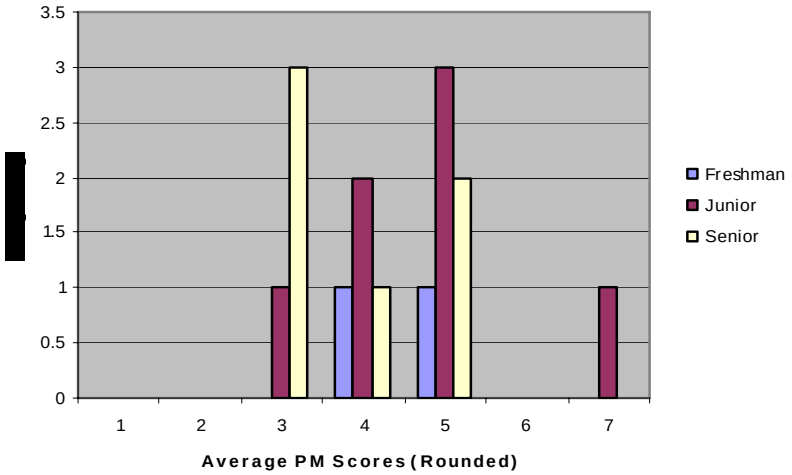

Figure 8. Distribution of science majors' average CRIS (PM) scores by class standing

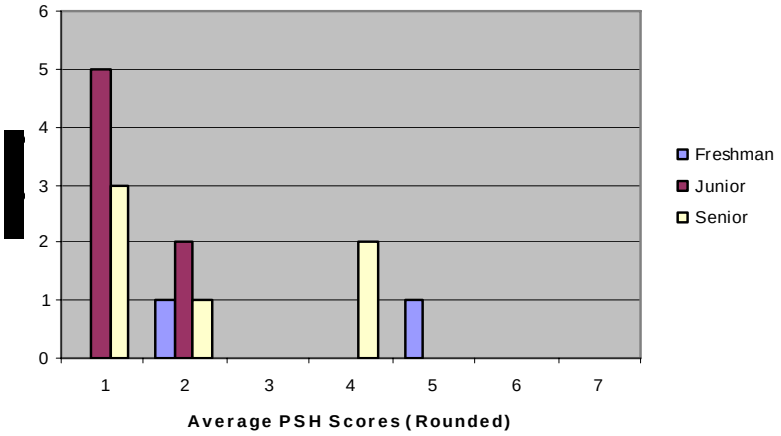

Figure 9. Distribution of science majors' average CRIS (PSH) scores by class standing

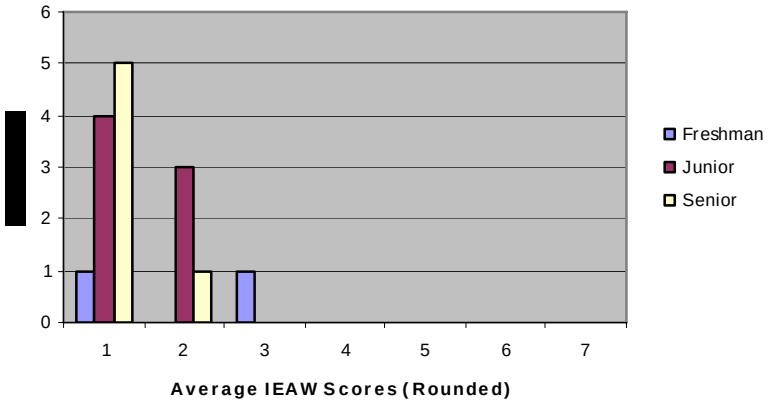

Figure 10. Distribution of science majors' average CRIS (IEAW) scores by class standing

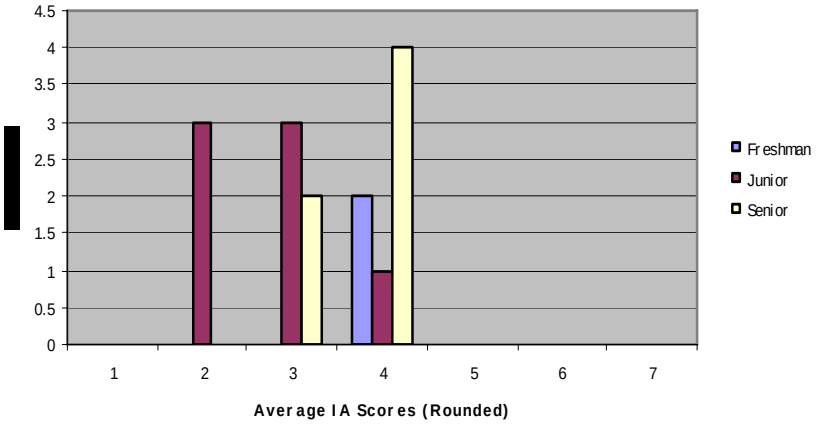

Figure 11. Distribution of science majors' average CRIS (IA) scores by class standing

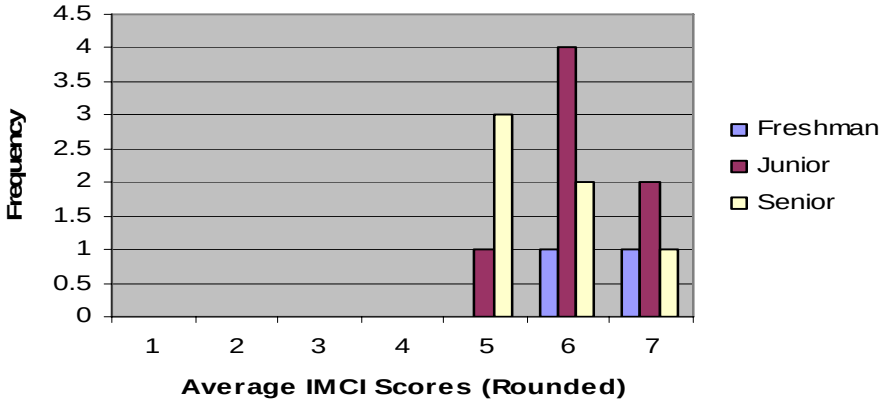

Figure 12. Distribution of science majors' average CRIS (IMCI) scores by class standing

Frequency distribution scores for the science majors' responses to each of the CRIS subscales exposed a number of patterns based on participants' academic classification. With regard to Pre-Encounter Assimilation (PA) attitudes, Figure 7 expresses that seven seniors and two freshman responded that they "disagree" with PA views while most of the

sophomores (six) commented that they, at a minimum, "somewhat agree" with such thoughts. Figure 8 illustrates that most of the participants, regardless of academic standing, replied that they "neither agree nor disagree" or "somewhat agree" with the Pre-Encounter Miseducation (PM) attitudes. None of the science majors expressed that the "strongly disagree" with PM conceptions. For the Pre-Encounter Self-Hatred (PSH) views, Figure 9 represents that one freshman, all seven juniors, and four seniors commented that they disagree with the PSH attitudes. No participants expressed that they agreed with such attitudes.

Figure 10 demonstrates that all of the students, regardless of academic classification, responded that they disagreed with the Immersion - Emersion Anti-White (IEAW) attitudes. Similar to distributions of IEAW responses, participants' comments for Internalization Afrocentricity (IA) views indicated that most juniors (six) and two seniors disagreed with IA conceptions (refer to Figure 11). The remaining participants reported that they "neither agree nor disagree" such attitudes. Finally, Figure 12 expresses that all participants agreed with the Internalization Multiculturalist Inclusive (IMCI) views regardless of their academic standing.

The frequency distribution of scores for non-science majors based on academic classification were also reviewed. Overall, the non-science majors depicted a broader range in agreement with the CRIS responses for each subscale. These findings can be attributed to the fact that there were more non-science majors (n = 20) who indicated their class standing in comparison to science majors (n = 15). Figures 13, 14, and 17 (PM, PA, and IA respectively) depict similar findings for the respondents. Both figures illustrate that the freshman and sophomores answered that they "neither agree nor disagree" or "disagree" with Pre-Encounter Assimilation (PA) views or Pre-Encounter Miseducation (PM) ideas. While

the juniors' and seniors' comments ranged from "strongly disagree" to "agree." None of the participants expressed that they "strongly agree" with the PA or PM attitudes. Findings for the Pre-Encounter Self-Hatred (PSH) (refer to Figure 15) and Immersion-Emersion Anti-White (IEAW) (refer to Figure 16) subscales produced comparable results. All but two seniors and one junior expressed that they disagreed with PSH attitudes. These three participants expressed that they either "somewhat agree" or "strongly agree" with PSH conceptions. Similarly, all of the respondents, regardless of academic standing, reported that they disagreed with IEAW ideals. Distributions for the Internalization Multiculturalist Inclusive subscale (IMCI) (see figure 18) express that the two freshman commented that they "neither agree nor disagree" IMCI views. In addition, most of the sophomores (three) remarked that they "agree" with attitudes indicative of IMCI. The majority of the juniors (seven) replied that they were in agreement with IMCI ideals. Finally, all of the seniors expressed that they at least "agree" with IMCI comments.

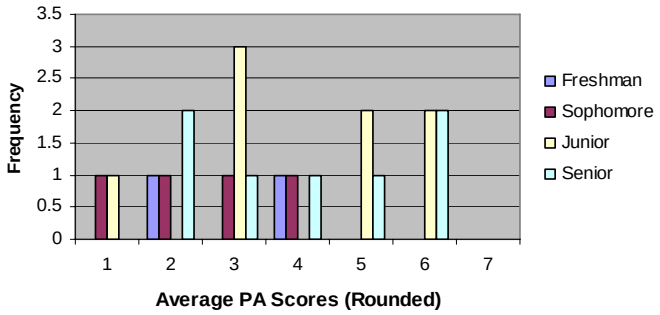

Figure 13. Distribution of non-science majors' average CRIS (PA) scores by class standing

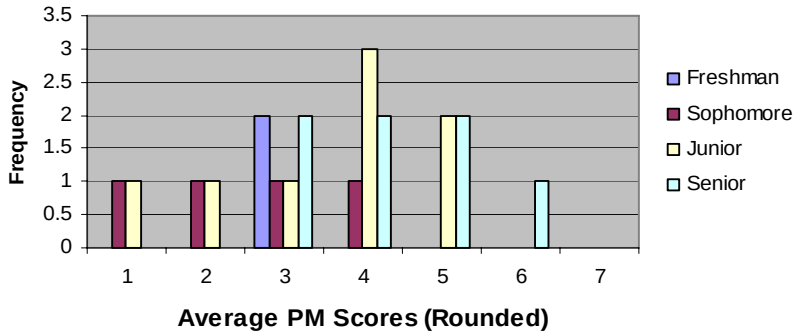

Figure 14. Distribution of non-science majors' average CRIS (PM) scores by class standing

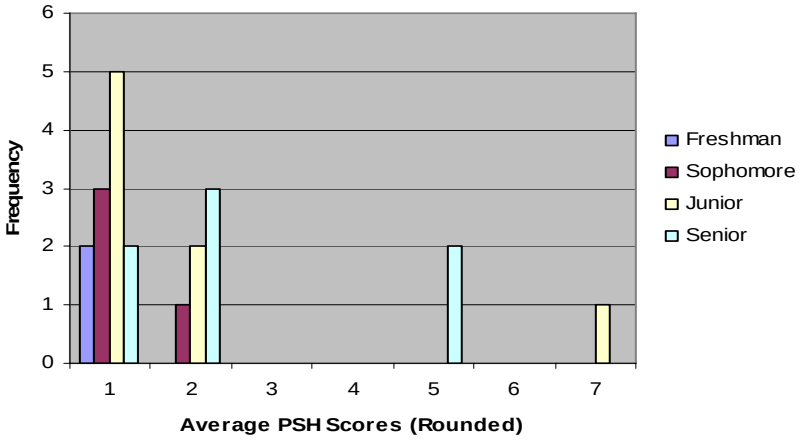

Figure 15. Distribution of non-science majors' average CRIS (PSH) scores by class standing

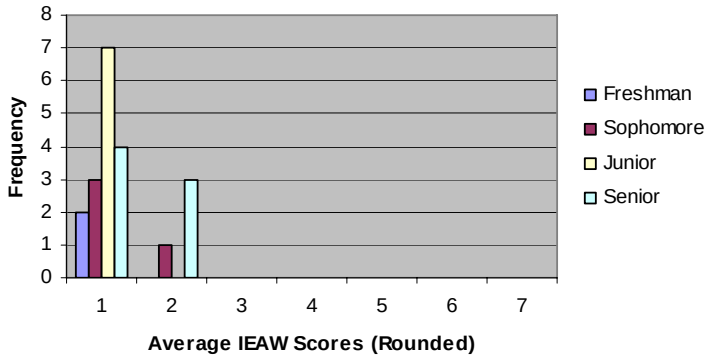

Figure 16. Distribution of non-science majors' average CRIS (IEAW) scores by class standing

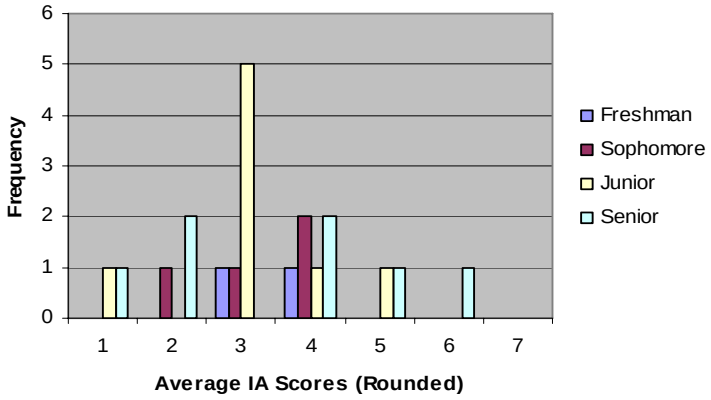

Figure 17. Distribution of non-science majors' average CRIS (IA) scores by class standing

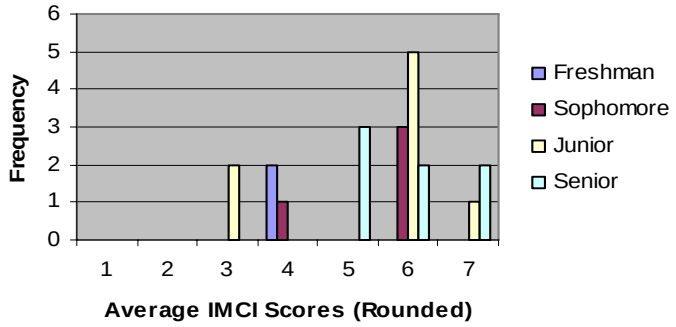

Figure 18. Distribution of non-science majors' average CRIS (IMCI) scores by class standing

In addition to frequency distributions of scores for each subscale, the means and standard deviations of participants' responses were also tabulated. Table 3 provides a summary of the participants' mean scores for each of the subscales of the instrument. Standard deviations and standard error of means are also reported. In the table, the science majors group is identified as SM and the non-science majors as NSM.

Table 3

Mean Scores for Cross Racial Identity Scale (CRIS)

Subscale	Group	N	Mean	Std. Deviation	Std. Error of Mean
PA Total	SM	17	15.35	6.74	1.63
	NSM	31	16.81	8.17	1.47
PM Total	SM	17	20.47	5.42	1.31
	NSM	31	17.16	5.83	1.05

Table 3 (continued)

PSH Total	SM	17	9.82	5.83	1.41
	NSM	31	9.45	7.30	1.31
IEAW Total	SM	17	7.18	2.77	.67
	NSM	31	6.16	1.63	.29
IA Total	SM	17	15.71	3.44	.83
	NSM	31	15.87	5.63	1.01
IMCI Total	SM	17	29.65	3.39	.82
	NSM	31	27.26	5.68	1.02
Grand Total	SM	17	98.18	12.32	2.99
	NSM	31	92.71	13.75	2.47

Analysis of the descriptive statistics expressed that both groups, science majors and non-science majors, displayed the highest agreement with racial identity attitudes reflected in the following subscales: Internalization Multiculturalist Inclusive (IMCI), 29.65 and 27.26 respectively for science majors and non-science majors, and Pre-Encounter Miseducation (PM), 20.47 and 17.16 respectively. Additionally, both groups exhibited the lowest agreement with racial identity attitudes in the following subscales: Immersion-Emersion Anti-White (IEAW), 7.18 and 6.16 respectively for science majors and non-science majors, and Pre-Encounter Self-Hatred (PSH) 9.82 and 9.45 respectively. A portion of these findings were consistent with the researcher's expectations in that it was anticipated that the science majors would possess highest degree of agreement with IMCI attitudes (29.65) in

comparison to the non-science majors (27.26). The researcher proposed that participants' agreement with IMCI statements would reflect an internalized racial identity and willingness to accept members of other racial and ethnic groups (Cross & Vandiver, 2001). As such, the researcher believed these attitudes would allow the participants to be more willing to enter into science fields as a college major.

As indicated in some of the participants' interview comments, IMCI attitudes (i.e., acceptance of one's race despite society's obstacles) reflected individuals' belief that Blacks can enter into and be successful in science fields. For example, Jennifer, a chemistry major, made the following statement which embraced IMCI views:

> I believe that, I think that you can succeed in anything that you want to succeed in. It takes hard work, it takes drive and you have to have the mindset that this is what I want to do and I'm going to do it regardless of what, what anyone says. And when you get that type of mindset, there's not really much that can get in your way.

Edith, a biomedical science major, also made comments that reflected IMCI attitudes. With regard to a question about whether she believes Blacks' are able to enter into science, she remarked that, "I think so. Society puts that stereotype on you again {that Blacks are not able to participate in science). Um, but we have to break away from that to see where our potential lies and where we want to go into, you know?"

Though the results for the science majors were consistent with what the researcher anticipated, the finding that the non-science majors also possessed strong agreement with the IMCI attitudes was not expected. The researcher believed that the non-science majors would exhibit attitudes more expressive of the Pre-Encounter subscales (Assimilation, Miseducation, and Self-Hatred) in comparison to the science majors. Only for the PA subscale was the non-science majors' score (16.81) greater than the science majors' (15.35).

The researcher hypothesized that the expression of stronger Pre-Encounter attitudes would prohibit the non-science majors from entering into the science field.

From interview findings, Pre-Encounter views were evident in one non-science majors' comments. Lily, a creative writing major, made the following remark which expressed Pre-Encounter Assimilation (i.e., references identity as being American rather than based on a racial orientation) views with regard to the term she prefers to use to express her racial identity. She stated that, "So, I consider myself American, I was raised by my mother's family and they are all American; down to the liking of apple pie and peach cobbler at Thanksgiving dinner." Despite the observation that Lily's comment indicated she possessed an assimilated view of her identity as American rather than in relation to a particular racial group, she did not express attitudes that race was a problem for her with regard to selecting her college major. For Lily, the primary factor that impacted her decision was her interest in the field; she did not enjoy science on the collegiate level and opted for creative writing as her major.

To evaluate the differences in means for CRIS scores between the science majors and non-science majors, a t-test for independent samples was performed. The t-test was an appropriate and acceptable measure to use because it accounted for instances of small sample sizes assuming that the dependent variable (i.e., test score) was normally distributed within each group and the two groups had approximately equal variance. The normality of the participants' scores was evaluated using the Levene's test. The Levene's test for equality of variances indicates whether or not the science majors and non-science majors exhibit approximately equal scores on the CRIS. If the Levene's test is significant ($< .05$), the two variances are significantly different. However, if the test is not significant ($> .05$), the two

variances are not significantly different; they are approximately equal (Gall, Gall, & Borg, 2003). Table 4 details the results for the Levene's test for equality of variances for the two groups and the t-test for equality of means.

Table 4

Levene's Test for Equality of Variances for the CRIS

	Levene's Test for Equality of Variances	
Subscale	F	Signicance
Equal Variances Assumed		
PA Total	1.31	0.26
PM Total	0.26	0.61
PSH Total	0.31	0.58
IA Total	3.78	0.06
Equal Variances Not Assumed		
IEAW Total	6.58	0.01
IMCI Total	5.45	0.02

The results from the Levene's test indicated that the variances for the Immersion - Emersion Anti-White (IEAW) and Internalization Multiculturalist Inclusive (IMCI) scores, 0.01 and 0.02 respectively, were significantly different. Therefore, the variances for these two tests were not approximately equal. Test results for the other subscale scores were not significantly different as indicated by significance greater than .05; the variances for these subscales were approximately equal.

Table 5 displays the results of the independent samples test. The results of the test revealed that the means for the participants' scores were not significantly different for any of the CRIS subscales. This finding was counter to what the researcher anticipated. The researcher hypothesized that a difference would exist in the racial identity attitudes and profiles between the science majors and non-science majors; however, such findings were not observed. The two groups of participants held similar racial identity attitudes and profiles.

In addition to the test for independence, Cronbach's alpha coefficients were calculated to assess the reliability of the subscales measured by the CRIS (Gall, Gall, & Borg, 2003). Since instrument scales represent a group of interrelated items that are designed to measure constructs, reliability assesses the degree to which the same set of questions would produce similar responses if the questions were re-ordered and issued to the same participants. Variables are identified as reliable if they result in stable responses over repeated administration of the instrument (Gall, Gall, & Borg, 2003). Alpha coefficients range in value from zero to one. A score close to one is viewed as a more reliable scale. Past researchers have indicated .70 as an acceptable reliability coefficient. Each of the CRIS subscales contained five items. The reliability coefficients for each subscale are presented in Table 6. Based on the calculated results, the reliability coefficients revealed that all of the CRIS subscales were reliable measures to assess the racial identity attitudes indicative of each subscale.

Table 5

Independent Samples Test for CRIS Scores

		T-Test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Diff.	
							Lower	Upper
PA Total	Variance assumed	-0.63	46	.54	-1.45	2.32	-6.13	3.22
PM Total	Variance assumed	1.93	46	.06	3.31	1.72	-0.15	6.76
PSH Total	Variance assumed	0.18	46	.89	0.37	2.06	-3.78	4.52
IEAW Total	Variance not assumed	1.39	22.28	.18	1.02	0.73	-0.50	2.53
IA Total	Variance assumed	-0.11	46	.91	-0.17	1.50	-3.19	2.86
IMCI Total	Variance not assumed	1.82	45.58	.08	2.39	1.31	-0.25	5.03

Though the findings regarding the strength of agreement with various racial identity attitudes were similar between the science majors and non-science majors and inconsistent with the researcher's initial thoughts, results such as these seem highly plausible. Considering the location of the study, a pre-dominantly White university in the south, the researcher would not surprised to find Black students with similar racial identity profiles to the participants in the study to select such a setting for their college experience. These individuals are likely to exhibit internalized racial identity attitudes (indicated by IA and IMCI) and enroll in a university environment with the majority of White students and limited interaction with Black peers (Cross & Vandiver, 2001).

Table 6

Reliability statistics for the subscales of the Cross Racial Identity Scale (CRIS)

Subscale	Cronbach's alpha
Pre-Encounter Assimilation (PA)	.87
Pre-Encounter Miseducation (PM)	.73
Pre-Encounter Self-Hatred (PSH)	.91
Immersion-Emersion Anti-White (IEAW)	.74
Internalization Afrocentricity (IA)	.72
Internalization Multicultural Inclusive (IMCI)	.71

Additional Insights on RID Profiles: Interview Segments Related to CRIS

In addition to completing the Cross Racial Identity Scale (CRIS) and the Draw-a-Scientist Test (DAST), 14 participants (eight science majors and six non-science majors) completed a one-on-one, semi-structured interview with the researcher. All of the science

majors interviewed were female and one of the non-science majors interviewed was a male. The interviews ranged in duration from 20 minutes to 60 minutes with an average time of about 35 minutes. During the interview, participants were asked to provide information about their background, thoughts on race, and perceptions of science as a college major and career choice. In addition, they were asked to elaborate on their DAST sketches that represented their images of scientists. Interview data were pertinent to this study because findings from the interviews related to the CRIS survey elucidated what was captured in the instrument - in what forms the racial identity attitudes were manifested (Gall, Gall, & Borg, 2003). Participants' verbatim interview comments were first analyzed using the six subscales of the Cross Racial Identity Scale (CRIS). Transcriptions were evaluated to identify comments that supported attitudes represented by each of the RID subscales: Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), Pre-Encounter Self-Hatred (PSH), Immersion-Emersion Anti-White (IEAW), Internalization Afrocentricity (IA), and Internalization Multiculturalist Inclusive (IMCI).

Evaluation of the participants' responses was based on the researcher's definitions for each subscale patterned after the descriptions for the stages reflected in the Cross Nigrescence Theory. Table 7 outlines each of the six subscales and the coding definitions the researcher used to analyze the transcripts. When statements reflected any of the coding descriptions, they were classified and labeled according to the corresponding CRIS subscale. For reporting, analysis of interview transcripts was separated by each subscale. Responses from participants reflective of racial identity attitudes for each of the subscales are presented. Verbatim comments are indicated by double quotations when applicable.

Table 7

Subscales and Coding Descriptions of Cross Racial Identity Scale (CRIS)

Subscale	Coding Descriptions for Comments
Pre-Encounter	
Assimilation (PA)	Exhibits limited salience for race
Miseducation (PM)	Accepts common stereotypes of Blacks
Self-Hatred (PSH)	Negates aspects about self because of Black race
Immersion-Emersion	
Anti-White (IEAW)	Exhibits hatred toward Whites
Internalization	
Afrocentricity (IA)	Celebrates aspects related to Black cultures
Multiculturalist Inclusive (IMCI)	Accepts racial identity and affiliates with other groups based on race, sexual orientation, gender, etc.

Pre-Encounter Assimilation

Analysis of the verbatim transcripts from the one-on-one interviews allowed the researcher to identify elements of conversations that reflected participants' Pre-Encounter Assimilation (PA) attitudes. Several of the individuals made comments that were classified in the PA category. Such responses expressed views that the participants possessed attitudes which reflected limited salience for race. For example, Jennifer, a chemistry major, made

comments about how she did not possess a regard for race prior to her fifth grade year in school. She remarked that,

> Um, yeah I think the first time that I really really realized that people was looking at your skin color was in the 5th grade. I was playing soccer and um this kid called me the N-word and said that N's aren't allowed to play soccer because we were beating them. And um, we got into a fight about it and that was the first time it actually hurt me like, wow why would you say something like that, why would try to hurt me like that and why can't I play soccer? *What's the difference between me and you?* That was the first time where I really realized that race was an issue beyond like …cause I never dealt with it at school, I just heard about it, you know, I saw it on TV, but that uh was the first time I dealt with it on my own.

Jennifer's comments express that she exhibited attitudes indicative of Pre-Encounter Assimilation when she was a child. Specifically, the statement "What's the difference between me and you?" indicates Pre-Encounter Assimilation; she viewed all people as being the same.

Pamela, a biomedical science major, also made several remarks that indicated her PA attitudes. When Pamela was asked if her scientist was of a particular racial group, she commented that she does not emphasize such concepts. The following dialogue exhibited Pamela's PA statements about race in relation to her scientist:

> Interviewer: Okay. Alright. And so you did a female scientist. Does your scientist have a race… a particular race or ethnic group?
>
> Pamela: No, it does not.
>
> Interviewer: And if you would make it a race or ethnic group, what would it be?
>
> Pamela: I don't know. Cause when I…*I don't place importance on stuff like that* so I wouldn't know what to make it (giggles).

Pamela also responded that she was unaware of racism around her because she either does not realize it occurs or she chooses to ignore it. She made the following statement about negative experiences based on race:

> Honestly, no I have not. It's probably but people always ask me questions about if I ever experienced racial discrimination or tension or anything like that. I haven't. Maybe it's happened and I haven't…I haven't…maybe it's happened and I just didn't know, but *I've come to ignore* and not let that con…stop me from doing what I need to do.

Not being aware of racism in society reflects Pre-Encounter Assimilation attitudes. If an individual does not "see" race, she is not likely to observe negative encounters based on race. However, if a person chooses to ignore negative racial experiences (as indicated in the latter part of Pamela's comment), she is aware of race, but disregards it as a factor in her interactions with others. This segment of Pamela's comment indicates that she also expressed views indicative of the Internalization stage; attitudes that reflect the understanding of one's own race, the race of others, and a call to action. In addition, Pamela's comments highlight the fluidity of one's racial identity. Depending on a person's experiences and position in life, one may express diverging racial identity attitudes (Cross, 1995; Cross & Vandiver, 2001; Parham & Helms, 1985). Pamela's views were pre-encounter with regard to her scientist, but internalized in relation to her own life. Though she has internalized her own racial identity, she does not place importance on race with her interactions with others.

Pre-Encounter Miseducation

Participants also made comments that indicated Pre-Encounter Miseducation (PM) attitudes. These remarks expressed views that indicated that the participants have tendencies to agree with some of the racial stereotypes that exist about Blacks. For example, regarding a

question about what types of individuals enter into the sciences, Jennifer, a chemistry major, stated that,

> Yeah. Um, because everyone who was doing it um, Caucasian, everyone who was going into the science field…all my friends that were going into the science field, they were Caucasian and all of my friends who wanted to do sports, criminology, um English and stuff like that, they were African American and so I had an idea that okay, *sciences and things like that are not…are more so for Caucasians* and they are the majority and I am the minority and if I went into something like sports, criminology or something like that, then I would be the majority and they would be the minority.

Edith, a biomedical science major, also commented in a manner that reflected Pre-Encounter Miseducation attitudes. In response to a question asking how she felt about conversations and interactions she had with her friends surrounding racial issues, Edith remarked that,

> Edith: Um. Yes, sometimes, um you know they looked at me cause they'd think I could dance well or something you know. Or um, "You know you can dance well you're Black" type of thing. But, yeah, I think that's mainly what it consisted of. Or, "Can't you sing, you're Black?" No, I can't sing that well.
>
> Interviewer: How did conversations like that make you feel?
>
> Edith: Um. Sometimes, I was like, "Yeah, I know I can dance because I am Black", but now, now a days. Like I'm taking this racism class and you *know not all Black people can dance*. I have to put that into my mind because *I sort of bought into that stereotype that all Black people dance and all White people can't dance or whatever*. So, yeah.

Pamela, a biomedical science major, expressed views indicative of attitudes in the Pre-Encounter Miseducation subscale; views that reflect that an individual accepts common negative stereotypes about Blacks. In response to a question to elicit Pamela's thoughts about whether or not Blacks can pursue science, she made remarks that showed that though she felt Blacks can enter science; however, she believed some of the stereotype that Blacks make a number of excuses and look for everything to be given to them. Pamela replied that,

> I think with a lot of African Americans were *looking for the easy way out* in the things that we do. We just, *we look for a lot of excuses*. *We don't want to*

> *challenge ourselves* and things like that. We feel it's too hard. And sometimes, I think it's hard to, but I know that I just have to stick with it because if other people are doing it, why can't I?

Pre-Encounter Self-Hatred

During the one-on-one interviews, one participant exhibited attitudes that were representative of the Pre-Encounter Self-Hatred (PSH) subscale. Lily, a creative writing major, expressed viewpoints that reflected instances when she possessed negative views about herself because of her Black race. During a time when she was growing up, Lily was down on herself because she could not understand why other Black children did not want to be her friend. The following dialogue displays the PSH attitudes Lily exhibited when she was growing up and socializing with peers:

> Lily: Um, I had Black friends, but they were like the kids I played with on the playground…the kids I sat with at lunch. Um, a lot of the other Black kids at my school…*I was too White for them one said.*
>
> Interviewer: What do you mean too White?
>
> Lily: My speech was too nice apparently. I never really figured that out. That was one thing that kind of puzzled me up until about high school when *I just stopped caring.*

Lily expressed Pre-Encounter Self-Hatred views about herself and interactions with Black peers during her youth.

Immersion - Emersion Anti-White

Though the Immersion - Emersion Anti-White subscale received the lowest scores for both the science majors and non-science majors on the CRIS, one participant's interview responses revealed attitudes indicative of IEAW. With regard to her experiences growing up, Jennifer, a chemistry major, expressed how she and her friends handled situations involving White people. Though she commented that these statements were made jokingly, the ideas

expressed reflect Immersion - Emersion Anti-White sentiments. Jennifer stated that, "Um, me and my friends we just always like…if something bad happened, like, "It's the White people." We would say that and you know just blame them for things…" Additionally, she said that, "Um, sometimes it was joking…a lot of the time it was joking, but sometimes you were serious. Sometimes it was like, "If it wasn't for those White people." Clearly such comments illustrate IEAW sentiments.

Internalization Afrocentricity

Several of the participants made remarks that revealed attitudes representative of Internalization Afrocentricity. These attitudes reflected instances when individuals internalize their Black race and used this realization in how they approach life and interact with others. Jennifer, a chemistry major, and Lola, an English major, expressed IA attitudes during their interviews. Concerning her thoughts about being Black, Jennifer commented that,

> Yeah. Yeah. I've always been taught to be proud of who I am and be proud to be Black. I'm an African American, Black female. I'm proud to be Black. I love my skin color. I think I have a beautiful hue and I'm happy to be the color that I am and I wouldn't change it.

Despite negative encounters with others based on race, Jennifer used her IA attitudes to persevere in science classes.

> I mean you walk into a class and there's only one African American female, you're kind of going to shy away from her and go with other people you know. I'd see them look at me, look at the chair and then kind of go sit somewhere else. Um, it kind of offended me, but not too much because I laugh inside because I knew, I mean science is my thing so you don't want to be my partner you're going to lose out.

Similarly, Lola's acknowledgement and acceptance of her Black race impacted how she approached life. Lola made the following remarks with regard to how she grew up and interacted with others as a result. She stated that,

> Um, I just…my household was pretty like unconventional, so I mean *I was very aware that I was Black*. And I was very um just always aware and aware of what that meant you know in terms of um….well my parents were a little different in the sense of they were like always telling me to be very cautious you know of what I said. It wasn't like kind of like I was speaking for me, i*t was kind of like you're representing a group of people*.

Internalization Multiculturalist Inclusive

Participant's comments during the interviews heavily reflected Internalization Multiculturalist Inclusive (IMCI) attitudes. Individuals' IMCI views depicted their personal acceptance of their internalized Black race as well as their willingness to embrace people from other reference groups whether it was based on race, gender, religion, sexual orientation, etc. For example, Jennifer, a chemistry major, made comments about her scientist's race that indicated she possessed IMCI attitudes about what racial groups can be scientists. Jennifer commented that,

> Um, I didn't give her a color because *there are so many different types of scientists* and I didn't just want to make her brown or white or peach or anything like that. She's just kind of *the color of the paper which represents all colors* and um she's a woman because I'm a woman and *women can be scientists* and most of the time people think of scientists as men and there are women scientists as well. That's why I drew it like that…Um, but then I realized I want to do this and maybe me pushing to go into the sciences will show someone else that *it's not only for Caucasians it's for anyone who wants to go into that field…African American, Asian, anyone who wants to be a scientist can be a scientist*.

Stefanie, a biomedical science major, made similar IMCI remarks when she was asked to explain why she drew her scientist as a vibrant pink color. She expressed views that exhibited

that she was aware of different races of people; however, she believed science was a field open to all individuals. Stefanie stated that,

> Um, well um I chose a pink scientist because my favorite color is pink. I was going {to draw} a Black scientist at first, but because you know, science is when you think of it, you think about White scientists, but *I feel like a scientist can be any color whether it's blue or purple or any other color*. So, that's why I chose pink and it's my favorite color.

In her remark, Stefanie recognized a number of factors that impacted her drawing of a scientist. She realized that her initial thought was to draw a Black scientist though she tends to think of scientists as being White. Despite these conceptions of scientists regarding race, Stefanie elected to illustrate her scientist as fuchsia pink to represent all races of people. In addition, Stefanie made comments about her decision to join the swim team in high school which reflected IMCI attitudes. Stefanie stated that,

> Like I have a *lot of White friends*. I swam on the swim team, when I was on that, it was like no Black people on the swim team. But I felt like I had to expand my boundaries. Because *I wasn't going to be like, be isolated* just because I was put into a situation. I'm so adaptive, like I mentioned early…adaptive. *I just don't want Black friends, I just don't want White friends. I want like a lot diverse* (inaudible).

Similarly, Roni, a biomedical science major, also expressed that she interacted with a diverse group of friends in high school and continues to possess IMCI attitudes in her college friendships. With regard to a question about whether she had any negative racial experiences with peers growing up, Roni commented that,

> Not that I can recall. Not that I can recall. Cause in high school *I got along with everybody* so that wasn't a problem. Here in college, I…I can't recall that happening, so I haven't had that happen yet. I do, *I have (giggles) a diverse group of friends*. It doesn't matter to me, I mean most of the friends I have are Black, but *I hang out with all types*, you know. I try to make friends with all of my classmates, it doesn't matter to me you know. We're both in the…going towards the same way.

Roni's comments about her scientist's race also reflected IMCI attitudes. When asked if her scientist represented any particular racial group, Roni stated that, "Um, not really. I mean I drew Black hair and I didn't really color the skin…so it can be any, any races." Roni possesses IMCI views reflected in her interactions with others and her views of scientists.

Stacey, a chemistry major, also expressed attitudes that indicated IMCI conceptions. Regarding a question about who could be a scientist, Stacey stated that, "I believe everyone can be a scientist in their own way because you're always hypothesizing, trying new things, so on and so forth, I guess." This comment reflects that Stacey embraces the race of all individuals and believes everyone can be represented in the sciences.

Regarding the participants from the non-science majors' group, Kimberly a psychology major, made comments that reflected the Internalization Multiculturalist Inclusive subscale. In response to a discussion about societal stereotypes concerning the races of individuals who enter the sciences, Kimberly stated that,

> Yeah, you know they push the smart people to it. I'm not saying that African Americans aren't smart or minorities aren't smart, it's just you know we have our stereotypically smart people. They're either White or their Asian or they're Indian or something like that. Um, and I believe that society does follow those stereotypes. They do. They do push towards that, *but there are people that break those boundaries and it can be done*. Well I do still believe that, maybe not 100% of the way, but certainly a certain percentage {of scientists} goes toward those…those stereotypically types of people.

Though Kimberly recognizes and acknowledges that racial stereotypes regarding intelligence and the pursuit of science exist in society, she did not accept these views. Kimberly's statement, "…there are people that break those boundaries and it can be done" signifies that she recognizes those stereotypes and their impact, but believes Blacks and people of other racial groups can overcome the influence of those stereotypes if they choose to become scientists. This comment is reflective of IMCI attitudes.

From the one-on-one interviews with participants, the researcher observed comments indicative of all six racial identity subscales measured by the Cross Racial Identity Scale. However, participants' comments predominately reflected the Internalization Multicultural Inclusive (IMCI) subscale. The researcher also observed that participants' interview responses were least reflective of the Pre-Encounter Self-Hatred (PSH) and Immersion - Emersion Anti-White (IEAW) subscales. These findings were evident for both the science majors and non-science majors and were consistent with the data collected from the CRIS; participants expressed the highest agreement with IMCI and PM attitudes and lowest agreement with PSH and IEAW conceptions. Four individuals expressed views relating to the IMCI subscale (29%). Two participants made remarks indicative of each of the following subscales: PA, PM, and IA (14% each). Only one participant made comments that reflected PSH and IEAW attitudes (7% each).

Part II: Findings Pertaining to DAST & DAST-C

Additional strategies for data collection allowed the researcher to answer the following research questions: What perceptions of scientists do Black students majoring in science possess? What perceptions of scientists do Black students majoring in non-science fields possess? Findings regarding Black college students' perceptions of scientists are presented based on results from the Draw-a-Scientist Test (DAST) and Draw-a-Scientist Test Checklist DAST-C as well as one-on-one interviews.

For the Draw-a-Scientist Test (DAST), participants were provided with an unlined sheet of white paper and a 24-pack of colored pencils and were asked to "Draw a picture that represents your image of a scientist." Participants were instructed to do their best and were given permission to use stick figure drawings if they preferred. Data from the DAST sketches

were collected from 48 participants (17 science majors and 31 non-science majors). Of the participants from the science majors group, one was male and 16 were female. For the non-science majors group, eight were male and 23 were female. After participants completed their DAST images, their sketches were collected and analyzed using the Draw-a-Scientist Test Checklist (DAST-C).

For the 48 participants who completed the DAST, drawings were first categorized based on the gender of the scientist represented. The gender of the scientist was classified as male, female, "dual-gender", and "non-human." Dual-gender was the term used to classify images that represented half of the scientist's face as male and the other half of the scientist's face as female. Male gender was indicated by short hair and in some instances facial hair. Female gender was represented by long hair, eyelashes, and in some instances lipstick and breasts. The non-human term was developed because several of the participants' drawings did not represent the scientist as a person instead they sketched objects or elements representative of the participants' perceptions of a scientist (i.e., beakers, test tubes). Appendix E represents a DAST picture of a White male scientist. A White female scientist is displayed in Appendix F. Appendix G illustrates a DAST picture of a non-White female scientist. Appendix H depicts a picture of a non-White male scientist. Appendix I shows a picture of a multi-racial, dual-gender scientist. An indeterminate male and indeterminate female or included in Appendices J and K respectively. Finally, Appendices L and M display pictures of non-human representations of scientists.

After sketches were separated based on gender they were then categorized based on race as indicated by skin color. Scientists were classified as White if participants enhanced their drawings with lighter colored pencils for skin color. Considering researcher could not

determine the specific race of scientists colored with brown skin as being a specific racial group (i.e., Black, Asian American, or Hispanic American), such images were termed as non-White. In addition, there were instances when participants distinguished half of the scientists' skin as one race and the other half as another race. These participants wanted to draw their scientists to reflect more than one race of people. As such, the term multi-racial was used for these drawings. Finally, there were drawings that did not express an assigned race for the scientists. These drawings were labeled "indeterminate."

The researcher provided the participants with unlined white paper; therefore, evaluation of drawings did not allow for the differentiation between instances when participants elected not to assign a race to their scientists and left it blank or when participants wanted the scientists to be Caucasian and left the drawing the color of the white paper. Illustrations of scientists in this category were labeled as indeterminate, a term used by Rosenthal (1993) to account for instances when the evaluator was unable to determine scientists' gender based on participants' sketches. Though the term is used with regard to gender in the aforementioned study, it is an appropriate label race because it provides a description for drawings that can not be classified in a specific racial group. These drawings were not eliminated from the findings. They were not identified as representing a specific race or absence of race, but were classified as indeterminate.

The findings are reported for the science majors and non-science majors groups. Table 8 depicts the percentage of drawings representing the different race and gender classifications for the scientists. The findings are reported by group.

Table 8

Percentage of Scientists Represented By Group

Type of Scientist	Science Majors	Non-Science Majors
Human Representations		
White Male	24	19
White Female	24	3
Indeterminate Male	18	23
Indeterminate Female	0	6
Multi-Racial Female	12	6
Multi-Racial Male	0	0
Multi-Racial Dual-gender	12	0
Non-White Male	0	23
Non-White Female	0	19
Non-Human Representations		
Other (Cross w/ crown of thorns; symbols of science; plant)	12	3

Science Majors

Scientist Represented as a White Male

Four of the 17 participants completed their drawings to represent a scientist as a White male. In three of the four images, the scientists were characterized as having blue eyes. The fourth drawing did not indicate a specific eye color for the scientist. Two of the scientists depicted a "mad scientist" figure with unkempt hair. Elements common among all four

drawings included the representation of the scientists as wearing lab coats and goggles or glasses. Two of the scientists were shown holding or working with chemicals. These two drawings included other elements of chemistry including test tubes, beakers, an eye wash station, and safety signs. One picture illustrated the scientist as a biologist instructing his class on mitosis. He asks, "Who can correctly explain the different stages of mitosis? Anyone?" This scientist carried a clipboard with notes on mitosis. The final scientist was not drawn expressing a specific field of science. Two of the four White male scientists were drawn as being middle-aged men as indicated by the wrinkled faces and balding hair.

Scientist Represented as an Indeterminate Male

As previously addressed, because the participants were given unlined white paper, the researcher could not differentiate instances when the participants did not want to define their scientists' race, and left the drawing uncolored, from occurrences when the participants wanted the scientist to be Caucasian, and left the paper white. The researcher was able to resolve this discrepancy with the participants who volunteered to participate in one-on-one interviews. Findings from the analysis of interview transcripts regarding participants' DAST drawings are presented following analysis of DAST images.

Of the 17 participants from the science majors group who completed the DAST, the researcher only identified with certainty that three sketched their images of a scientist to represent an indeterminate male. All three of the drawings with indeterminate males depicted middle-aged or elderly individuals, as reflected by their wrinkled faces and balding hair. Two of the three men were completely bald and one was balding in the center of his head. In addition, two of the scientists were drawn wearing eyeglasses or goggles. All three of the indeterminate male scientists were depicted in an environment with tools of chemistry. They

were surrounded by test tubes, graduated cylinders, and beakers bubbling with liquid. Only one of the scientists drawn in this group was shown wearing a lab coat.

Scientist Represented as a White Female

From the science majors group, four of the 17 participants represented their scientists as a White female. Three of the four drawings showed the female wearing a lab coat or apron. Two of the females were wearing dresses while the other two were wearing pants. Three of the four pictures showed the White female scientists in a lab environment while the fourth did not depict the scientist doing any specific type of work. The lab settings expressed included elements of chemistry such as test tubes, flasks, and beakers. One of three also included aspects related to astronomy, such as a model of a space ship. The scientist in the picture with astronomy symbols conducted a countdown, "5, 4, 3…" All four of the White female scientists were shown wearing eyeglasses or goggles.

Scientist Represented as a Multi-racial Female

While two of the 17 participants in the science majors group represented their drawings as female scientists, they identified their scientists' race as being multi-racial or representative or women from all racial backgrounds. Both of the Multi-racial female scientists were drawn wearing a lab coat. One of the scientists was illustrated as a "mad scientist" with unkempt hair that is blue in color. She had on a pink lab coat and fuchsia pink skin tone. The participant indicated that she drew the scientist pink because it was her favorite color, but for her, pink represented any racial or ethnic group. The other scientists' skin was colored a brown hue; however, the participant included the following note next to her sketch, "Don't take the color into consideration…wanted it not colored so this scientist can represent anybody, any RACE!"

Scientist Represented as a Dual-gender/Multi-Racial Individual

Two of the 17 drawings analyzed sketched a scientist as a dual-gender, multi-racial person. Each of these drawings expressed an individual's head with half of his face as being male and the other half of her face as being female. The male side had short hair while the female side had long hair. On one of the drawings, the male side also had facial hair. In addition, each picture was drawn with half of the figure enhanced by one skin tone and the other half with a darker skin tone. One participant also sketched her drawing to show one side having a blue eye color and the other half possessing a brown eye color. Neither artist elected to draw the rest of the scientists' body. In one of the images, the scientist was drawn in proximity to the Earth and the caption, "Change the World" was written around the top of the planet. The scientist in the other picture was not represented in any particular setting or performing any specific task.

Scientist Represented as Non-Human

Two of the 17 participants who completed the DAST instrument elected not to represent their scientists as a person. Instead, they used objects of science and other personal symbols to illustrate their views. One participant identified in her sketch similar elements of science found in the other drawings. She included flasks, test tubes (some of which were broken), and beakers. She also drew strands of DNA molecules and a glass slide with a specimen under a cover slip. Finally, she sketched a flame, the sun, and the sky. The other participant whose picture was labeled non-human expressed her image of a scientist by drawing a brown cross with a crown of thorns on the top. The cross was glowing as shown by yellow and orange lines emanating from it. On her drawing, the participant noted that, "Christ is the Greatest Scientist of them all!"

Non-Science Majors

Scientist Represented as a White Male

For the non-science majors group, 31 participants completed the Draw-a-Scientist Test (DAST). Of the participants, six individuals depicted their scientists as White males. Five of the six scientists were represented as wearing lab coats and eyeglasses or goggles. Two of the scientists were middle-aged or elderly as illustrated by wrinkled faces. One of the scientists was expressed as a "Mad Scientist" as indicated by his wild hair and alarming expression on his face. In addition, this scientist had a sign that read, "Patients Beware" above his head. Half of the scientists drawn as White males were pictured with chemistry supplies surrounding them. These men had test tubes, flasks, and beakers either on a table in front of them, in their hands, or in their pockets. One of the scientists sketched as White male was shown thinking of mathematical equations as expressed in a caption above is head, "(+), π, xyz, (-) 123…(/)." Three of the scientists were also illustrated with writing utensils (e.g., pens and pencils) in the front pocket of the lab coat.

Scientist Represented as a Non-White Male

Seven of the 31 sketches depicted non-White male scientists. The drawings of these individuals were enhanced with skin tones that ranged in complexion from light brown to very dark brown. As such, the researcher was not able to differentiate specific racial or ethnic backgrounds for the scientists; therefore, the term non-White was used. ; However, one drawing did have the caption, "Typical perception of a scientist…Asian." This category of scientists had findings similar to the White scientists. Six of the seven images illustrated scientists wearing lab coats. Conversely, only one of the non-White scientists represented was shown wearing goggles. While most of the scientists were not drawn doing work in any

specific field of science, three were shown with chemistry materials. They were shown near flasks with exploding chemicals and racks of test tubes. The scientist labeled as "Asian" was drawn holding a chart with a picture of a DNA molecule.

Scientist Represented as an Indeterminate Male

From the non-science majors group, seven individuals sketched their scientists as indeterminate males. Since these participants elected not to enhance their drawings with colored pencils, the researcher could not classify the specific racial or ethnic background of the scientists; however, other findings were apparent in these drawings. Three of the seven indeterminate males were depicted as middle-aged or elderly men as expressed by the wrinkles on their faces and or balding hair. Two of the seven images illustrated the male as a "Mad Scientist" based on unruly hair that pointed toward the ceiling. Five of the scientists had on lab coats and four of them wore goggles. In addition, three of the males were shown wearing neckties. One of the ties had mathematical information written on it, "π…3.14...Pie." This same scientist was the only one drawn in an academic environment. He was illustrated next to a bench with bubbling flasks and beakers. Above his work table there was a framed picture of a person with the label "Einstein" on it. Finally, he had books titled Calculus, Chemistry, and Physics beneath his table. One of the scientists in the indeterminate male category was shown with a stethoscope around his neck and the title "Dr. Benson" next to his head. Another scientist was illustrated with a question mark on the front of his shirt and several captions above his head, "I wonder…What if?...How does this work/apply?...Questions, thoughts, ponder, challenge, study."

Scientist Represented as a White Female

Of all the sketches completed by the non-science majors group, only one of the pictures represented the scientist as a White female. The scientist was identified as female based on her long hair and feminine characteristics and or features (i.e., lipstick, earrings, breasts).This woman was drawn wearing a lab coat and goggles. She had pens in her front coat pocket. She was depicted standing next to a table with a book and flask on it.

Scientist Represented as a Non-White Female

The majority of the female scientists (six) represented by the non-science majors group were illustrated as non-White females. The scientists were identified as female based on their long hair and feminine characteristics and or features (i.e., lipstick, earrings, breasts). These pictures were enhanced with dark brown colored pencils. Most of the women were shown with long hair while one was drawn with a short afro. Five of the females were depicted wearing lab coats and three had on goggles. Only two of the women were shown doing a specific type of science while the others were drawn without being engaged in any activity. One of the non-White females was working in a chemistry lab. She was holding a beaker with a thermometer in it. The other was shown holding a stick in one hand and book titled *Law of Gravity* in the other.

Scientist Represented as an Indeterminate Female

Two pictures of female scientists were labeled as indeterminate as participants did not color their drawings to indicate a racial or ethnic background. The scientists were identified as female based on their long hair and feminine characteristics and or features (i.e., lipstick, earrings, breasts). Both of these women were shown wearing lab coats, but neither of them had on goggles or glasses. One of the females was illustrated standing next to a table with a

beaker boiling on a hot plate. The notations "H_20= water" and "CO_2" were written above her head. The other woman was not shown engaged in an activity.

Scientist Represented as Non-Human

For the non-science majors group, only one image of a scientist was labeled as non-human". This participant chose to represent a scientist by drawing a picture of a plant. The specific type of plant was indistinguishable to the researcher. The plant was drawn using a purple colored pencil.

Draw-a-Scientist Test Checklist (DAST-C)

Descriptive and inferential statistics were also used to analyze the participants' illustration of stereotypical images in their Draw-a-Scientist Test (DAST) sketches via the participants' scores on the Draw-a-Scientist Test Checklist (DAST-C). The DAST-C was used to assess DAST drawings for representations indicative of common stereotypes of scientists. Individuals' drawings were evaluated on 16 stereotypical elements expressed for scientists. One checkmark was made for each stereotype represented in the drawing. The percentages of participants expressing stereotypical views, mean scores for the DAST-C, and results of the Levene's test of variances and the independent samples test are described.

First, the number of responses for each stereotypical category were summed and divided by the total number of participants in each group to obtain the percentage of science majors and non-science majors who drew images representing that particular stereotype. Table 9 provides an outline of the DAST-C with the percentages of individuals responding to each stereotypical element. Second, Table 10 outlines the mean scores on the DAST-C for the science majors (coded as SM) and non-science majors (coded as NSM). The mean represents the average number of stereotypical elements represented in the participants'

drawings. Findings revealed that both groups, science majors and non-science majors, represented an average of four stereotypes in their illustrations of scientists. These results indicate that when scores are rounded, both groups of participants held 25% of the stereotypical views of scientists. Third, Table 11 summarizes the independent samples test performed for the DAST-C.

Table 9

Percentages of participants by group indicating stereotypical elements

Stereotype	Science	Non-Science
1. Lab Coat (usually but not necessarily white)	53	84
2. Eyeglasses	65	43
3. Facial Growth of Hair (beards, mustaches, Abnormally long sideburns)	24	23
4. Symbols of Research (scientific instruments, lab equipment of any kind)	47	32
5. Symbols of Knowledge (principally books, filing cabinets, clipboards, pens in pocket, etc.)	35	26
6. Technology (the "products of science)	12	0
7. Relevant Captions (formulae, taxonomic Classification, the "eureka!" syndrome)	29	23
8. Male Gender	41	61
9. Caucasian	53	23
10. Indications of Danger	6	6
11. Presence of Light Bulbs	0	3
12. Mythic Stereotypes (Frankenstein creatures, Jekyll/Hyde figures, "Mad/Crazed")	12	13

Table 9 (continued)

13. Indications of Secrecy (signs or warnings of "Private", "Keep Out", "Do Not Enter", "Go Away", "Top Secret", etc.)	0	3
14. Scientist Doing Work Indoors	35	32
15. Middle Aged or Elderly Scientist	24	26
16. Open Comments		
• Smiling Face	59	26
• Chemist	53	26

Table 10

Mean Scores for Draw-a-Scientist Test Checklist (DAST-C)

Total Score	Group	N	Mean	Std. Dev.	Std. Error of Mean
	SM	17	4.35	3.10	.75
	NSM	31	4.03	2.34	.42

Table 11

Levene's and Independent Samples Test for DAST-C Scores

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Diff.	Std. Error Diff.	95% CI of the Difference	
								Lower	Upper
Total Score	1.44	.24	.44	46	.69	.32	.79	-1.28	1.92

The Levene's test to measure the normality of the variances for the science majors' and non-science majors' scores revealed that the two variances were not significantly different (.24 > .05); they were approximately equal. As such, equal variances can be assumed. Based on the significance value of .69, there was no significant difference in means for the science majors and non-science majors on the DAST-C; each group illustrated approximately the same number of stereotypical images in their drawings of scientists. This finding was contrary to what the researcher anticipated because the hypothesis was that the science majors would sketch less than 50% of the stereotypes of scientists and the non-science majors would illustrate greater than 50% of the stereotypes. However, the means of the groups were similar, 4.35 (27% of the stereotypes) and 4.03 (25% of the stereotypes) respectively. These numbers indicated the science majors sketched 2% more stereotypes than the non-science majors.

Finally, reliability analysis for DAST-C was also computed using SPSS. For the first 15 (the 16th item was the additional comments section) items evaluated by the DAST-C, the calculated Cronbach's alpha was .69. This number indicated that the reliability coefficient did not successfully meet the standard of .70. As such, if the instrument was re-cast and re-administered to the same participants, their scores on the DAST-C may differ from those observed in this present study. Considering such findings resulted, it was necessary for the researcher to conduct further analysis of the DAST drawings and the DAST-C using additional methods to compare the science majors and non-science majors. Though additional analyses were completed on the DAST-C data, the reader should keep in mind the concerns about reliability. Analysis of interview data collected from 14 volunteers was another approach to address the reliability of information obtained from the DAST-C

instrument. Specific interview questions were asked regarding participants' perceptions of scientists as expressed in DAST drawings (Refer to APPENDIX).

Interview Segments Related to DAST & DAST-C

Comments from participants' interviews were categorized according to the scientists' race, gender, work, family status, and mental qualities. Table 12 provides labels and details of the categories that emerged from the participants' responses with regard to their DAST sketches. The data are reported using participants' actual words. The findings are reported based on the two groups of participants, science majors and non-science majors.

Table 12

Categories and Descriptions of Coding System

Category	Description
Race	Phenotypic expression of scientists' ethnicity
Multi-racial	The scientist represents any racial demographic
Black	The scientist represents those of African descent
White	The scientist represents those of European descent
Gender	Sexual distinction between male and female
Male	The scientist represents men
Female	The scientist represents women
Dual-gender	The scientist represents both men and women

Table 12 (continued)

Work	The field of study the scientist works in or the type of work he or she performs
Family Status	The type of familial unit the scientist possesses or belongs to
Single	The scientist is unmarried
Married	The scientist is married
Parent	The scientist has at least one child
Sibling	The scientist has at least one brother and or sister
Mental Qualities	Aspect related to the scientist's mental functioning (e.g., thought process, personality, attitudes)

Science Majors

Comments Regarding Scientist's Race & Gender

From the interview sessions, findings revealed that five of the seven science majors identified their scientist as being multi-racial individuals. Respondents were diplomatic in their decisions about whether to select a specific race to represent their scientists. These participants either elected to leave the sketch free of skin color by not using the colored pencils or they enhanced their pictures with colors (i.e., pink) and indicated that that color signified all races of people. In addition, some participants choose to differentiate one half of the scientist' face as one race and the other half as another race. In response to a prompt to describe her scientist in detail, Jennifer, a chemistry major, indicated the following explanation for her scientist being expressed as a multi-racial individual:

> Um, I didn't give her a color because there are so many different types of scientists and I didn't just want to make her brown or white or peach or anything like that. She's just kind of the color of the paper which represents all colors…

Similarly, another chemistry major, Stacey, responded in a manner that also reflected a multi-racial depiction of scientists. She wanted to ensure that the researcher understood that science is represented by individuals from all racial backgrounds. Stacey replied that:

> So when you said scientist, um, I believe everyone can be a scientist in their own way because you're always hypothesizing, trying new things, so on and so forth, I guess… Science has no race, ethnicity, or gender. It's just like math. You know, it's, it's own language basically.

In her drawing, Stefanie represented her scientist as having fuchsia pink skin. She explained her selection of the pink color in her interview. She indicated that,

> Um, well um I chose a pink scientist because my favorite color is pink. I was going a Black scientist at first, but because you know, science is when you think of it, you think about white scientists, but I feel like a scientist can be any color whether it's blue or purple or any other color. So, that's why I chose pink and it's my favorite color.

The final science majors to draw their scientists as being multi-racial were Roni, a biomedical science major, and Allison, an exercise science major. In response to the researcher's question about the scientist having any particular race or ethnicity, Roni replied, "Um, not really. I mean I drew black hair and I didn't really color the skin…so it can be any…any races." Similar to her other comments, Roni's reply reflected that her scientist was inclusive of all races of people. Allison also expressed multi-racial views for her scientist. She responded that, "I put half brown and half White. Different nationalities."

While these four participants did not designate their scientists as reflecting one particular race, the remaining participants in the science majors group did. Edith, a biomedical science major, indicated that her scientist was White when she was questioned

about the scientist's race. She responded that, "Yeah. She's white. I don't know. When I first thought of it, I thought of a White crazy guy. So, I put it as White." Pamela, also a biomedical science major, made comments that corresponded with Edith's. She declared that, "Um, the scientist is…he is White, Caucasian."

From these findings one can see that of the science majors who were interviewed, the majority of the participants represented their scientist as individuals reflective of people from all races. They viewed the field as being open to all racial and ethnic demographics. Only three respondents declared their scientist as having a specific race, White. None of the respondents reported their scientists as being Black or from another ethnic minority group.

In addition to conversations about the scientist's race, gender was also a topic discussed with participants. Comments revealed that three of the seven respondents identified their scientist as being female. Regarding their thoughts on the gender of their scientists, Jennifer, a chemistry major, replied that, "Um, my scientist is a woman and she has black hair…" Roni, a biomedical science major, responded that, "It's a female." While these two participants were straightforward in their declaration of the scientist being a woman, another participant selected the female gender as a default. Edith, a biomedical science major, replied that, "When I first thought of it, I thought of a White crazy guy. So, I put it as White. Then, since it didn't really turn out to be looking like a guy, I made it into a girl." Her initial desire was to draw her scientist as a man; however, she ended up deferring to the scientist as being a woman.

While four participants identified their pictures as women, two represented their scientist as males. Pamela, a biomedical science major, commented that she patterned her scientist after her current organic chemistry teacher. In contrast, Stefanie, a biomedical

science major, never officially stated that her scientist was a man, but used masculine pronouns (e.g., he, him, and his) when referencing her scientist. The final two participants did not assign their scientist a specific gender. Instead their scientists were dual-gender and encompassed all people. In her drawing, Stacey, a chemistry major, did not draw a person, she drew symbols of science. Again, Stacey stated that, "Science has no race, ethnicity, or gender." Similarly, when asked if her scientist was a particular gender, Allison replied that, "Um, no, like half of it is a female and half is a male."

Comments Regarding Scientist's Work

With regard to the type of work in which the scientist was involved, five of the seven participants indicated that their scientist primarily works in the laboratory, specifically in some branch of chemistry. For example, Jennifer commented that, "…scientists they're always working in the lab. Probably mixing chemicals or heating something on a Bunsen burner or something like that." Though her initial impression of a scientist was of a chemist, Jennifer, a biomedical science major, made additional remarks regarding career choices for scientists. She noted that,

> Uh yeah, I mean…when I think of scientists I think of someone who works with chemicals, making something a drug or…uh there are scientists who make automobiles…how to build a car…there was a scientist to come up with that…or who thought of physics. They're all scientists who do things like that. When I drew her, I had thought basically about a scientist in chemistry but there is physics and all other types of sciences.

Angie, a biomedical science major, illustrated her scientist as being a woman working in a lab setting doing astronomy. She drew her scientist simulating a launch countdown. Finally, Roni, a biomedical science major, mentioned that her scientist also worked in a laboratory environment. She replied that, "…they have test tubes they're boiling something, like they're working on and experiment, something like that." In contrast to Jennifer and Roni, Stacey, a

chemistry major, did not draw a picture of a person as a scientist, she used symbols of science instead. The symbols she used to represent the work of a scientist were materials related to chemistry and biology. While discussing her drawing, she remarked that,

> This would be like a DNA strand. Fire. Some test tubes. Broken glass. Um, chemicals. A slide with I guess bacteria on it. Basically, I guess cause I'm a chemistry and those are just things that I use. So when you said scientist, um, I believe everyone can be a scientist in their own way because you're always hypothesizing, trying new things, so on and so forth, I guess.

While most of the participants indicated that their scientists worked in a laboratory or primarily with chemicals, Allison, an exercise science major, chose not to designate any specific type of work for her scientist. She just commented that her scientist was analyzing the world and pondering ideas. Allison stated that, "Um, basically I put the scientist as looking at the world and seeing what ideas they can have to improve the world in general". In contrast, Roni, a biomedical science major, identified that her scientist worked as a researcher. She felt her scientist was, "Somebody in the field probably like, I don't know, probably trying to find a cure for cancer or something…or AIDS".

Comments Regarding Scientist's Family Status

When talking about their scientist's family status, most of the participants spoke in terms of how work impacts family life. Jennifer, a biomedical science major, reported that her scientist was a married woman and a parent of one or two children. She mentioned that it is often difficult for her scientist to balance family life and work. She stated that, "Um, sometimes I feels like we don't have a personal life, but it's really just her work ethic and trying to juggle between having time for her friends and family and having time for work at the same time." Similarly, Edith, also a biomedical science major, remarked that her scientist was a married woman with three children. However, her comments highlighted that her

scientist did not have as difficult time balancing the demands of work and home. Regarding her scientist, Edith remarked that,

> I picture her as a mother who goes home to leave her work at work. You know? She's good at what she does, but then she goes home to her husband and her kids. Yeah, I think she does, but um…she leaves her work where the work needs to be at; tunes her mind to the family as soon as she goes home.

Additionally, though Allison did not comment on her scientist's family status, she stated that, "Um, yes, I feel like they would have a family even though it would be hard…many scientists do have to work a lot and research and…but I would feel like they would have a family."

In contrast to the participants whose scientist endeavored to balance their family and work, Stefanie, a biomedical science major, indicated her scientist placed more emphasis on his work. When asked to discuss her scientist's family and personal life, the following dialogue ensued:

> Interviewer: … can you think of the scientist you drew, does your scientist have a personal life?
>
> Stefanie: No, he doesn't really have personal life (speaks softly).
>
> Interviewer: Why's that?
>
> Stefanie: Because he's always in the lab. He…no, I think he doesn't have a personal life. He tried to have a person life and it just doesn't work very well because he always has to go back to work.
>
> Interviewer: So do you think he has family…a family? Stefanie: Yes, but he doesn't really talk to his family because he's always busy.

Stefanie's comments were very similar to Roni's thoughts. Roni, also a biomedical science major, indicated that her scientist places priority for work over family. Though she detailed that her scientist was a married woman who was a mother, the scientist did not actively

engage in her personal life. The following segment of conversation displayed Roni's ideas about her scientist:

> Interviewer: For your scientist, do you think that person has a personal life?
>
> Roni: Yeah, but they probably don't have much of a personal life if they do have one .
>
> Interviewer: Why is that?
>
> Roni: Because it looks like they spend more time with their job doing their work. It's really time consuming so, it's really hard to make time for a personal life if they do have one.
>
> Interviewer: So you think they have a family and kids?
>
> Roni: Yes.
>
> Interviewer: But most of their time is devoted to work?
>
> Roni: Yes.

Finally, Pamela, a biomedical science major, also made similar comments about her scientist's commitment to work over family. Pamela stated that her scientist was a married man, but did not indicate if he was a parent. When asked if her scientist was able to spend time with his wife, Pamela commented, "No. Always doing research, always on the go. Always on the go. So I always wonder if scientists are going to slow down sometimes."

Comments Regarding Scientist's Mental Qualities

The final aspect that is described regarding the participants' scientists is their mental qualities. Two of the participants remarked that their scientists exhibited a crazy personality. Regarding the nature of her scientist's personality and thought process, Jennifer, a biomedical science major, believed her scientist was smart, funny, crazy, and creative. Jennifer stated that,

> I think scientists have to be kooky and kind of crazy and off the wall and come up with weird things because they're trying to um figure out the universe around us and there's a lot of crazy and kooky things going on in the world and to come up with these ideas they have to have a mind that's outside of the box.

Edith, a biomedical science major, also commented that she thought her scientist possessed a crazy personality. She remarked that,

> Um…I think she has that, like I said you know with the crazy hair, she has that erratic (yeah) type of personality. So that also goes home with her, in the lab and at home. You know, like crazy, you know talkative…Let's do this, let's do this and stuff like that.

In her thoughts about her scientist, Stacey, a chemistry major, did not refer to her scientist as being crazy. Instead, she talked about her scientist's eagerness to think outside the box. Stacey stated that her scientist is someone who has,

> An open mind, analytical, experimental, willing to learn, willing to try new things. You've got to be willing to try new things. Willing to experiment, to analyze, to research. Um, someone who just, I guess you just want to learn something. You got to have that drive.

Three other participants made comments that their scientists were committed workers. Roni (biomedical science major) believed that her scientist had to be devoted to her work in order to come up with cures and get everything accomplished. Allison (exercise science major) also felt that her scientist was dedicated to his work and research. Regarding her scientist's personality and what it took to be in that field, Allison replied that her scientist needed to possess, "Um, dedication…um motivated to want to research many things that affect people. Um intelligence…not necessarily book smarts, but also commons sense to understand people and also bring it back to the lab." Though Stefanie (biomedical science major) responded similarly that her scientist exhibited dedication to work, she also stated that

her scientist was a perfectionist. She commented that her scientist would devote his entire life to accomplishing one task if that was what was required.

Non-Science Majors

Comments Regarding Scientist's Race & Gender

Analysis of the non-science majors' interview transcripts revealed that two of the five participants identified their scientists as a non-White, specifically Black, male. The remaining three participants indicated that their scientist was a non-White (Black) female, multi-racial female, and multi-racial, dual-gender person.

Wesley, a criminology major and the only male interview participant, identified his drawing as an Black male ballistics scientist. Similarly, Kimberly, a psychology major, also stated that her scientist was a Black male. Specifically, she commented that her scientist was, "Um, he light-skinned I guess…" While Wesley and Kimberly depicted Black men in their drawings, the other participants represented differing images of scientists.

Lola, an English major, provided a vivid image of her Black female scientist. Lola stated that, "I drew a Black woman**,** in her, maybe early forties with an afro and gold earrings… she looks aged around the eyes maybe a little." Kayla, a psychology major, also expressed that she drew her scientist as a Black female. However, Jane, an early childhood education major, was firm in her declaration that her scientist was a female; however, she did not want to assign her scientist a race. Regarding gender, Jane remarked that,

> Um, it's a female. I did that because your first, well my first thought when you think of a scientist is probably male, so I made a point to draw a female. So, I think that's the most important part of my picture, the gender.

In addition, when asked about the scientist's race, Jane stated, "I don't know. Cause when I…I don't place importance on stuff like that so I wouldn't know what to make it."

Lily, a creative writing major, did not want to assign either a race or a gender to her scientist. She preferred her drawing to represent anyone who wants to be a scientist; therefore, her scientist was multi-racial and dual-gender. Her rationale for this was that, "Um, I was trying to make like an average person. Someone who didn't look this, who wasn't totally female, totally male." When asked if the scientist was of a particular race, Lily replied that, "No, it's just a person who asks a lot of questions and most of the time they actually go out and try to find the answers to them."

Comments Regarding Scientist's Work

Analysis of participants' discussions about their scientist's work revealed that two individuals commented that their scientists worked as researchers. Lola (English major major) indicated that her scientist was an AIDS researcher. She mentioned that her scientist possessed a physical marker with dispositional implications that made her think the scientist could succeed at this type of work. She stated, "Um, I see her doing, maybe AIDS research. Yeah, I think AIDS research because of her eyes she's kind of soulful, deep eyes. I see her doing that." Additionally, Jane (early childhood education major) also affirmed that her scientist conducted research. Instead of working to cure AIDS, Jane's scientist was a cancer researcher.

The other participants in the non-science majors group all identified their scientist as working in different branches of the field. Wesley (criminology major) identified his scientist as working in criminology as a ballistic scientist. He stated that, "He can be a ballistic scientist where he can find matches to bullets and stuff or try to find matches pretty much…look for physical evidence." In contrast, Kimberly (psychology major) noted that her scientist worked in chemistry. When asked what her scientist was doing in the picture, she

commented that, “Um, he’s just holding up a flask…just sitting there chillin.” Finally, Lily (creative writing major) elected not to identify her scientist in any specific field. Instead, she viewed her scientist representing a person who ponders a number of questions and actively works to answer them. Lily replied,

> So, I tried to just draw like any person you know who just asked a lot of questions. Because, that was one thing I noticed about a lot of science students, they ask a lot of questions or at least um most of the study of science involves people who are always asking questions are who are always thinking about things. So, I just drew a person who was walking around, “I wonder” “What if?” “How about this? I think he’s on his way to wherever he’s going to go find his answers. Like, he’s got his questions in mind already and now he’s just walking towards someplace he’s going to get him those answers.

Comments Regarding Scientist’s Family Status

Concerning the scientist’s family status, the non-science majors held a variety of perspectives. Lola (English major) identified that her scientist was a parent of one child who was close to other family. Wesley (criminology major) commented about his scientist that, “He has a family…kids.” Lily (creative writing major) indicated that a scientists’ family status would depend on the individual. She chose not to comment on his family situation. In contrast, Kimberly (psychology major) did not think her scientist had a spouse or children, but that the scientist did have siblings. She stated that,

> That’s not what I assumed for a scientist. Most scientists have…my perception is they don’t have much of a life as far as…like chemical and engineering scientists, I wouldn’t expect them to have much of a social life. He can have some brothers or some sisters. I don’t really know about a wife and some kids. I don’t know about that.

Finally, Jane’s (early childhood education major) comments revealed that her scientist had a very active family life. She replied that, “Um she, goes out to dinner with friends and her husband. Has children and probably attends weekend soccer games… things

like that." In addition, Jane was the only non-science major to comment on the impact of work on her scientist's family status. In response to a question about whether the scientist spends more time with family or working, Jane noted that, "Probably more time working than friends and family."

Comments Regarding Scientist's Mental Qualities

The final area that participants discussed about their scientist was the mental qualities they believed the scientists possessed. Lola (English major) felt her scientist was an intelligent and open-minded person. I addition, she thought her scientist needed to be very caring to conduct AIDS research. Lola commented that,

> "I think that you have to, you have to be driven. I think like primarily in this field, like AIDS research, you have to be driven by something. I think there is maybe for her there is this wanting to help, take care of, cure, heal type of aspect, so maybe."

Kimberly (psychology major) also replied that her scientist had to be an amicable person. She stated that, "Um, he's nice, polite, genuine, honest, hard-worker…well he'd have to be to be a scientist. Um, I don't know if he's that interesting." Lily (creative writing major) indicated that her scientist had to be committed to be successful, but that he or she was stubborn. She stated that,

> I would say my scientist is probably a bit persistent. They might get caught up in their studies. Um, they might be a bit stubborn. A lot of the science students I know they're pretty stubborn. So I think my scientist might be stubborn as well, but I think underneath, at the core, that they're pretty laid back. They like the usually things, to go out, meet people, have fun, but at the same time, they like to get their work done as well.

Like Lily, Wesley (criminology major) also mentioned that his scientist was a person committed to his work. For a person to be a ballistic scientist, Wesley remarked that, "Well it takes um dedication, a lot of studying, learning, um it's very high risk because you really

have to be on point." Finally, Jane (early childhood education major) declared that her scientist had to have a more structured personality. Regarding her scientist, Jane stated that she's, "Determined, a slight perfectionist, and very meticulous. I think that's her traits."

Part III: Discussion of Findings, Limitations, & Future Research

Cross Racial Identity Scale (CRIS)

Based on the independent samples t-test that evaluated the significance of the mean scores on the Cross Racial Identity Scale (CRIS), the researcher was surprised to find that there was no significant difference in means for science majors and non-science majors. It was hypothesized that differences would exist. Specifically, the researcher believed that science majors would express higher agreement with racial identity attitudes reflective of the latter stages of racial identity development, Internalization Afrocentricity (IA) and Internalization Multicultural Inclusive (IMCI) and lower agreement with the earlier stages, Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), and Pre-Encounter Self-Hatred (PSH). The researcher rationalized that science majors expressing internalized attitudes would possess an defined Black racial identity and would be more open to individuals outside of their race (Cross & Vandiver, 2001; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). These conceptions would allow the individuals to look beyond society's stereotypes of scientists and be able to see themselves entering into the field and being successful.

In contrast, the researcher hypothesized that the non-science majors would express higher levels of agreement with the early stages of racial identity development, PA, PM, and PSH and exhibit lower agreement with the later stages, IA and IMCI. Individuals accepting PA conceptions hold limited regard for race and do not reference their identity as being a

member of a racial group. In addition, people who hold PM views often accept negative stereotypes about Blacks (Cross, 1995; Parham & Helms, 1985; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). The researcher purported that subscription to such viewpoints would inhibit Black college student from selecting science as a college major. They would be more inclined to believe the stereotypes that Blacks are not smart enough and do not belong in the science field and fail to pursue the field. Despite the researcher's hypotheses, both the science majors and non-science majors displayed the highest agreement with IMCI and PM attitudes, while both groups showed lowest agreement with PSH and IEAW views.

The frequency distributions for the participants' CRIS responses for science and non-science majors reflected that differences did exist based on academic standings. Such findings support Cross' Nigrescence Theory which asserts that individuals' racial identity development may vary depending on age and life experiences (Cross 1991; 1995; 2001). As such, one would expect to find a range in responses to the CRIS instrument across freshman, sophomore, junior, and senior academic standings. Moreover, the distribution of findings did reflect the other results obtained by the study; the majority of participants expressed highest agreement with IMCI views and least agreement with IEAW and IA attitudes regardless of class standing.

Results from the interview segments related to the Cross Racial Identity Scale support the data obtained from the survey instrument. Analysis of 14 volunteers' interview transcripts revealed that the majority of the participants made comments reflective of Internalization Multicultural Inclusive (IMCI) and Pre-Encounter Miseducation (PM) views. Both science majors' and non-science majors' interviews exhibited attitudes that indicated they possessed

an internalized racial identity and acceptance of others (an IMCI view); however, they often accept some of the negative stereotypes society perpetuates regarding Blacks (a PM conception) (Cross & Vandiver, 2001; Parham & Helms, 1985). In addition, fewer respondents were identified that illustrated Pre-Encounter Self-Hatred (PSH) and Immersion-Emersion Anti-White (IEAW) attitudes. Participants' responses contained a limited number of references to views expressing negative feelings about self because of one's race (a PSH view) and notions that aspects related to White culture are evil (an IEAW attitude) (Cross, 1991; 1995). Interview findings align with the literature that accounts for a range in responses based on participants' age and life experiences (Cross, 2001). In addition, individuals attending a predominately White college or university have been observed to exhibit RID profiles similar to those observed in this study: high agreement with IMCI attitudes and low agreement with IEAW views (Cross & Vandiver, 2001; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001).

These findings reflect that overall both groups of participants approach life and others from a multicultural perspective. In part, the researcher believes that this is due to the fact that the participants were enrolled at a college that represents a diverse study body which potentially resulted in the plausibility of a pre-disposition effect. Students may have held racial identity profiles assessed during this study prior to selecting the specific university where this research was conducted. As a result, students probably received exposures to a number of individuals from different racial and ethnic backgrounds, genders, religions, etc. Such interactions with a variety of individuals may have engendered and nurtured their IMCI attitudes. Conversely, because both groups showed high levels of agreement with PM views,

results indicate that the participants do believe in some of the negative stereotypes surrounding Blacks and their inabilities to be in science.

Regarding the participants low agreement with Pre-Encounter Self-Hatred (PSH) and Immersion-Emersion Anti-White (IEAW), the researcher also has comments regarding these findings. Some of the participants who were interviewed expressed views demonstrating that they love their Black heritage and its impact on their outward appearance and attributes. These conceptions were also expressed in their discussions of their DAST drawings of their scientists. Participants indicated that their scientists were Black, intelligent, able to overcome obstacles, and highly successful in the science field. Such attitudes are not reflective of individuals possessing agreement with PSH attitudes; supporting the results which revealed that few participants conveyed these conceptions. In addition, findings also depicted that participants expressed lowest agreement with IEAW attitudes as exhibited by the lowest mean scores on the CRIS. In addition, interview data elucidated this finding; only one participant made comments, regarding her ideas about race as a child during the interview that relayed IEAW views. None of the participants sampled expressed IEAW attitudes as their highest subscale.

Draw-a-Scientist Test & Draw-a-Scientist Test Checklist

Analysis of the participants' sketches for the Draw-a-Scientist Test (DAST) and Draw-a-Scientist Test Checklist (DAST-C) revealed a number of differences between the science majors and non-science majors concerning their perceptions of scientists. Findings exposed that the science majors completed drawings that reflected a limited, less multicultural perspective of scientists. Their illustrations primarily represented White men. As expressed in their interview findings, the science majors often drew pictures that reflected

their past or current science teachers and or professors; the majority of whom are White males and females. Science majors were less likely to draw pictures of themselves or individuals who looked like them to illustrate a scientist. For example, Pamela indicated that her scientist represented her current chemistry professor, a White male. Pamela's statement suggested the possibility that science majors have had years of exposure to scientists who were unlikely to be Blacks; their perceptions of scientists were reflections of those individuals who instructed them. These findings were counter to Rosenthal's (1993) study of science majors' and liberal arts majors'. She found that liberal arts majors were more inclined to sketch stereotypical images of scientists while science majors' representations were more diverse. She attributed her findings to science majors' exposure to the find as exhibited in their diverse examples of scientists on the DAST. The present researcher attributes this disparity in results to the population of participants in the study, all Black college students in comparison to Rosenthal's racially diverse participants.

In contrast to the science majors' drawings, the non-science majors depicted broader, more multicultural perspectives of scientists. The non-science majors were more inclined to draw images of themselves as scientists. For example, Wesley illustrated his Black male image as a ballistic scientist; Wesley is criminology major. Additionally, Lola sketched a picture of a Black woman with an afro and gold hoop earrings. She indicated that her scientist was around 40 years of age. Lola is a 31-year old who wears her hair as an afro and had on hoop earrings the day of the interview. Findings such as these suggest that the non-science majors used a variety of reference points that impacted their images of scientists. Such influences included their personal interests and characteristics, friends, family, and media (Chambers, 1983; Finson, 2003). Results surrounding influences on participants'

perceptions of scientists are consistent with data obtained by previous researchers. They also indicated that media and societal factors heavily impacts individuals' images of scientists (Barman, 1999; Chambers, 1983; Finson, 2003).

From the science majors' DAST sketches, it was interesting to find that none of the participants illustrated their scientists as a non-White male or female. Though the Multiracial female scientists represented all racial and ethnic demographics of people, none of the participants declared their scientists as being members of a racial or ethnic minority group. Again, this finding reflects that the science majors were less inclined to draw themselves or someone of their racial group as the scientist. Such results are consistent with past research assessing the race of scientists illustrated by participants completing the DAST. Previous researchers have identified that individuals stereotypically represent a scientist as a White male with limited illustrations depicting a person of color (Finson, 2003; Fung, 2002; Mason, Kahle, & Gardner, 1991; Parsons, 1997). Images sketched featuring White male scientists are observed by participants of all races; Black students were inclined to draw Caucasian men rather than Black male scientists (Finson, 2003; Parsons, 1997).

Finally, the finding that the average number of stereotypes represented by the participants was four is consistent with previous research studies. Earlier studies using the DAST to assess individuals' perceptions of scientists indicated that the number of stereotypes depicted in images increased as individuals progressed through school (Chambers, 1983; Schibeci & Sorensen, 1983). While most second-grade students illustrated two images and fifth graders expressed three or four, adults were observed to include four or five elements, similar to findings for the science majors and non-science majors in this study (Chambers, 1983; Schibeci & Sorensen, 1983). However, instances were observed when participants in

the present study depicted as few as zero elements and many as 12 stereotypes in their illustration of scientists.

Limitations & Future Research

The work presented in this study exhibited several limitations. A set of limitations pertain to the generalizability of the findings regarding the selectivity based on race of participants and institution where the study occurred. For example, the researcher incorporated purposeful sampling and only collected data from Black college students. Random sampling would have helped to improve the generalizability of the results. Though the researcher justified this restriction for participants due to the fact that Blacks are underrepresented in the sciences and factors needed to be explored to understand the low numbers, a more diverse sample of participants may produce additional findings. As such, future research should be conducted to explore aspects of White racial identity development and the impact it may have on Caucasian students' decisions to select science as a college major.

The geographic region in which the study occurred was a third limitation. Data collection was limited to Black college students in one region of the United States at one university setting. Being that the study took place in the southern area of the country, specifically at a predominately White university, findings may not be indicative of the rest of the country. For future exploration, the researcher would expand the study beyond the south to other regions as well as different academic settings. The researcher would sample students at historically Black colleges and universities as well.

A fourth drawback to the study was that the researcher was unable to recruit a large number of male participants. Therefore, data collected did not allow for inferences to be

made about the sample regarding the gender of the participants involved in the study. The sample disproportionately consisted of females; therefore, views reflected in this study primarily reflect that demographic.

Another limitation was the diversity of the sample regarding their reference group orientation. Few participants identified themselves as African American. Individuals in the sample represented those who declared their racial orientation as Black, African, West Indian - Caribbean Black, Hispanic Black, and mixed (e.g., Jamaican Black, Haitian Black). Though the development of the Cross Racial Identity Scale factored in these differences in reference group orientation, a number of the participants were born in other countries and raised under different social attitudes which may have impacted their conceptions of racial identity. Consequently, Ogbu's (1986) classification system for minorities in America needed to be addressed because the African American students (43% of the participants) represented castelike minorities (i.e., involuntary immigration to the United States) while the students from other orientations (e.g., Black, African, West Indian – Caribbean, and Hispanic Black; 57% of the participants) reflected immigrant minorities (i.e., voluntary immigration into the US) (Ogbu, 1986).

Few differences were observed in the participants' agreement with racial identity attitudes based on reference group orientation. Table 13 shows the percentage of participants from different reference group orientations and the racial identity attitude expressing their strongest agreement. For comparison, the reference orientations were separated into African American (n = 21) and Black (n = 27). Black encompasses those who self-reported their orientation as Black, African, West Indian – Caribbean Black, Hispanic Black, Mixed, or

Other. Instances when participants' average score for two subscales were the same are denoted by a slash mark between the two categories.

Table 13

Strongest racial identity attitudes by reference group orientation

African American	%	Black	%
IMCI	81	IMCI	81
IMCI/PA	9	PM	7
PA	5	PA	4
PM	5	PM	4
		PA/PM	4

One a Likert scale ranging from (1) *strongly disagree* to (7) *strongly agree*, Lily, an African – Caribbean student expressed the highest average agreement (6.4) with Pre-Encounter Assimilation attitudes. Wesley, an Black male, commented with the highest strength of agreement with Pre-Encounter Miseducation views as indicated by a score of 5.4. Iris, an African female, replied with most agreement (4.2) with Pre-Encounter Self-Hatred views. Tempest, a Jamaican – Black participant, expressed equal agreement with Pre-Encounter Assimilation and Pre-Encounter Miseducation concepts as reflected in her score of 5.2 for both subscales. Finally, Nancy, an Black participant, identified two subscales with equal levels of agreement. With a score of 5.8, she illustrated affiliation with Pre-Encounter Assimilation and Internalization Multiculturalist Inclusive attitudes.

The restriction of the participants' Grade Point Average was a fifth limitation to this study. The researcher established a limit of a 3.0 for the academic GPA for the participants. Though this designation was to account for the stereotype that Blacks are not smart enough to participate in science, the researcher acknowledges that the GPA restriction eliminated a number of students from the study who may have volunteered to participate. A sixth limitation was the nature of the interview questioning. Analysis of interview data revealed instances when the researcher used closed-ended inquires in her questioning of participants. In contrast to open-ended questioning, closed-ended inquires may influence interviewees' responses.

In addition to the limitations previously presented, using Cross' Nigrescence model as a theoretical framework has drawbacks. Though this model thoroughly details the steps through which an individual progresses along the pathway to racial identity development, it fails to describe the exact psychological transitions one experiences during the process. Finally, when using Likert type scales additional issues must be accounted. For example, some students tend to respond to Likert scales by "sitting on the fence" or selecting the neutral response if given the possibility (Hodge & Gillespie, 2003). Moreover, some researchers suggest constructing a Likert scale using an odd number of choices to "force" the respondents to have an opinion on a topic. Unfortunately, doing so may result in a participant responding to an opinion that he or she did not possess (Hodge & Gillespie, 2003).

Implications

Future Research on RID & Perceptions of Scientists

Though limitations were acknowledged for this study, findings presented a number of implications for the field of science education. Participants' racial identity development, as

assessed by the Cross Racial Identity Scale, and perceptions of scientists, as captured in their Draw-a-Scientist Test, produced relevant findings. First, factors related to the attitudes individuals accept regarding their personal racial identity development impact their interactions with others. This study demonstrated that the participants primarily possessed Internalization Multiculturalist Inclusive (IMCI) attitudes which allowed them to accept their racial identity and embrace the orientations of others. Additionally, participants did not express strong Immersion-Emersion Anti-White (IEAW) views. Instances where Black individuals strongly agree with IMCI conceptions and disagree with IEAW ideals express that they should have an internalized identity about their Black race and possess a willingness to embrace others from different racial or reference groups, especially Whites.

In addition, findings suggested that participants' perceptions of scientists were impacted by the images they encountered regarding scientists. Despite the fact that the science majors who participated in this study were Black, the majority of them accepted the image of a White male scientist and expressed these views in their drawings. This result is an issue because it supports the notion that racial stereotypes of scientists are evident and persistent in individuals' perceptions. It speaks to the fact that media influences and continued low percentages of people of color in science disciplines affect how students internalize and express their views of who is able to become a scientist. When perceptions reveal that individuals do not view Blacks as scientists, society will continue to perpetuate the stereotype that Blacks are not present or capable of being in the discipline. Consequently, findings express that the future workforce is not scientifically literature. One aspect of the nature of science and scientific literacy recognizes that science is culturally and socially embedded. As such, everyone, regardless of race, is capable of being a scientist (Lederman,

Abd-El-Khalick, Bell, & Schwartz, 2002). Findings from this study suggest that the majority of the participants do no express this conception.

Practice & Recruitment

Results from this study imply that not only is it important to assess students' racial identity and perceptions of scientists and their potential impact in the classroom, it is also vital to evaluate the research and practice of teachers and administrators. The fact that science majors primarily represented illustrations of scientists as White men which reflected their experiences with science teachers and professors indicates that the teaching profession needs racial diversification. Few participants in the study expressed that they had been educated by a Black science teacher or professor; they indicated that their science instructors were mostly White males and females. Additionally, the racial identity development of Black and White educators may have an impact on how they develop or restrict their interactions with students, select instructional practices, determine grading procedures, and implement classroom management techniques. Finally, results from this study express that Black individuals may possess inadequate ideals and information regarding the history due to years of miseducation in American schools. As a result, educators and parents need to make a concerned effort to provide students with accurate and comprehensive knowledge of Black history, outside of Black History Month. Such instruction will help all students develop an appreciation for and understanding of the achievements of Blacks**.**

LIST OF REFERENCES

Abrams, L., & Trusty, J. (2004). African Americans' racial identity and socially desirable responding: An empirical model. *Journal of Counseling & Development, 82*, 365-374.

Atwater, M. M. (2000). Equity for Black Americans in precollege science. *Science Education, 84*(2), 154-179.

Bamberger, G. (1987). *Occupational choice: The role of undergraduate education.* Unpublished Ph.D. Dissertation, University of Chicago, Chicago.

Barlow, A., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 41*(9), 861-881.

Barman, C. R. (1999). Students' views about scientists and school science: Engaging K-8 teachers in a national study. *Journal of Science Teacher Education, 10*(1), 43-54.

Barton, A. C., Hindin, T. J., Contento, I. R., Trudeau, M., Yang, K., Hagiwara, S., et al. (2001). Underprivileged mothers' perspectives on science. *Journal of Research in Science Teaching, 38*(6), 688-711.

Barton, A. C., Koch, P. D., Contento, I. R., & Hagiwara, S. (2005). From global sustainability to inclusion education: Understanding urban children's ideas about the food system. *International Journal of Science Education 27*(10), 1163-1186.

Basalla, G. (1976). Pop science: The depiction of science in popular culture. In G. Holton & W. A. Blanpied (Eds.), *Science and its public* (pp. 261-278). Dordrecht-Holland: Reidel Publishing Co.

Basu, S. J., & Barton, A. C. (2005). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching*, 1-24.

Bogdan, R. C., & Bilken, S. K. (1998). *Qualitative research in education: An introduction to theory and methods* (3rd ed.). Boston, MA: Allyn and Bacon.

Boykin, A. (1983). The academic performance of Afro-American children. In J. Spencer (Ed.), *Achievement and achievement motives* (pp. 321-371). San Francisco: W. Freeman.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching, 38*(8), 965-980.

Brown, B. A. (2004). Discursive Identity: Assimilation into the culture of science and its implications for minority students. *Journal of Research in Science Teaching, 41*(8), 810-834.

Brown, B. A. (2005). The politics of public discourse: Discourse, identity, and African Americans in science education. *The Journal of Negro Education, 56*(2&3), 205-220.

Brown, B. A. (2006). "It isn't no slang that can be said about this stuff": Language, identity, and appropriating science discourse. *Journal of Research in Science Teaching, 43*(1), 96-126.

Carter, R. T., & Helms, J. E. (1988). The relationship between racial identity attitudes and social class. *The Journal of Negro Education, 57*(1), 22-30.

Chambers, D. W. (1983). Stereotypic Images of the scientist: The Draw-a-Scientist Test. *Science Education, 67*(2), 255-265.

Chang, D. F., & Sue, S. (2003). The effects of race and problem type on teachers' assessments of student behavior. *Journal of Consulting and Clinical Psychology, 71*(2), 235-242.

Cokley, K. O., & Helm, K. (2001). Testing the construct validity scores on the Multidimensional Inventory of Black Identity. *Measurement & Evaluation in Counseling & Development, 34*, 80-95.

Cross, W. E., Jr. (1971). The Negro-to-Black conversion experience. *Black World*, 13-27.

Cross, W. E., Jr. (1991). *Shades of Black: Diversity in African-American identity.* Philadelphia: Temple University Press.

Cross, W. E., Jr. (1995). The psychology of Nigrescence: Revising the Cross Model. In J. G. Ponterotto, J. M. Casas, L. A. Suzuki & C. M. Alexander (Eds.), *Handbook of multicultural counseling* Thousand Oaks, CA: Sage.

Cross, W. E., Jr, & Vandiver, B. J. (2001). Nigrescence theory and measurement: Introducing the Cross Racial Identity Scale (CRIS). In J. G. Ponterotto, J. M. Casas, L. M. Suzuki & C. M. Alexander (Eds.), *Handbook of Multicultural Counseling* (2nd ed., pp. 371-393). Thousand Oaks: CA: Sage.

Duru, M., & Mingat, A. (1979). Comportement des bacheliers: modele de choix de disciplines (High school graduates behaviour, model of the choice of subject when entering university). *Consommation, 26*(3-4), 245-262.

Erickson, E. (1959/1980). *Identity and the Life Cycle*. New York: Norton.

Fadigan, K. A., & Hammrich, P. L. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Journal of Research in Science Teaching 41*(8), 835-860.

Finson, K. D. (2003). Applicability of the DAST-C to the images of scientists drawn by students of different racial groups. *Journal of Elementary Science Education, 15*(1), 15-26.

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the draw-a-scientist test. *School Science and Mathematics, 95*, 195-205.

Fung, Y. Y. H. (2002). A comparative study of primary and secondary school students' images of scientists. *Research in Science & Technological Education, 20*(2), 199-212.

Fusco, D. (2001). Creating relevant science through urban planning and gardening. *Journal of Research in Science Teaching, 38*(8), 860-877.

Fusco, D., & Barton, A. C. (2001). Representing student achievements in science. *Journal of Research in Science Teaching, 38*(3), 337-354.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational research: An introduction*. Boston, MA: Pearson Education, Inc.

Gilbert, A., & Yerrick, R. (2001). Same school, separate worlds: A sociocultural study of identity, resistance, and negotiation in a rural, lower track science classroom. *Journal of Research in Science Teaching, 38*(5), 574-598.

Good, T. L. (1987). Two decades of research on teacher expectations: Findings and future directions. *Journal of Teacher Education, 38*, 32-47.

Goodlad, J., & Oakes, J. (1998). We must offer equal access to knowledge. *Educational Leadership, 45*(5), 16-22.

Green, P. (1999). Separate and still unequal: Legal challenges to school tracking and ability grouping in America's public schools. In L. Parker, D. Deyhle & S. Villeras (Eds.), *Race is...Race isn't: Critical race theory and qualitative studies in education* (pp. 231-250). Boulder, CO: Westview Press.

Griffard, P. B., & Wandersee, J. H. (1999). Challenges to meaningful learning in African American females at an urban science high school. *International Journal of Science Education, 21*(6), 611-632.

Helms, J. (1999). Another meta-analysis of the White racial identity attitude scale's Cronbach Alphas: Implications for validity. *Measurement & Evaluation in Counseling & Development, 32*(3), 122-138.

Helms, J. (Ed.). (1990). *Black and White racial identity: Theory, research, and practice*. Westport, CT: Greenwood Press.

Hodge, D., & Gillespie, D. (2003). Phrase completions: An alternative to Likert scales. *Social Work Research, 27*(1), 45-55.

Jayaratne, T. E., Thomas, N. G., & Trautmann, M. (2003). Intervention program to keep girls in the science pipeline: Outcome differences by ethnic status. *Journal of Research in Science Teaching, 40*(4), 393-414.

Lederman, N. G., Abd-El-Khalick, F., Bell, R., & Schwartz, R. S. (2002). Toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39*(6), 497-521.

Lewis, B. F., & Collins, A. (2001). Interpretive investigation of the science-related career decisions of three African American college students. *Journal of Research in Science Teaching, 38*(5), 599-621.

Lockett, C. T., & Harrell, J. P. (2003). Racial identity, self-esteem, and academic achievement: Too much interpretation, too little supporting data. *Journal of Black Psychology, 29*(3), 325-336.

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

Mason, C. L., Kahle, J. B., & Gardner, A. L. (1991). Draw-a-Scientist Test: Future implications. *School Science and Mathematics, 91*(5), 193-198.

Maton, K., Hrabowski, F., & Schmitt, C. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching, 37*(7), 629-654.

Mead, M., & Metraux, R. (1957). The image of the scientist among high school students: A pilot study. *Science Education, 126*(3269), 383-390.

Miller, D. B. (1999). Racial socialization and racial identity: Can they promote resiliency for African American adolescents? *Adolescence, 34*(135), 493-501.

Montmarquette, C., Cannings, K., & Mahseredjian, S. (2001). How do young people choose college majors? *Economics of Education Review, 21*(6), 543-556.

Moreland, C., & Leach, M. M. (2001). The relationship between Black racial identity and moral development. *Journal of Black Psychology, 27*(3), 255-271.

NCES. (2006). Retrieved August 1, 2006 from http://nces.ed.gov/index.asp.

Neal, L. V. I., McCray, A. D., Webb-Johnson, G., & Bridgest, S. T. (2003). The effects of African American movement styles on teachers' perceptions and reactions. *The Journal of Special Education, 37*(1), 49–57.

NSF. (2006). Retrieved August 4, 2006, from http://www.nsf.gov/

Ogbu, J. U. (1986). Consequences of the American caste system. In U. Neisser (Ed.), *The school achievement of minority children* (pp. 19-56). Hillsdale: NJ: Lawrence Erlbaum Associates, Inc.

Parham, T. A., & Helms, J. E. (1985). Relation of racial identity attitudes to self-actualization and affective states in Black students. *Journal of Counseling Psychology, 32*, 432-440.

Parsons, E. C. (1997). Black high school females' images of the scientist: Expression of culture. *Journal of Research in Science Teaching, 34*(7), 745-768.

Parsons, E. C., Travis, C., & Simpson, J. S. (2005). The Black cultural ethos, students' instructional context preferences, and student achievement: An examination of culturally congruent science instruction in the eighth grade classes of one African American and one Euro-American teacher. *The Journal of Negro Education, 56*(2&3), 183-203.

Phinney, J. (1989). Stages of ethnic identity in minority group adolescents. *Journal of Early Adolescence, 9*, 34-49.

Rascoe, B., & Atwater, M. M. (2004). Black males' self-perceptions of academic ability and gifted potential in advanced science classes. *Journal of Research in Science Teaching, 42*(8), 888-911.

Rosenthal, D. B. (1993). Images of scientists: A comparison of biology and liberal studies majors. *School Science and Mathematics, 93*(4), 212-216.

Rowley, S. J., Chavous, T. M., & Cooke, D. Y. (2003). A person-centered approach to African-American gender differences in racial ideology. *Self and Identity, 2*, 287-306.

Rubin, E., Bar, V., & Cohen, A. (2003). The images of scientists and science among Hebrew- and Arabic-speaking pre-service teachers in Israel. *International Journal of Science Education, 25*(7), 821-846.

Russell, M. L. (2005). Untapped talent and unlimited potential: African American students and the science pipeline. *Negro Educational Review, 56*(2&3), 167-182.

Russell, M. L., & Atwater, M. M. (2004). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominantly White institution. *Journal of Research in Science Teaching, 42*(6), 691-715.

Schibeci, R. A., & Sorensen, I. (1983). Elementary school children's perceptions of scientist. *School Science and Mathematics, 83*(1), 14-20.

Scott, L. D., Jr. (2003). The relation of racial identity and racial socialization to coping with discrimination among African American adolescents. *Journal of Black Psychology, 33*(4), 520-538.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38*(9), 1000-1014.

Seller, R. M., Rowley, S. A., Chavous, T. M., Shelton, J. N., & Smith, M. A. (1997). Multidimensional Inventory of Black Identity: A preliminary investigation of reliability and construct validity. *Journal of Personality and Social Psychology, 73*, 805-815.

Seyfried, S. F. (1998). Academic achievement of African American preadolescents: The influence of teacher perceptions. *American Journal of Community Psychology, 26*(3), 381-402.

Songer, N., Lee, H.-S., & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching, 39*(2), 128-150.

Tate, W. F. (2001). Science Education as a Civil Right: Urban schools and opportunity-to-learn considerations. *Journal of Research in Science Teaching, 38*(9), 1015-1028.

Tatum, B. D. (2004). Family life and school experience: Factors in the racial identity development of Black youth in White communities. *Journal of Social Issues, 60*(1), 117-135.

Thomas, A. J., & Speight, S. L. (1999). Racial identity and racial socialization attitudes of African American parents. *Journal of Black Psychology, 25*(2), 152-170.

Thompson, V. L. S., & Akbar, M. (2003). The understanding of race and the construction of African American identity. *The Western Journal of Black Studies, 27*(2), 80-88.

Thornton, M. C. (1997). Strategies of racial socialization among Black parents: Mainstream, minority, and cultural messages. In R. J. Taylor, J. S. Jackson & L. M. Chatters (Eds.), *Family life in Black America* (pp. 201-215). Thousand Oaks, CA: Sage.

Tobin, K., Roth, W.-M., & Zimmermann, A. (2001). Learning to teach science in urban schools. *Journal of Research in Science Teaching, 38*(8), 941-964.

Tucker, C. M., & Herman, K. C. (2002). Using culturally sensitive theories and research to meet the academic needs of low-income African American children. *American Psychologist, 57*(10), 762-773.

Tucker, C. M., Porter, T., Reinke, W. M., Herman, K. C., Ivery, P. D., Mack, C. E., et al. (2005). Promoting teacher efficacy for working with culturally diverse students. *Preventing School Failure, 50*(1), 29-34.

USCB. (2006). *United States Census 2000*. Retrieved August 1, 2006. from http://www.census.gov/main/www/cen2000.html.

Vandiver, B. J., Fhagen-Smith, P. E., Cokley, K. O., Cross, W. E., Jr., & Worrell, F. C. (2001). Cross's Nigrescence Model: From theory to scale to theory. *Journal of Multicultural Counseling & Development, 29*(3).

Vinson, T. S., & Neimeyer, G. J. (2000). The relationship between racial identity development and multicultural counseling competency. *Journal of Multicultural Counseling & Development, 28*(3).

Winston, C. E., Rice, D. W., Bradshaw, B. J., Lloyd, D., Harris, L. T., Burford, T. I., et al. (2004). Science success, narrative theories of personality, and race self complexity: Is race represented in the identity construction of African American adolescents? *New Directions for Child and Adolescent Development, 106*, 55-76.

Worrell, F. C., William, K., Jr., & Vandiver, B. J. (2001). Nigrescence theory: Current status and challenges for the future. *Journal of Multicultural Counseling & Development, 29*(3).

APPENDICES

Appendix A

Cross Racial Identity Scale (CRIS)

Code: _____

CROSS SOCIAL ATTITUDE SCALE

Beverly J. Vandiver, William E. Cross, Jr., Peony E. Fhagen-Smith, Frank C. Worrell, Janet K. Swim, & Leon D. Caldwell.

Section I

1. Male ☐ Female ☐

2. How old are you? _____

3. Please indicate your ethnic background **by circling the answer** that applies to you. Choose **only one** category.

a. African	e. Hispanic Black
b. African-American	f. Mixed _____/_____
c. Black	g. Other _____
d. West Indian/Caribbean Black	

4. If you are **currently** a student, are you a high schooler ☐ an undergraduate ☐ or a graduate student ☐?

5. Name of School: _____ 5b. City where school is located: _____

6. What is your semester standing in the school you listed in #5? _____

7. What is the racial composition of the school listed in #5? Mostly Black ☐ Mixed ☐ Mostly White ☐

8. What is your current grade point average? _____

9. If you are attending college, what is your major? _____

10. If you are **no longer a student**, what is the highest education level obtained? Circle one.

a. Elementary school	d. Business or trade school	g. Bachelor's or four-year degree
b. Some high school	e. Some college	h. Some graduate/professional school
c. High school diploma/equivalent	f. Associate or two-year degree	i. Graduate or professional degree

11. If you are **no longer a student**, what is your current occupation? _____

12. What religious affiliation do you hold? _____

13. How often do you attend religious services? Seldom ☐ Sometimes ☐ Often ☐

14. How important is your religion to you? Not Important ☐ Somewhat Important ☐ Very Important ☐

15. What is the best estimate of your/your family's yearly income before taxes? Circle "Y" for yours and "F" for family.

a. Less than $10,000	Y	F	d. Between $30,000 and $40,000	Y	F
b. Between $10,000 and $20,000	Y	F	e. Between $40,000 and $60,000	Y	F
c. Between $20,000 and $30,000	Y	F	f. Over $60,000	Y	F

16. How would you describe the primary community in which you were raised?

Rural ☐ Suburban ☐ Urban ☐ Other _____

17. What is the racial composition of the community listed in #16? Mostly Black ☐ Mixed ☐ Mostly White ☐

18. Are you a United States citizen ☐ a permanent resident of the US ☐ or Other ☐ _____?

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Code: _____

19. How many ethnic organizations do you belong to? 1 2 3 4 5 5+

20. What is the highest education level obtained by your mother (or female guardian) and father (or male guardian)? For mother, circle the "M" in the appropriate box; for father, circle the "F."

a. Elementary school	M	F	f. Associate or two-year degree	M	F
b. Some high school	M	F	g. Bachelor's or four-year degree	M	F
c. High school diploma or equivalent	M	F	h. Some graduate or professional school	M	F
d. Business or trade school	M	F	i. Graduate or professional degree	M	F
e. Some college	M	F			

21. How would you describe your family's socioeconomic status?

Poor ☐ Working Class ☐ Middle Class ☐ Upper Middle ☐ Wealthy ☐

22. How would you describe your current physical health?

Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good ☐

23. How would you describe your current mental health?

Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good ☐

Section II

Instructions: Read each item and indicate to what degree it reflects your own thoughts and feelings, using the 7-point scale below. There are no right or wrong answers. Base your responses on your opinion at the present time. **To ensure that your answers can be used, please respond to the statements as written**, and place your numerical response on the line provided to the left of each question.

1	2	3	4	5	6	7
strongly disagree	disagree	somewhat disagree	neither agree nor disagree	somewhat agree	agree	strongly agree

_____1. As an African American, life in America is good for me.

_____2. I think of myself primarily as an American, and seldom as a member of a racial group.

_____3. Too many Blacks "glamorize" the drug trade and fail to see opportunities that don't involve crime.

_____4. I go through periods when I am down on myself because I am Black.

_____5. As a multiculturalist, I am connected to many groups (Hispanics, Asian-Americans, Whites, Jews, gays & lesbians, etc.).

_____6. I have a strong feeling of hatred and disdain for all White people.

_____7. I see and think about things from an Afrocentric perspective.

Code: _____

1	2	3	4	5	6	7
strongly disagree	disagree	somewhat disagree	neither agree nor disagree	somewhat agree	agree	strongly agree

_____8. When I walk into a room, I always take note of the racial make-up of the people around me.

_____9. I am not so much a member of a racial group, as I am an American.

_____10. I sometimes struggle with negative feelings about being Black.

_____11. My relationship with God plays an important role in my life.

_____12. Blacks place more emphasis on having a good time than on hard work.

_____13. I believe that only those Black people who accept an Afrocentric perspective can truly solve the race problem in America.

_____14. I hate the White community and all that it represents.

_____15. When I have a chance to make a new friend, issues of race and ethnicity seldom play a role in who that person might be.

_____16. I believe it is important to have both a Black identity and a multicultural perspective, which is inclusive of everyone (e.g., Asians, Latinos, gays & lesbians, Jews, Whites, etc.).

_____17. When I look in the mirror at my Black image, sometimes I do not feel good about what I see.

_____18. If I had to put a label on my identity, it would be "American," and not African American.

_____19. When I read the newspaper or a magazine, I always look for articles and stories that deal with race and ethnic issues.

_____20. Many African Americans are too lazy to see opportunities that are right in front of them.

_____21. As far as I am concerned, affirmative action will be needed for a long time.

_____22. Black people cannot truly be free until our daily lives are guided by Afrocentric values and principles.

_____23. White people should be destroyed.

_____24. I embrace my own Black identity, but I also respect and celebrate the cultural identities of other groups (e.g., Native Americans, Whites, Latinos, Jews, Asian Americans, gays & lesbians, etc.).

Code: _____

1	2	3	4	5	6	7
strongly disagree	disagree	somewhat disagree	neither agree nor disagree	somewhat agree	agree	strongly agree

_____25. Privately, I sometimes have negative feelings about being Black.

_____26. If I had to put myself into categories, first I would say I am an American, and second I am a member of a racial group.

_____27. My feelings and thoughts about God are very important to me.

_____28. African Americans are too quick to turn to crime to solve their problems.

_____29. When I have a chance to decorate a room, I tend to select pictures, posters, or works of art that express strong racial-cultural themes.

_____30. I hate White people.

_____31. I respect the ideas that other Black people hold, but I believe that the best way to solve our problems is to think Afrocentrically.

_____32. When I vote in an election, the first thing I think about is the candidate's record on racial and cultural issues.

_____33. I believe it is important to have both a Black identity and a multicultural perspective, because this connects me to other groups (Hispanics, Asian-Americans, Whites, Jews, gays & lesbians, etc.).

_____34. I have developed an identity that stresses my experiences as an American more than my experiences as a member of a racial group.

_____35. During a typical week in my life, I think about racial and cultural issues many, many times.

_____36. Blacks place too much importance on racial protest and not enough on hard work and education.

_____37. Black people will never be free until we embrace an Afrocentric perspective.

_____38. My negative feelings toward White people are very intense.

_____39. I sometimes have negative feelings about being Black.

_____40. As a multiculturalist, it is important for me to be connected with individuals from all cultural backgrounds (Latinos, gays & lesbians, Jews, Native Americans, Asian-Americans, etc.).

Appendix B

Questions Composing Each CRIS Subscale

Pre-Encounter	
Assimilation (PA)	2, 9, 18, 26, 34
Miseducation (PM)	3, 12, 20, 28, 36
Self-Hatred (PSH)	4, 10, 17, 25, 39
Immersion – Emersion	
Anti-White (IEAW)	6, 14, 23, 30, 38
Internalization	
Afrocentricity (IA)	7, 13, 22, 31, 37
Multiculturalist Inclusive (IMCI)	5, 16, 24, 33, 40
Filler Items: not used in scoring	1, 8, 11, 15, 19, 21, 27, 29, 32, 35

Appendix C

Draw-a-Scientist Test Checklist (DAST-C)

INSTRUCTIONS FOR USE

Each item on the checklist represents one stereotypical image characteristic. The items on the checklist have been derived from reviews of literature, primarily the work of Chambers (1983) and Mead and Metraux (1957).The "upper" checklist items (items #1-7) relate specifically to those characteristics discussed by Chambers (1983) and others' work and/or items representing stereotypes that have emerged (in science education literature, at least) as concerns over the past few years. Item #16 is an open-ended item provided for specific details not indicated in items #1-15, such as type of scientist (chemist, biologist, etc.), facial expressions, hair style, etc.

1. Use one checklist sheet per subject drawing.
2. Place a maximum of only one mark per blank on the checklist.
3. If multiple images are present in the drawing (such as two of more scientific instruments), count the drawing as having ONE, NOT TWO.
4. If multiple images of persons appear, such as a group of scientists, mark for any and all stereotypical images that are present. (Note: If one member of the group is male and one is female, record a mark in the "male gender" blank but note the presence of the female in item #16.)
5. For item #4, the sub-category blanks for "size" are not counted into the checklist score. These subcategorical items are for more detailed analysis of the images and do not in and of themselves represent stereotypical images. The same applies to subcategory items #4b and #6a.
6. Any relevant captions (item #7) should be written down in item #16 if room doesn't allow under #7 itself.
7. TOTALS:

A. Add the number of marks for the upper checklist and record in the box at the checklist's lower left corner. REMEMBER to add ONLY ONE mark per blank.

B. Add the number of marks for the lower checklist and record in the box at the checklist's lower left corner. REMEMBER to add ONLY ONE mark per blank.

C. Add the upper and lower checklist scores for the TOTAL SCORE, and record on the blank at the bottom right corner.

8. ANALYSIS:

A. You may select to use the TOTAL SCORE for analysis purposes or you may select to use only the upper (or lower) checklist scores. Use of TOTAL SCORE provides for more variance than use of only half scores.

B. The checklist has been used in a pretest-posttest format with ANCOVA procedures. Other analytical procedures will likely work as well.

C. Report other data (such as those in item #16) as percentages of drawings possessing specific images.

Chambers, D.W. (1983). Stereotypic images of the scientist: The Draw-A-Scientist Test. Science Education, 67(2), 255-265.

Mead, M., & Metraux, R. (1957). The image of the scientist among high school students: A pilot study. Science, 126(3269), 384-390.

RATER: (_____) STUDENT NAME: (_____) ASSESSMENT 1 2 3

DRAW-A-SCIENTIST CHECKLIST **Participant Code _____**

1. Lab Coat (usually but not necessarily white) _____

2. Eyeglasses _____

3. Facial Growth of Hair (beards, mustaches, abnormally long sideburns) _____

4. Symbols of Research (scientific instruments, lab equipment of any kind) _____

   a. Size of Scientific Instruments/Equipment in Relation to Scientist:

      1. Small _____
      2. Normal _____
      3. Large _____

   b. Types of Scientific Instruments/Equipment:

5. Symbols of Knowledge (principally books, filing cabinets, clipboards, pens in pockets, etc.) _____

6. Technology (the "products" of science) _____

   a. Types of Technology (tv, telephone, missiles, computers, etc.):

7. Relevant Captions (formulae, taxonomic classification, the "eureka!" syndrome) _____

ALTERNATIVE IMAGES:

8. Male Gender _____

9. Caucasian _____

10. Indications of Danger _____

11. Presence of Light Bulbs _____

12. Mythic Stereotypes (Frankenstein creatures, Jekyll/Hyde figures, "Mad/Crazed") _____

13. Indications of Secrecy (signs or warnings of "Private," "Keep Out," "Do Not Enter," "Go Away," "Top Secret," etc.) _____

14. Scientist Doing Work Indoors _____

15. Middle Aged or Elderly Scientist _____

NOTE: Several indicators of the same type in a single drawing count as ONE indicator (eg. Two scientists each with eyeglasses counts as one, not two).

16. Open Comments (dress items,neckties/necklaces, hair style/grooming, smile or frown, stoic expression, bubbling liquids, smoke/steam, type of scientist -- chemist, physicist, etc., -- etc.):

UPPER / LOWER SCORE:

_____ / _____

TOTAL SCORE: _____

Appendix D

Interview Guide

Questions Related to the Draw-a-Scientist Test

1. Describe the scientist you represented in your picture.

2. What is your scientists' race and/or ethnic orientation?

3. What is your scientist doing?

4. Describe your scientists' personal life.
    a. Where does he or she live?
    b. Does your scientist have a family?

5. Describe your scientists' job.
    a. Where does he or she work?
    b. What does he or she do?

6. Does your scientist like his or her job?

7. What types of personality traits does your scientist have?

8. What educational background does your scientist possess?

9. Does your scientist have any similarities or differences to you? If so, please describe.

10. Can you tell me of any famous White scientists?

11. Can you tell me of any famous African American scientists?

Questions Related to Selection of Science as a College Major

1. What is your major in school?
    a. If science, continue with following questions.
    b. If not science, also ask questions in underlined.
    c. Why did you select that major?
    d. Did you ever consider science as a major?
    e. Does your major use science?

2. What are you thoughts about science?

3. What experiences did you have in science when you were in elementary, middle, and high school?

4. What types of grades have you received in science?

5. What types of class and activities did you participate in related to science?

6. What factors lead to your decision to select science as a college major?

7. Do you think science is a field for African Americans to pursue?

8. Do you think African Americans can be successful in science?

Questions Related to Racial Identity Development

1. Describe your childhood for me.

2. When you were growing up, did your parents talk to you about race?

    a. If so, what types of conversations did you have? How did these discussions make you feel?
    b. If not, how did you learn about race?

3. Did you experience any problems in science because of your race?
    a. If so, please describe.
    b. If not, do you know of anyone who did?
4. Do you think science is a field open to people of all races or reserved for a select group? If so, why do you hold this opinion?

Appendix E

DAST Image of White Male Scientist

Appendix F

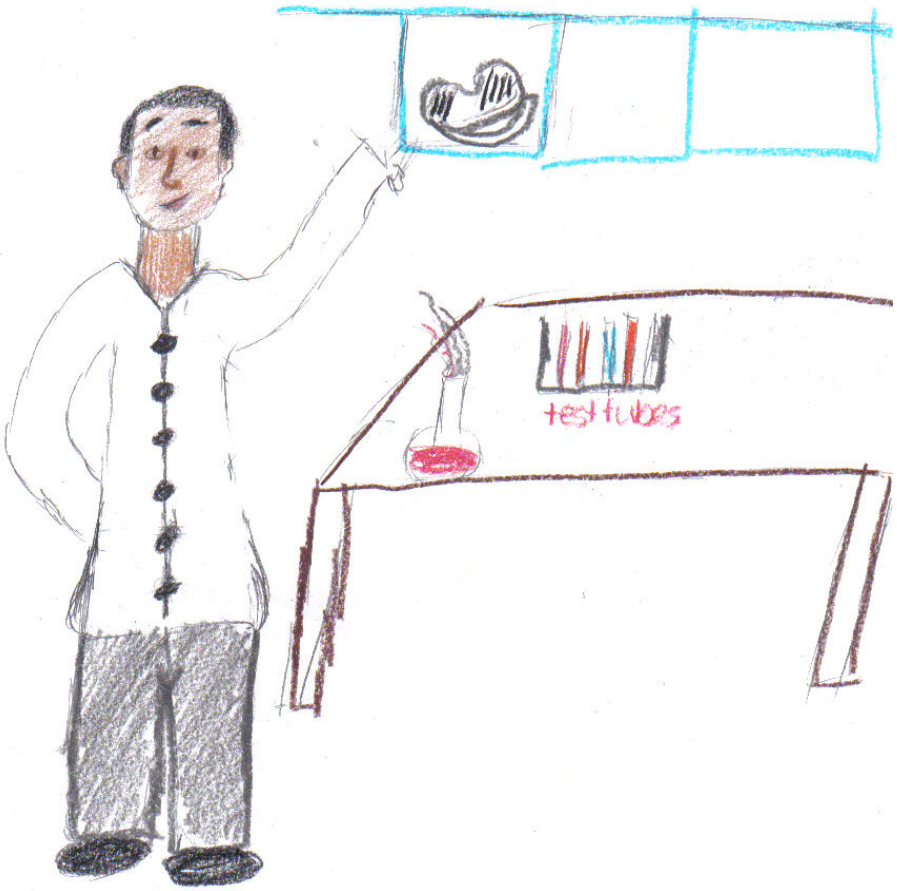
DAST Image of White Female Scientist

Appendix G

DAST Image of Non-White Female Scientist

Appendix H

DAST Image of Non-White Male Scientist



Appendix I

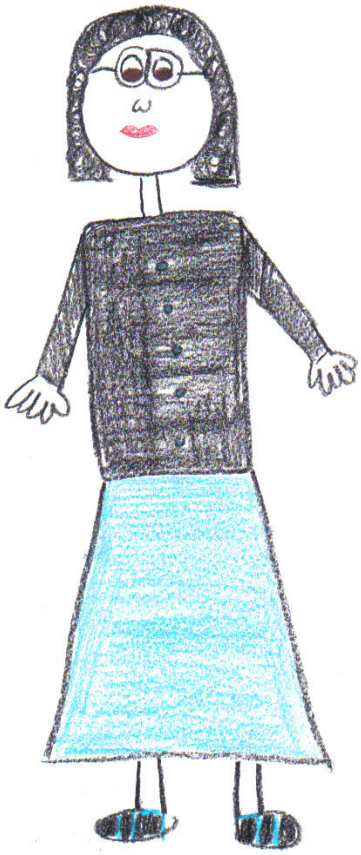
DAST Image of Multi-racial, Dual-Gender Scientist

Appendix J

DAST Image of Indeterminate Male Scientist

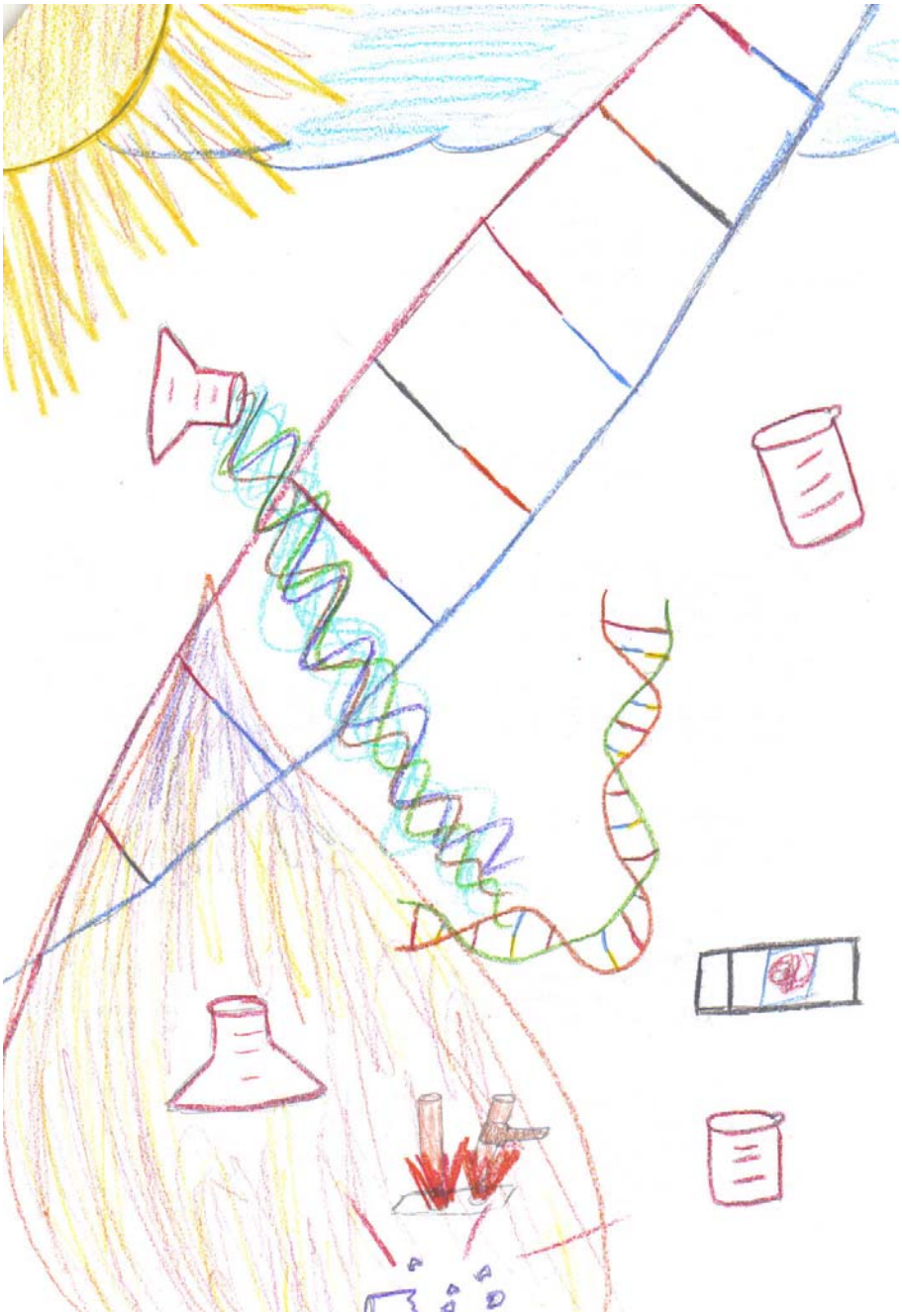
Appendix K

DAST Image of Indeterminate Female Scientist



Appendix L

DAST Image of Non-Human Scientist



Appendix M

DAST Image of Non-Human Scientist

CHAPTER FIVE: JOURNAL-READY MANUSCRIPT

Science Majors and Non-Science Majors: Black College Students' Racial Identity Profiles

Crystall S. Gomillion

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University of North Carolina at Chapel Hill

Abstract

This study evaluated the racial identity profiles exhibited by college students based on their selection of major. From a purposeful sample of 48 Black participants ranging from college freshmen to seniors, the researcher examined the racial identity attitudes expressed by science majors (n = 17) and non-science majors (n = 31). Data were collected from all participants using the Cross Racial Identity Scale (CRIS), an instrument developed to evaluate six subscales for Black racial identity attitudes, and one-on-one, semi-structured interviews with 14 volunteers. Results from independent samples tests for the CRIS revealed that few differences existed in the racial identity profiles of science majors and non-science majors; both groups primarily agreed with statements reflective of the Internalization Multiculturalist Inclusive (IMCI) subscale and disagreed with the Immersion-Emersion Anti-White (IEAW) subscale.

Science Majors and Non-Science Majors: Black College Students' Racial Identity Profiles

While the scientific enterprise expands and demands the skills of a scientifically literate workforce, the racial demographics of people participating in science careers continue to represent Caucasian[6] male individuals. Nationally, reform efforts in science education have attempted to address the disparities that exist between Black and White students regarding divergences in their enrollment and participation in science course (K-12), identification of science as a college major, and selection of science as a career endeavor (Atwater, 2000; Seiler, 2001).

In 2002, the United States Census Bureau publicized data which revealed that Blacks represented 12.3% of the population and Whites consisted of 75.6% (USCB, 2006). However, information pertaining to the racial demographics of doctoral scientists for 2001 misaligned with population expectations. Of the 656,030 scientists, Black only accounted for 2.4% while Caucasian Americans represented 80% of the group (National Center for Education Statistic-NCES, 2006). In addition to attainment of science careers by Blacks and Whites, disparities such as these are also observed at the high school through college levels. Specifically, differences exist in the percentages of students enrolling in science courses and obtaining science degrees.

As students progress through high school and determine their academic course, research reveals that fewer Blacks enroll in advanced science courses. In part, their restricted selection of higher-level science courses is hindered by their low representation in the rigorous mathematical prerequisites. Data revealed that in 1998, 72.5% of Black pupils and

[6] The terms Caucasian and White are used interchangeably throughout.

77.7% of White students enrolled in Geometry. However, only 6.6% of Blacks and 12.1% of Whites pursued calculus, an advanced math course (NCES, 2006). Inequalities in trends are also observed at the collegiate level.

In 2001, the National Science Foundation reported that of the bachelor's degrees conferred to students in science-related disciplines, 67.7% were awarded to Caucasian graduates while only 8.1% were Black (NSF, 2006). Additionally, in 1998, 5.7% of the master's level science degrees earned were represented by Blacks while 74.6% were conferred to Whites (NSF, 2006). Due to the low attainment of science and related degrees, Blacks are unable to endeavor into careers and represent a viable demographic in the science workforce; a factor which limits the values, views, and approaches of the discipline to those of mainstream, White America.

Science education researchers have examined factors that impact the chasm that exists between Black and Caucasian students. Research has revealed that several factors influence the low percentages of Blacks in high school science courses, college majors, and science careers. Such influences include the impediment of tracking on minority student matriculation (Green, 1999; Winston et al., 2004) (Goodlad & Oakes, 1998; Green, 1999; Luft, 1998; Tate, 2001); impact of low teacher expectations for Black students success (Chang & Sue, 2003; Neal, McCray, Webb-Johnson, & Bridgest, 2003; Rascoe & Atwater, 2004; Tobin, Roth, & Zimmermann, 2001); authority of educator content knowledge and instructional practices on Black students' views of school (Songer, Lee, & Kam, 2002; Tate, 2001); influence of parental views on their children's academic interests (Barton et al., 2001; Fusco, 2001; Fusco & Barton, 2001; Luft, 1998); hindrance of stereotypic images of scientists perceived by students (Chambers, 1983; Parsons, 1997; Rubin, Bar, & Cohen,

2003); and persistence of negative self-perceptions held by Black pupils regarding their abilities in science (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Brown, 2006; Luft, 1998; Seiler, 2001).

Though previous research has identified the aforementioned factors, few studies have explored the impact of racial identity development (RID) on Black college students' selection of science as a college major. Specifically, this study used the Cross Racial Identity Scale (CRIS) and one-on-one, semi-structured interviews to addresses the following questions: What are the racial identity profiles of Black college students majoring in science? What are the racial identity profiles of Black college students majoring in non-science fields? The researcher believed that differences would exist between the racial identity profiles of science majors and non-science majors. It was hypothesized that science majors would exhibit greatest agreement with RID attitudes reflected in the Internalization Multiculturalist Inclusive (IMCI) subscale and least agreement with Pre-Encounter Assimilation (PA) views. In contrast, it was predicted that non-science majors would express strong agreement with PA ideals and low agreement with IMCI conceptions.

Overview of Racial Identity Literature

Erikson (1968) was one of the principle researchers to study identity formation. In his work, he postulated eight stages through which a person progresses over a lifetime along the pathway to discovering his or her identity. Theories surrounding racial identity development have built upon Erikson's work. Specifically, Cross (1971; 1991; 2001) posited his Nigrescence[7] theory which outlined the racial identity development for Blacks along their journey from a mainstream, White identity to one that is Afrocentric or Black-focused (Cross, 1971, , 1991). The Nigrescence model details five stages through which a person

[7] Nigrescence refers to the process of "becoming Black-oriented."

advances: Pre-Encounter, Encounter, Immersion - Emersion, Internalization, and Internalization - Commitment (Cross, 1995; Helms, 1999; Worrell, William, & Vandiver, 2001).

The Pre-encounter stage of the identity model encompasses three attitude clusters exhibited by Blacks at this level: Assimilation, Miseducation, and Anti-Black (self-hatred) (Cross, 1991). Assimilation depicts a person who does not possess prominence for race; he or she considers his or her reference group orientation as being purely American. Miseducation attitudes involve an individual who has been inadequately educated in American society and has accepted inaccurate information regarding Blacks and Black history. A person with Miseducation views often agrees with negative stereotypes of Blacks perpetuated in society (Cross, 1991). The Anti-Black attitude cluster describes a person who demonstrates conceptions of self-hatred and feels inadequate because he or she is Black. As a result, the individual elects to separate him or herself from Black culture (Cross, 1991; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). The Encounter stage occurs when an individual is confronted with an unpleasant event which prompts him or her to re-evaluate previously held beliefs regarding race (Lockett & Harrell, 2003; Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001; Worrell, William, & Vandiver, 2001). This event is often racist or discriminatory and causes their person to examine his or her previous acceptance of White cultural values (Cross, 1971; 1991).

After experiencing an encounter event, an individual may regress back to their Pre-Encounter racial identity or proceed to the Immersion – Emersion stage (Cross, 1971). Immersion – Emersion is marked by a period of transition during which the individuals begins to explore his or her new racial identity. This stage is delineated into two separate

identity clusters: 1) Intense Black Involvement, composed of individuals possessing the view that everything Black or Afrocentric is good, and 2) Anti-White, the notion that all aspects related to White or Eurocentric culture are evil (Cross, 1991). Upon determining which course of action one chooses to follow, he or she progresses to the Internalization stage. Internalization represents the period during which an individual reaches a humanistic level of acceptance for his or her Black racial identity. Internalization is marked by three ideologies: Nationalism (strives for Black empowerment, economic independence, and an increased need for awareness of Black history and culture); Biculturalism (acceptance of the positive aspects of being both Black and American); and Multiculturalism (recognition of American identity and affiliation with another reference group based on gender, age, race, sexual orientation, etc.) (Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001). Though an individual may develop an internalized Black racial identity, differences exist in nature of one's call to action surrounding this new identity. When a person makes a committed effort to continue to develop his or her Black racial identity and uses this knowledge to uplift other Blacks in society, he or she has reached Internalization – Commitment (Vandiver, Fhagen-Smith, Cokley, Cross, & Worrell, 2001).

The concept of Black racial identity has also been linked to different elements of one's life. Such aspects include moral development, family experiences, racial socialization, and self-esteem (Carter & Helms, 1988; Collins & Lightsey, 2001; Hagrow, 2001; Lockett & Harrell, 2003; Miller, 1999; Moreland & Leach, 2001; Scott, 2003; Tatum, 2004; Thomas & Speight, 1999; Vinson & Neimeyer, 2000; Wilson & Constantine, 1999).

Impact of RID on other Factors

Regarding moral development, research has revealed that individuals expressing internalized RID were more apt to express moral reasoning for the greater good of society. In contrast, those representing the pre-encounter views of RID were likely to exhibit moral reason conducive to personal and individual needs (Moreland & Leach, 2001). Studies have also been conducted to identify connections between Black racial identity development and family experiences. Studies have posited that practices parents used to approach the concept of race during child rearing (i.e., race-conscious, race-neutral, class-conscious, and race-avoidant) impacted their children's racial identity (Tatum, 2004). Young people raised in a race-avoidant home were likely to exhibit Pre-Encounter attitudes during their college years. In contrast, those reared in race-conscious environments, were apt to express Immersion – Emersion or Internalized identities (Tatum, 2004). Finally, racial identity was also linked to self-esteem. Research purported that individuals possessing Pre-Encounter views were inclined to exhibit low self-esteem while those with Internalized ideals expressed higher self-esteem (Collins & Lightsey, 2001).

Findings from the aforementioned studies illustrate the impact one's racial identity development has on his or her moral development, family experiences, racial socialization, and self-esteem. Furthermore, such research provides support that racial identity development may impact other areas of Blacks' lives, one aspect being Black college students' selection of college major. Depending on one's views of the world, he or she may perceive science as a field limited to Caucasian individuals and fail to pursue it as a viable career pathway. This researcher contends that such views are expressed by college students exhibiting traits indicative of the Pre-Encounter stage while Blacks in the Internalization stage denounce that science is limited to White people and pursue it as a college major.

Methodology

Participants

This study involved 48 Black college students majoring in various programs located at a large, predominantly White university in the southern region. The participants were divided into two groups for comparison: science majors and non-science majors. The science majors group consisted of 17 participants (one male and 16 female) with an average age of 20.6 years and an average grade point average of 3.32 on a 4.0 scale. The non-science majors group was composed of 31 participants (eight males and 23 females) with an average age of 21.7 years with an average grade point average 3.18 on a 4.0 scale. For this study, participants were recruited using a variety of methods including researcher contact with student organizations on campus and solicitation of participants at common campus locations (i.e., library and student union).

Students majoring in science declared their areas of study as biomedical science (65%), chemistry (11%), chemical engineering (6%), exercise science (6%), biology (6%), and pre-medicine (6%). The non-science majors' group was composed of 31 participants (eight males and 23 females) with an average age of 21.7 years with an average GPA of 3.18 on a 4.0 scale. Individuals in this group selected their college majors as education (16%), business (13%), mass communications (10%), political science (10%), accounting (10%), psychology (7%), criminology (6%), social work (6%), creative writing and or history (3%), interdisciplinary social sciences (3%), English (3%), audiology (3%), marketing (3%), management information systems (3%), and undecided (3%).

Data Collection

The Cross Racial Identity Scale (CRIS) is a 40-item quantitative instrument on a Likert-type scale used to assess individuals' racial identity development (RID). Participants' responses can be averaged to produced six scores reflective of six social attitudes: Pre-Encounter Assimilation (PA), Pre-Encounter Miseducation (PM), Pre-Encounter Self-Hatred (PSH), Immersion – Emersion Anti-White (IEAW), Internalization Afrocentricity (IA), and Internalization Multiculturalist Inclusive (IMCI) (Cross & Vandiver, 2001). The subscale receiving the highest score indicated the strongest social attitude for the respondents. The CRIS was scored according to the developers' protocol s. This instrument required approximately 20 minutes to complete. After completion of the CRIS, participants were asked if they were willing to continue in the study with a one-on-one interview with the principal investigator. Fourteen volunteers (one male and 13 female) participated in interviews. Data from interviews elucidated participants' responses on the CRIS. Table 1 outlines the characteristics for the sample for this study. Table 2 provides information regarding each of the interview participants.

Table 1

Characteristics of Science Majors (n=48)

	% of Sample
Gender	
Female	77

Male	19
Age	
<19	10
19	10

Table 1(continued)

20	27
21	17
22	8
>22	23
Academic Class Standing	
Freshman	8
Sophomore	8
Junior	40
Senior	23
Undeclared	25
Ethnic Self-Designation	
African	15
African American	44
Black	10
West Indian - Caribbean Black	23
Hispanic Black	2
Mixed	4
Other	0
Socioeconomic Standing	
Poor	4
Lower Class	0
Working Class	35
Middle Class	44
Upper Middle Class	10
Upper Class	0
Wealthy	2
Primary Community	
Rural	8
Urban	31
Suburban	54
Other (ghetto)	2

Table 2

Information for Interview Participants[8]

Science Majors

Jennifer	Female; African American; 20 year-old junior; chemistry major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Edith	Female; African; 21-year-old senior; biomedical science major; had a 3.26 Grade Point Average; grew up in a mostly White, suburban neighborhood; did not belong to any ethnic organizations
Stacey	Female; African American; 21-year old senior; chemistry major; had a 3.3 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Stefanie	Female; African American; 20 year-old junior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Roni	Female; African American; 21 year-old senior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mixed race, urban neighborhood; belonged to one ethnic organization
Pamela	Female; African; 19 year-old junior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations
Angie	Female; African American; 21 year-old senior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mostly Black, rural neighborhood; belonged to two ethnic organizations
Allison	Female; Black; 20 year-old junior; exercise science major; had a 3.1 Grade Point Average; grew up in a mixed race, rural neighborhood; belonged to two ethnic organizations

Non-Science Majors

[8] The names presented in this work are pseudonyms to protect participants.

Lola	Female; African; 31 year-old junior; English major; had a 3.4 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations

Table 2 (continued)

Lily	Female; African-Caribbean American; 22 year-old senior; creative writing major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Wesley	Male; African American; 23 year-old senior; criminology major; had a 3.0 Grade Point Average; grew up in a mostly Black, urban neighborhood (ghetto); belonged to two ethnic organizations
Kimberly	Female; African American; 20 year-old psychology major; had a 3.4 Grade Point Average; grew up in a mostly Black, suburban neighborhood; belonged to one ethnic organization
Jane	Female; West Indian-Caribbean Black; 22 year-old; started the study as an early childhood education major, but changed to a biomedical science major; had a 3.0 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to one ethnic organization
Kayla	Female; African American; 20 year-old; psychology major; had a 3.8 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations

Data Analysis

Considering the CRIS includes 10 filler questions, 30 of the 40 items make up the six subscales which are composed of five items each. As a result, the CRIS produces six subscale scores that are not able to be collectively summed for interpretation (Cross & Vandiver, 2001). Rather, a profile is generated expressing individuals' strength of agreement with each of the racial identity subscales. For comparison or statistical computations, scores can either be tabulated by totaling the items over all five questions making up the subscale and obtaining scores from five to 35 on each subscale (i.e., 1 + 2 + 3 + 4 + 5 = 15) or the sum

for each subscale can be divided five (the number of items composing each subscale) (i.e., 15 / 5 = 3) (Cross & Vandiver, 2001). The researcher used both methods for calculating and reporting scores. Raw scores for each question were used to compute statistical applications using SPSS software. Reliability coefficients and Cronbach's alpha were calculated. Average scores were used to determine the degree of agreement we racial identity attitudes were expressed by individuals from specific reference group orientations (i.e., African American, Black, Hispanic American, West Indian – Caribbean Black).

Participants' surveys were divided into two groups for comparison: science majors and non-science majors. Descriptive and inferential statistical computations were used to compare the two groups. The SPSS software was used to analyze the data. For all tests completed, the confidence interval was set at 95% where $p < .05$ unless otherwise indicated. To analyze the qualitative data, the interviews with the participants were first be transcribed. After transcription, responses were organized based on questions from an interview guide (See APPENDIX). From the responses, themes were identified and the segments from the comments were coded accordingly (Bogdan & Bilken, 1998; Gall, Gall, & Borg, 2003). To validate the information collected from the interviews, verbal member checking was used to ensure that information reported accurately reflected the participants' perspectives. Verbal member checking occurred at the conclusion of the interview in the form of a summary of the participants' comments. At that time, individuals were able to clarify or correct information that may have been misunderstood.

Findings

The means and standard deviations of participants' responses were tabulated. Table 3 provides a summary of the participants' mean scores for each of the subscales of the

instrument. Standard deviations and standard error of means are also reported. In the table, the science majors group is identified as SM and the non-science majors as NSM.

Table 3

Mean Scores for Cross Racial Identity Scale (CRIS)

Subscale	Group	N	Mean	Std. Dev.	Std. Error of Mean
PA Total	SM	17	15.35	6.74	1.63
	NSM	31	16.81	8.17	1.47
PM Total	SM	17	20.47	5.42	1.31
	NSM	31	17.16	5.83	1.05
PSH Total	SM	17	9.82	5.83	1.41
	NSM	31	9.45	7.30	1.31
IEAW Total	SM	17	7.18	2.77	.67
	NSM	31	6.16	1.63	.29
IA Total	SM	17	15.71	3.44	.83
	NSM	31	15.87	5.63	1.01
IMCI Total	SM	17	29.65	3.39	.82
	NSM	31	27.26	5.68	1.02
Grand Total	SM	17	98.18	12.32	2.99
	NSM	31	92.71	13.75	2.47

Analysis of the descriptive statistics expressed that both groups, science majors and non-science majors, displayed the highest agreement with racial identity attitudes reflected in

the following subscales: Internalization Multiculturalist Inclusive (IMCI), 29.65 and 27.26 respectively for science majors and non-science majors, and Pre-Encounter Miseducation (PM), 20.47 and 17.16 respectively. Additionally, both groups exhibited the lowest agreement with racial identity attitudes in the following subscales: Immersion-Emersion Anti-White (IEAW), 7.18 and 6.16 respectively for science majors and non-science majors, and Pre-Encounter Self-Hatred (PSH) 9.82 and 9.45 respectively. A portion of these findings were consistent with the researcher's expectations in that it was anticipated that the science majors would possess highest degree of agreement with IMCI attitudes (29.65) in comparison to the non-science majors (27.26). The researcher proposed that participants' agreement with IMCI statements would reflect an internalized racial identity and willingness to accept members of other racial and ethnic groups (Cross & Vandiver, 2001). As such, the researcher believed these attitudes would allow the participants to be more willing to enter into science fields as a college major.

As indicated in some of the participants' interview comments, IMCI attitudes (i.e., acceptance of one's race despite society's obstacles) reflected individuals' belief that Blacks can enter into and be successful in science fields. For example, Jennifer, a chemistry major, made the following statement which embraced IMCI views:

> I believe that, I think that you can succeed in anything that you want to succeed in. It takes hard work, it takes drive and you have to have the mindset that this is what I want to do and I'm going to do it regardless of what, what anyone says. And when you get that type of mindset, there's not really much that can get in your way.

Edith, a biomedical science major, also made comments that reflected IMCI attitudes. With regard to a question about whether she believes Blacks' are able to enter into science, she remarked that, "I think so. Society puts that stereotype on you again {that Blacks are not able

to participate in science). Um, but we have to break away from that to see where our potential lies and where we want to go into, you know?"

Though the results for the science majors were consistent with what the researcher anticipated, the finding that the non-science majors also possessed strong agreement with the IMCI attitudes was not expected. The researcher believed that the non-science majors would exhibit attitudes more expressive of the Pre-Encounter subscales (Assimilation, Miseducation, and Self-Hatred) in comparison to the science majors. Only for the PA subscale was the non-science majors' score (16.81) greater than the science majors' (15.35). The researcher hypothesized that the expression of stronger Pre-Encounter attitudes would prohibit the non-science majors from entering into the science field.

From interview findings, Pre-Encounter views were evident in one non-science majors' comments. Lily, a creative writing major, made the following remark which expressed Pre-Encounter Assimilation (i.e., references identity as being American rather than based on a racial orientation) views with regard to the term she prefers to use to express her racial identity. She stated that, "So, I consider myself American, I was raised by my mother's family and they are all American; down to the liking of apple pie and peach cobbler at Thanksgiving dinner." Despite the observation that Lily's comment indicated she possessed an assimilated view of her identity as American rather than in relation to a particular racial group, she did not express attitudes that race was a problem for her with regard to selecting her college major. For Lily, the primary factor that impacted her decision was her interest in the field; she did not enjoy science on the collegiate level and opted for creative writing as her major.

To evaluate the differences in means for CRIS scores between the science majors and non-science majors, a t-test for independent samples was performed. The t-test was an appropriate and acceptable measure to use because it accounted for instances of small sample sizes assuming that the dependent variable (i.e., test score) was normally distributed within each group and the two groups had approximately equal variance. The normality of the participants' scores was evaluated using the Levene's test. The Levene's test for equality of variances indicates whether or not the science majors and non-science majors exhibit approximately equal scores on the CRIS. If the Levene's test is significant (< .05), the two variances are significantly different. However, if the test is not significant (> .05), the two variances are not significantly different; they are approximately equal (Gall, Gall, & Borg, 2003). Table 4 details the results for the Levene's test for equality of variances for the two groups and the t-test for equality of means.

Table 4

Levene's Test for Equality of Variances for the CRIS

	Levene's Test for Equality of Variances	
Subscale	F	Signicance
Equal Variances Assumed		
PA Total	1.31	0.26
PM Total	0.26	0.61
PSH Total	0.31	0.58
IA Total	3.78	0.06
Equal Variances Not Assumed		

IEAW Total	6.58	0.01
IMCI Total	5.45	0.02

The results from the Levene's test indicated that the variances for the Immersion - Emersion Anti-White (IEAW) and Internalization Multiculturalist Inclusive (IMCI) scores, 0.01 and 0.02 respectively, were significantly different. Therefore, the variances for these two tests were not approximately equal. Test results for the other subscale scores were not significantly different as indicated by significance greater than .05; the variances for these subscales were approximately equal.

Table 5 displays the results of the independent samples test. The results of the test revealed that the means for the participants' scores were not significantly different for any of the CRIS subscales. This finding was counter to what the researcher anticipated. The researcher hypothesized that a difference would exist in the racial identity attitudes and profiles between the science majors and non-science majors; however, such findings were not observed. The two groups of participants held similar racial identity attitudes and profiles.

In addition to the test for independence, Cronbach's alpha coefficients were calculated to assess the reliability of the subscales measured by the CRIS (Gall, Gall, & Borg, 2003). Since instrument scales represent a group of interrelated items that are designed to measure constructs, reliability assesses the degree to which the same set of questions would produce similar responses if the questions were re-ordered and issued to the same participants. Variables are identified as reliable if they result in stable responses over repeated administration of the instrument (Gall, Gall, & Borg, 2003). Alpha coefficients range in value from zero to one. A score close to one is viewed as a more reliable scale. Past

researchers have indicated .70 as an acceptable reliability coefficient. Each of the CRIS subscales contained five items. The reliability coefficients for each subscale are presented in Table 6. Based on the calculated results, the reliability coefficients revealed that all of the CRIS subscales were reliable measures to assess the racial identity attitudes indicative of each subscale.

Though the findings regarding the strength of agreement with various racial identity attitudes were similar between the science majors and non-science majors and inconsistent with the researcher's initial thoughts, results such as these seem highly plausible. Considering the location of the study, a pre-dominantly White university in the south, the researcher would not surprised to find Black students with similar racial identity profiles to the participants in the study to select such a setting for their college experience. These individuals are likely to exhibit internalized racial identity attitudes (indicated by IA and IMCI) and enroll in a university environment with the majority of White students and limited interaction with Black peers (Cross & Vandiver, 2001).

Table 6

Reliability Statistics for the Subscales of the Cross Racial Identity Scale (CRIS)

Subscale	Cronbach's Alpha
Pre-Encounter Assimilation (PA)	.87
Pre-Encounter Miseducation (PM)	.73
Pre-Encounter Self-Hatred (PSH)	.91
Immersion-Emersion Anti-White (IEAW)	.74
Internalization Afrocentricity (IA)	.72

Evaluation of the participants' responses was based on the researcher's definitions for each subscale patterned after the descriptions for the stages reflected in the Cross Nigrescence Theory. Table 7 outlines each of the six subscales and the coding definitions the researcher used to analyze the transcripts. When statements reflected any of the coding descriptions, they were classified and labeled according to the corresponding CRIS subscale. For reporting, analysis of interview transcripts was separated by each subscale. Responses from participants reflective of racial identity attitudes for each of the subscales are presented. Verbatim comments are indicated by double quotations when applicable.

Table 7

Subscales and Coding Descriptions of Cross Racial Identity Scale (CRIS)

Subscale	Coding Descriptions for Comments
Pre-Encounter	
Assimilation (PA)	Exhibits limited salience for race
Miseducation (PM)	Accepts common stereotypes of Blacks
Self-Hatred (PSH)	Negates aspects about self because of Black race
Immersion-Emersion	
Anti-White (IEAW)	Exhibits hatred toward Whites
Internalization	
Afrocentricity (IA)	Celebrates aspects related to Black cultures
Multiculturalist Inclusive (IMCI)	Accepts racial identity and affiliates with other groups based on race, sexual orientation, gender, etc.

Pre-Encounter Assimilation

Analysis of the verbatim transcripts from the one-on-one interviews allowed the researcher to identify elements of conversations that reflected participants' Pre-Encounter Assimilation (PA) attitudes. Several of the individuals made comments that were classified in the PA category. Such responses expressed views that the participants possessed attitudes which reflected limited salience for race. For example, Jennifer, a chemistry major, made comments about how she did not possess a regard for race prior to her fifth grade year in school. She remarked that,

> Um, yeah I think the first time that I really really realized that people was looking at your skin color was in the 5th grade. I was playing soccer and um this kid called me the N-word and said that N's aren't allowed to play soccer because we were beating them. And um, we got into a fight about it and that was the first time it actually hurt me like, wow why would you say something like that, why would try to hurt me like that and why can't I play soccer? *What's the difference between me and you?* That was the first time where I really realized that race was an issue beyond like …cause I never dealt with it at school, I just heard about it, you know, I saw it on TV, but that uh was the first time I dealt with it on my own.

Jennifer's comments express that she exhibited attitudes indicative of Pre-Encounter Assimilation when she was a child. Specifically, the statement "What's the difference between me and you?" indicates Pre-Encounter Assimilation; she viewed all people as being the same.

Pamela, a biomedical science major, also made several remarks that indicated her PA attitudes. When Pamela was asked if her scientist was of a particular racial group, she commented that she does not emphasize such concepts. The following dialogue exhibited Pamela's PA statements about race in relation to her scientist:

> Interviewer: Okay. Alright. And so you did a female scientist. Does your scientist have a race… a particular race or ethnic group?
>
> Pamela: No, it does not.
>
> Interviewer: And if you would make it a race or ethnic group, what would it be?
>
> Pamela: I don't know. Cause when I…*I don't place importance on stuff like that* so I wouldn't know what to make it (giggles).

Pamela also responded that she was unaware of racism around her because she either does not realize it occurs or she chooses to ignore it. She made the following statement about negative experiences based on race:

> Honestly, no I have not. It's probably but people always ask me questions about if I ever experienced racial discrimination or tension or anything like that. I haven't. Maybe it's happened and I haven't…I haven't…maybe it's happened and I just didn't know, but *I've come to ignore* and not let that con…stop me from doing what I need to do.

Not being aware of racism in society reflects Pre-Encounter Assimilation attitudes. If an individual does not "see" race, she is not likely to observe negative encounters based on race. However, if a person chooses to ignore negative racial experiences (as indicated in the latter part of Pamela's comment), she is aware of race, but disregards it as a factor in her interactions with others. This segment of Pamela's comment indicates that she also expressed views indicative of the Internalization stage; attitudes that reflect the understanding of one's own race, the race of others, and a call to action. In addition, Pamela's comments highlight the fluidity of one's racial identity. Depending on a person's experiences and position in life, one may express diverging racial identity attitudes (Cross, 1995; Cross & Vandiver, 2001; Parham & Helms, 1985). Pamela's views were pre-encounter with regard to her scientist, but internalized in relation to her own life. Though she has internalized her own racial identity, she does not place importance on race with her interactions with others.

Pre-Encounter Miseducation

Participants also made comments that indicated Pre-Encounter Miseducation (PM) attitudes. These remarks expressed views that indicated that the participants have tendencies to agree with some of the racial stereotypes that exist about Blacks. For example, regarding a question about what types of individuals enter into the sciences, Jennifer, a chemistry major, stated that,

> Yeah. Um, because everyone who was doing it um, Caucasian, everyone who was going into the science field…all my friends that were going into the science field, they were Caucasian and all of my friends who wanted to do sports, criminology, um English and stuff like that, they were African American and so I had an idea that okay, *sciences and things like that are not…are more so for Caucasians* and they are the majority and I am the minority and if I went into something like sports, criminology or something like that, then I would be the majority and they would be the minority.

Edith, a biomedical science major, also commented in a manner that reflected Pre-Encounter Miseducation attitudes. In response to a question asking how she felt about conversations and interactions she had with her friends surrounding racial issues, Edith remarked that,

> Edith: Um. Yes, sometimes, um you know they looked at me cause they'd think I could dance well or something you know. Or um, "You know you can dance well you're Black" type of thing. But, yeah, I think that's mainly what it consisted of. Or, "Can't you sing, you're Black?" No, I can't sing that well.
>
> Interviewer: How did conversations like that make you feel?
>
> Edith: Um. Sometimes, I was like, "Yeah, I know I can dance because I am Black", but now, now a days. Like I'm taking this racism class and you *know not all Black people can dance*. I have to put that into my mind because *I sort of bought into that stereotype that all Black people dance and all White people can't dance or whatever*. So, yeah.

Pamela, a biomedical science major, expressed views indicative of attitudes in the Pre-Encounter Miseducation subscale; views that reflect that an individual accepts common

negative stereotypes about Blacks. In response to a question to elicit Pamela's thoughts about whether or not Blacks can pursue science, she made remarks that showed that though she felt Blacks can enter science; however, she believed some of the stereotype that Blacks make a number of excuses and look for everything to be given to them. Pamela replied that,

> I think with a lot of African Americans were *looking for the easy way out* in the things that we do. We just, *we look for a lot of excuses*. *We don't want to challenge ourselves* and things like that. We feel it's too hard. And sometimes, I think it's hard to, but I know that I just have to stick with it because if other people are doing it, why can't I?

Pre-Encounter Self-Hatred

During the one-on-one interviews, one participant exhibited attitudes that were representative of the Pre-Encounter Self-Hatred (PSH) subscale. Lily, a creative writing major, expressed viewpoints that reflected instances when she possessed negative views about herself because of her Black race. During a time when she was growing up, Lily was down on herself because she could not understand why other Black children did not want to be her friend. The following dialogue displays the PSH attitudes Lily exhibited when she was growing up and socializing with peers:

> Lily: Um, I had Black friends, but they were like the kids I played with on the playground…the kids I sat with at lunch. Um, a lot of the other Black kids at my school…*I was too White for them one said.*
>
> Interviewer: What do you mean too White?
>
> Lily: My speech was too nice apparently. I never really figured that out. That was one thing that kind of puzzled me up until about high school when *I just stopped caring.*

Lily expressed Pre-Encounter Self-Hatred views about herself and interactions with Black peers during her youth.

Immersion - Emersion Anti-White

Though the Immersion - Emersion Anti-White subscale received the lowest scores for both the science majors and non-science majors on the CRIS, one participant's interview responses revealed attitudes indicative of IEAW. With regard to her experiences growing up, Jennifer, a chemistry major, expressed how she and her friends handled situations involving White people. Though she commented that these statements were made jokingly, the ideas expressed reflect Immersion - Emersion Anti-White sentiments. Jennifer stated that, "Um, me and my friends we just always like…if something bad happened, like, "It's the White people." We would say that and you know just blame them for things…" Additionally, she said that, "Um, sometimes it was joking…a lot of the time it was joking, but sometimes you were serious. Sometimes it was like, "If it wasn't for those White people." Clearly such comments illustrate IEAW sentiments.

Internalization Afrocentricity

Several of the participants made remarks that revealed attitudes representative of Internalization Afrocentricity. These attitudes reflected instances when individuals internalize their Black race and used this realization in how they approach life and interact with others. Jennifer, a chemistry major, and Lola, an English major, expressed IA attitudes during their interviews. Concerning her thoughts about being Black, Jennifer commented that,

> Yeah. Yeah. I've always been taught to be proud of who I am and be proud to be Black. I'm an African American, Black female. I'm proud to be Black. I love my skin color. I think I have a beautiful hue and I'm happy to be the color that I am and I wouldn't change it.

Despite negative encounters with others based on race, Jennifer used her IA attitudes to persevere in science classes.

> I mean you walk into a class and there's only one African American female, you're kind of going to shy away from her and go with other people you know. I'd see them look at me, look at the chair and then kind of go sit somewhere else. Um, it kind of offended me, but not too much because I laugh inside because I knew, I mean science is my thing so you don't want to be my partner you're going to lose out.

Similarly, Lola's acknowledgement and acceptance of her Black race impacted how she approached life. Lola made the following remarks with regard to how she grew up and interacted with others as a result. She stated that,

> Um, I just…my household was pretty like unconventional, so I mean *I was very aware that I was Black*. And I was very um just always aware and aware of what that meant you know in terms of um….well my parents were a little different in the sense of they were like always telling me to be very cautious you know of what I said. It wasn't like kind of like I was speaking for me, i*t was kind of like you're representing a group of people*.

Internalization Multiculturalist Inclusive

Participant's comments during the interviews heavily reflected Internalization Multiculturalist Inclusive (IMCI) attitudes. Individuals' IMCI views depicted their personal acceptance of their internalized Black race as well as their willingness to embrace people from other reference groups whether it was based on race, gender, religion, sexual orientation, etc. For example, Jennifer, a chemistry major, made comments about her scientist's race that indicated she possessed IMCI attitudes about what racial groups can be scientists. Jennifer commented that,

> Um, I didn't give her a color because *there are so many different types of scientists* and I didn't just want to make her brown or white or peach or anything like that. She's just kind of *the color of the paper which represents all colors* and um she's a woman because I'm a woman and *women can be scientists* and most of the time people think of scientists as men and there are women scientists as well. That's why I drew it like that…Um, but then I

> realized I want to do this and maybe me pushing to go into the sciences will show someone else that *it's not only for Caucasians it's for anyone who wants to go into that field…African American, Asian, anyone who wants to be a scientist can be a scientist*.

Stefanie, a biomedical science major, made similar IMCI remarks when she was asked to explain why she drew her scientist as a vibrant pink color. She expressed views that exhibited that she was aware of different races of people; however, she believed science was a field open to all individuals. Stefanie stated that,

> Um, well um I chose a pink scientist because my favorite color is pink. I was going {to draw} a Black scientist at first, but because you know, science is when you think of it, you think about White scientists, but *I feel like a scientist can be any color whether it's blue or purple or any other color*. So, that's why I chose pink and it's my favorite color.

In her remark, Stefanie recognized a number of factors that impacted her drawing of a scientist. She realized that her initial thought was to draw a Black scientist though she tends to think of scientists as being White. Despite these conceptions of scientists regarding race, Stefanie elected to illustrate her scientist as fuchsia pink to represent all races of people. In addition, Stefanie made comments about her decision to join the swim team in high school which reflected IMCI attitudes. Stefanie stated that,

> Like I have a *lot of White friends*. I swam on the swim team, when I was on that, it was like no Black people on the swim team. But I felt like I had to expand my boundaries. Because *I wasn't going to be like, be isolated* just because I was put into a situation. I'm so adaptive, like I mentioned early…adaptive. *I just don't want Black friends, I just don't want White friends. I want like a lot diverse* (inaudible).

Similarly, Roni, a biomedical science major, also expressed that she interacted with a diverse group of friends in high school and continues to possess IMCI attitudes in her college friendships. With regard to a question about whether she had any negative racial experiences with peers growing up, Roni commented that,

> Not that I can recall. Not that I can recall. Cause in high school *I got along with everybody* so that wasn't a problem. Here in college, I…I can't recall that happening, so I haven't had that happen yet. I do, *I have (giggles) a diverse group of friends*. It doesn't matter to me, I mean most of the friends I have are Black, but *I hang out with all types*, you know. I try to make friends with all of my classmates, it doesn't matter to me you know. We're both in the…going towards the same way.

Roni's comments about her scientist's race also reflected IMCI attitudes. When asked if her scientist represented any particular racial group, Roni stated that, "Um, not really. I mean I drew Black hair and I didn't really color the skin…so it can be any, any races." Roni possesses IMCI views reflected in her interactions with others and her views of scientists.

Stacey, a chemistry major, also expressed attitudes that indicated IMCI conceptions. Regarding a question about who could be a scientist, Stacey stated that, "I believe everyone can be a scientist in their own way because you're always hypothesizing, trying new things, so on and so forth, I guess." This comment reflects that Stacey embraces the race of all individuals and believes everyone can be represented in the sciences.

Regarding the participants from the non-science majors' group, Kimberly a psychology major, made comments that reflected the Internalization Multiculturalist Inclusive subscale. In response to a discussion about societal stereotypes concerning the races of individuals who enter the sciences, Kimberly stated that,

> Yeah, you know they push the smart people to it. I'm not saying that African Americans aren't smart or minorities aren't smart, it's just you know we have our stereotypically smart people. They're either White or their Asian or they're Indian or something like that. Um, and I believe that society does follow those stereotypes. They do. They do push towards that, *but there are people that break those boundaries and it can be done*. Well I do still believe that, maybe not 100% of the way, but certainly a certain percentage {of scientists} goes toward those…those stereotypically types of people.

Though Kimberly recognizes and acknowledges that racial stereotypes regarding intelligence and the pursuit of science exist in society, she did not accept these views. Kimberly's

statement, "…there are people that break those boundaries and it can be done" signifies that she recognizes those stereotypes and their impact, but believes Blacks and people of other racial groups can overcome the influence of those stereotypes if they choose to become scientists. This comment is reflective of IMCI attitudes.

From the one-on-one interviews with participants, the researcher observed comments indicative of all six racial identity subscales measured by the Cross Racial Identity Scale. However, participants' comments predominately reflected the Internalization Multicultural Inclusive (IMCI) subscale. The researcher also observed that participants' interview responses were least reflective of the Pre-Encounter Self-Hatred (PSH) and Immersion - Emersion Anti-White (IEAW) subscales. These findings were evident for both the science majors and non-science majors and were consistent with the data collected from the CRIS; participants expressed the highest agreement with IMCI and PM attitudes and lowest agreement with PSH and IEAW conceptions. Four individuals expressed views relating to the IMCI subscale (29%). Two participants made remarks indicative of each of the following subscales: PA, PM, and IA (14% each). Only one participant made comments that reflected PSH and IEAW attitudes (7% each).

Limitations & Implications

The work presented in this study exhibited several limitations. A set of limitations pertain to the generalizability of the findings regarding the selectivity based on race of participants and institution where the study occurred. For example, the researcher incorporated purposeful sampling and only collected data from Black college students. Random sampling would have helped to improve the generalizability of the results. Though the researcher justified this restriction for participants due to the fact that Blacks are

underrepresented in the sciences and factors needed to be explored to understand the low numbers, a more diverse sample of participants may produce additional findings. As such, future research should be conducted to explore aspects of White racial identity development and the impact it may have on Caucasian students' decisions to select science as a college major.

The geographic region in which the study occurred was a third limitation. Data collection was limited to Black college students in one region of the United States at one university setting. Being that the study took place in the southern area of the country, specifically at a predominately White university, findings may not be indicative of the rest of the country. For future exploration, the researcher would expand the study beyond the south to other regions as well as different academic settings. The researcher would sample students at historically Black colleges and universities as well.

A fourth drawback to the study was that the researcher was unable to recruit a large number of male participants. Therefore, data collected did not allow for inferences to be made about the sample regarding the gender of the participants involved in the study. The sample disproportionately consisted of females; therefore, views reflected in this study primarily reflect that demographic.

Another limitation was the diversity of the sample regarding their reference group orientation. Few participants identified themselves as African American. Individuals in the sample represented those who declared their racial orientation as Black, African, West Indian - Caribbean Black, Hispanic Black, and mixed (e.g., Jamaican Black, Haitian Black). Though the development of the Cross Racial Identity Scale factored in these differences in reference group orientation, a number of the participants were born in other countries and raised under

different social attitudes which may have impacted their conceptions of racial identity. Consequently, Ogbu's (1986) classification system for minorities in America needed to be addressed because the African American students (43% of the participants) represented castelike minorities (i.e., involuntary immigration to the United States) while the students from other orientations (e.g., Black, African, West Indian – Caribbean, and Hispanic Black; 57% of the participants) reflected immigrant minorities (i.e., voluntary immigration into the US) (Ogbu, 1986).

Few differences were observed in the participants' agreement with racial identity attitudes based on reference group orientation. Table 8 shows the percentage of participants from different reference group orientations and the racial identity attitude expressing their strongest agreement. For comparison, the reference orientations were separated into African American (n = 21) and Black (n = 27). Black encompasses those who self-reported their orientation as Black, African, West Indian – Caribbean Black, Hispanic Black, Mixed, or Other. Instances when participants' average score for two subscales were the same are denoted by a slash mark between the two categories.

Table 8

Strongest racial identity attitudes by reference group orientation

African American	%	Black	%
IMCI	81	IMCI	81
IMCI/PA	9	PM	7
PA	5	PA	4
PM	5	PM	4

One a Likert scale ranging from (1) *strongly disagree* to (7) *strongly agree*, Lily, an African – Caribbean student expressed the highest average agreement (6.4) with Pre-Encounter Assimilation attitudes. Wesley, an Black male, commented with the highest strength of agreement with Pre-Encounter Miseducation views as indicated by a score of 5.4. Iris, an African female, replied with most agreement (4.2) with Pre-Encounter Self-Hatred views. Tempest, a Jamaican – Black participant, expressed equal agreement with Pre-Encounter Assimilation and Pre-Encounter Miseducation concepts as reflected in her score of 5.2 for both subscales. Finally, Nancy, an Black participant, identified two subscales with equal levels of agreement. With a score of 5.8, she illustrated affiliation with Pre-Encounter Assimilation and Internalization Multiculturalist Inclusive attitudes.

The restriction of the participants' Grade Point Average was a fifth limitation to this study. The researcher established a limit of a 3.0 for the academic GPA for the participants. Though this designation was to account for the stereotype that Blacks are not smart enough to participate in science, the researcher acknowledges that the GPA restriction eliminated a number of students from the study who may have volunteered to participate. A sixth limitation was the nature of the interview questioning. Analysis of interview data revealed instances when the researcher used closed-ended inquires in her questioning of participants. In contrast to open-ended questioning, closed-ended inquires may influence interviewees' responses.

In addition to the limitations previously presented, using Cross' Nigrescence model as a theoretical framework has drawbacks. Though this model thoroughly details the steps

through which an individual progresses along the pathway to racial identity development, it fails to describe the exact psychological transitions one experiences during the process. Finally, when using Likert type scales additional issues must be accounted. For example, some students tend to respond to Likert scales by "sitting on the fence" or selecting the neutral response if given the possibility (Hodge & Gillespie, 2003). Moreover, some researchers suggest constructing a Likert scale using an odd number of choices to "force" the respondents to have an opinion on a topic. Unfortunately, doing so may result in a participant responding to an opinion that he or she did not possess (Hodge & Gillespie, 2003).

Though limitations were acknowledged for this study, findings presented a number of implications for the field of science education. Participants' racial identity development, as assessed by the Cross Racial Identity Scale, and perceptions of scientists, as captured in their Draw-a-Scientist Test, produced relevant findings. First, factors related to the attitudes individuals accept regarding their personal racial identity development impact their interactions with others. This study demonstrated that the participants primarily possessed Internalization Multiculturalist Inclusive (IMCI) attitudes which allowed them to accept their racial identity and embrace the orientations of others. Additionally, participants did not express strong Immersion-Emersion Anti-White (IEAW) views. Instances where Black individuals strongly agree with IMCI conceptions and disagree with IEAW ideals express that they should have an internalized identity about their Black race and possess a willingness to embrace others from different racial or reference groups, especially Whites.

Practice & Recruitment

Finally, findings from this study imply that not only is it important to assess students' racial identity their potential impact in the classroom, it is also vital to evaluate the research

and practice of teachers and administrators. The racial identity of African American and White educators may have an impact on how they develop or restrict their interactions with students, select instructional practices, determine grading procedures, and implement classroom management techniques. In addition, the fact that a number of racial stereotypes exist regarding African Americans and a number of individuals are miseducated about Black history and achievements, this study identifies the need to properly instruct all students on the impact and achievement of individuals from all racial and ethnic groups. Such instruction will help to establish a classroom environment that is receptive and respectful of all learners and instructors.

References

Atwater, M. M. (2000). Equity for Black Americans in precollege science. *Science Education, 84*(2), 154-179.

Barton, A. C., Hindin, T. J., Contento, I. R., Trudeau, M., Yang, K., Hagiwara, S., et al. (2001). Underprivileged mothers' perspectives on science. *Journal of Research in Science Teaching, 38*(6), 688-711.

Bogdan, R. C., & Bilken, S. K. (1998). *Qualitative research in education: An introduction to theory and methods* (3rd ed.). Boston, MA: Allyn and Bacon.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching, 38*(8), 965-980.

Brown, B. A. (2006). "It isn't no slang that can be said about this stuff": Language, identity, and appropriating science discourse. *Journal of Research in Science Teaching, 43*(1), 96-126.

Carter, R. T., & Helms, J. E. (1988). The relationship between racial identity attitudes and social class. *The Journal of Negro Education, 57*(1), 22-30.

Chambers, D. W. (1983). Stereotypic Images of the scientist: The Draw-a-Scientist Test. *Science Education, 67*(2), 255-265.

Chang, D. F., & Sue, S. (2003). The effects of race and problem type on teachers' assessments of student behavior. *Journal of Consulting and Clinical Psychology, 71*(2), 235-242.

Collins, K. W., & Lightsey, O. R., Jr. (2001). Racial identity, generalized self-efficacy, and self-esteem: A pilot study of a mediation model for African American women. *Journal of Black Psychology, 27*(3), 272-287.

Cross, W. E., Jr. (1971). The Negro-to-Black conversion experience. *Black World*, 13-27.

Cross, W. E., Jr. (1991). *Shades of Black: Diversity in African-American identity.* Philadelphia: Temple University Press.

Cross, W. E., Jr. (1995). The psychology of Nigrescence: Revising the Cross Model. In J. G. Ponterotto, J. M. Casas, L. A. Suzuki & C. M. Alexander (Eds.), *Handbook of multicultural counseling* Thousand Oaks, CA: Sage.

Cross, W. E., Jr, & Vandiver, B. J. (2001). Nigrescence theory and measurement: Introducing the Cross Racial Identity Scale (CRIS). In J. G. Ponterotto, J. M. Casas, L. M. Suzuki & C. M. Alexander (Eds.), Handbook of Multicultural Counseling (2nd ed., pp. 371-393). Thousand Oaks, CA: Sage.

Fusco, D. (2001). Creating relevant science through urban planning and gardening. *Journal of Research in Science Teaching, 38*(8), 860-877.

Fusco, D., & Barton, A. C. (2001). Representing student achievements in science. *Journal of Research in Science Teaching, 38*(3), 337-354.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational Research: An Introduction* (7th ed.). Boston: Pearson Education, Inc.

Goodlad, J., & Oakes, J. (1998). We must offer equal access to knowledge. *Educational Leadership, 45*(5), 16-22.

Green, P. (1999). Separate and still unequal: Legal challenges to school tracking and ability grouping in America's public schools. In L. Parker, D. Deyhle & S. Villeras (Eds.), Race is...Race isn't: Critical race theory and qualitative studies in education (pp. 231-250). Boulder, CO: Westview Press.

Hagrow, A. M. (2001). Racial identity development: The case of Mr. X, an African American. *Journal of Mental Health Counseling, 23*(3).

Helms, J. (1999). Another meta-analysis of the White racial identity attitude scale's Cronbach Alphas: Implications for validity. *Measurement & Evaluation in Counseling & Development, 32*(3), 122-138.

Hodge, D., & Gillespie, D. (2003). Phrase completions: An alternative to Likert scales. *Social Work Research, 27*(1), 45-55.

Lockett, C. T., & Harrell, J. P. (2003). Racial identity, self-esteem, and academic achievement: Too much interpretation, too little supporting data. *Journal of Black Psychology, 29*(3), 325-336.

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

Miller, D. B. (1999). Racial socialization and racial identity: Can they promote resiliency for African American adolescents? *Adolescence, 34*(135), 493-501.

Moreland, C., & Leach, M. M. (2001). The relationship between Black racial identity and moral development. *Journal of Black Psychology, 27*(3), 255-271.

NCES. (2006). Retrieved August 1, 2006 from http://nces.ed.gov/index.asp.

Neal, L. V. I., McCray, A. D., Webb-Johnson, G., & Bridgest, S. T. (2003). The effects of African American movement styles on teachers' perceptions and reactions. *The Journal of Special Education, 37*(1), 49–57.

NSF. (2006). Retrieved August 4, 2006, from http://www.nsf.gov/

Ogbu, J. U. (1986). Consequences of the American caste system. In U. Neisser (Ed.), *The school achievement of minority children* (pp. 19-56). Hillsdale: NJ: Lawrence Erlbaum Associates, Inc.

Parham, T. A., & Helms, J. E. (1985). Relation of racial identity attitudes to self-actualization and affective states in Black students. *Journal of Counseling Psychology, 32*, 432-440.

Parsons, E. C. (1997). Black high school females' images of the scientist: Expression of culture. *Journal of Research in Science Teaching, 34*(7), 745-768.

Rascoe, B., & Atwater, M. M. (2004). Black males' self-perceptions of academic ability and gifted potential in advanced science classes. *Journal of Research in Science Teaching, 42*(8), 888-911.

Rubin, E., Bar, V., & Cohen, A. (2003). The images of scientists and science among Hebrew- and Arabic-speaking pre-service teachers in Israel. *International Journal of Science Education, 25*(7), 821-846.

Scott, L. D., Jr. (2003). The relation of racial identity and racial socialization to coping with discrimination among African American adolescents. *Journal of Black Psychology, 33*(4), 520-538.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38*(9), 1000-1014.

Songer, N., Lee, H.-S., & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching, 39*(2), 128-150.

Tate, W. F. (2001). Science Education as a Civil Right: Urban schools and opportunity-to-learn considerations. *Journal of Research in Science Teaching, 38*(9), 1015-1028.

Tatum, B. D. (2004). Family life and school experience: Factors in the racial identity development of Black youth in White communities. *Journal of Social Issues, 60*(1), 117-135.

Thomas, A. J., & Speight, S. L. (1999). Racial identity and racial socialization attitudes of African American parents. *Journal of Black Psychology, 25*(2), 152-170.

Tobin, K., Roth, W.-M., & Zimmermann, A. (2001). Learning to teach science in urban schools. *Journal of Research in Science Teaching, 38*(8), 941-964.

USCB. (2006). *United States Census 2000*. Retrieved August 1, 2006. from http://www.census.gov/main/www/cen2000.html.

Vandiver, B. J., Fhagen-Smith, P. E., Cokley, K. O., Cross, W. E., Jr., & Worrell, F. C. (2001). Cross's Nigrescence Model: From theory to scale to theory. *Journal of Multicultural Counseling & Development, 29*(3).

Vinson, T. S., & Neimeyer, G. J. (2000). The relationship between racial identity development and multicultural counseling competency. *Journal of Multicultural Counseling & Development, 28*(3).

Wilson, J. W., & Constantine, M. G. (1999). Racial identity attitudes, self-concept, and perceived family cohesion in Black college students. *Journal of Black Studies, 29*(3), 354-366.

Winston, C. E., Rice, D. W., Bradshaw, B. J., Lloyd, D., Harris, L. T., Burford, T. I., et al. (2004). Science success, narrative theories of personality, and race self complexity: Is race represented in the identity construction of African American adolescents? New Directions for Child and Adolescent Development, 106, 55-76.

Worrell, F. C., William, K., Jr., & Vandiver, B. J. (2001). Nigrescence theory: Current status and challenges for the future. *Journal of Multicultural Counseling & Development, 29*(3).

CHAPTER SIX: JOURNAL-READY MANUSCRIPT

BLACK COLLEGE STUDENTS' PERCEPTIONS OF SCIENTISTS

Science Majors and Non-Science Majors: Black College Students' Perceptions of Scientists

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Abstract

The objective of this research was to discover the perceptions of scientists possessed by Black college students. Forty-eight participants, 17 science majors and 31 non-science majors, volunteered for the study. All individuals completed the Draw-a-Scientist Test (DAST) and 14 individuals participated in one-on-one, semi-structured interviews with the researcher. DAST images were analyzed using the Draw-a-Scientist Test Checklist (DAST-C) to determine the number of stereotypical images depicted in the drawings. Verbatim interview transcripts were analyzed to expound upon participants' perceptions of scientists as revealed by the DAST. Results from an independent samples test for DAST scores indicated that science majors and non-science majors did not differ in the number of stereotypical elements illustrated. Both groups averaged four of the 16 elements. However, findings did expose that divergences existed in racial and gender representations of the scientists illustrated.

Science Majors and Non-Science Majors: Black College

Students' Perceptions of Scientists

While the scientific enterprise expands and demands the skills of a scientifically literate workforce, the racial demographics of people participating in science careers continue to represent White male individuals. Nationally, reform efforts in science education have attempted to address the disparities that exist between Black and Caucasian[9] students regarding divergences in their enrollment and participation in science course (K-12), identification of science as a college major, and selection of science as a career endeavor (Atwater, 2000; Seiler, 2001).

In 2002, the United States Census Bureau publicized data which revealed that Blacks represented 12.3% of the population and Whites consisted of 75.6% (USCB, 2006). However, information pertaining to the racial demographics of doctoral scientists for 2001 misaligns with population expectations. Of the 656,030 scientists, Blacks only accounted for 2.4% while Caucasians represented 80% of the group (National Center for Education Statistic-NCES, 2006). In addition to attainment of science careers by Blacks and Whites, disparities such as these are also observed at the high school through college levels. Specifically, differences exist in the percentages of Blacks and Whites enrolling in science courses and obtaining science degrees.

As students progress through high school and determine their academic course, research reveals that fewer Blacks enroll in advanced science courses. In part, their restricted

[9] The terms Caucasian and White are used interchangeably throughout.

selection of higher-level science courses is hindered by their low representation in the rigorous mathematical prerequisites. Data revealed that in 1998, 72.5% of Black pupils and 77.7% of White students enrolled in Geometry. However, only 6.6% of Blacks and 12.1% of Whites pursued calculus, an advanced math course (NCES, 2006). Inequalities in trends surrounding science are also observed at the collegiate level.

In 2001, the National Science Foundation reported that of the bachelor's degrees conferred to students in science-related disciplines, 67.7% were awarded to European American graduates while only 8.1% were Blacks (NSF, 2006). Additionally, in 1998, 5.7% of the master's level science degrees earned were represented by Blacks while 74.6% were conferred to Caucasians (NSF, 2006). Due to the low attainment of science and related degrees, Blacks are unable to endeavor into careers and represent a viable demographic in the science workforce; a factor which limits the values, views, and approaches to those of mainstream, White America.

Science education researchers have examined factors that impact the chasm that exists between Black and Caucasian students. Research has revealed that several factors influence the low percentages of Blacks in high school science courses, college majors, and science careers. Such influences include the impediment of tracking on minority student matriculation (Green, 1999; Winston et al., 2004) (Goodlad & Oakes, 1998; Green, 1999; Luft, 1998; Tate, 2001); impact of low teacher expectations for Black student achievement (Chang & Sue, 2003; Rascoe & Atwater, 2004; Tobin, Roth, & Zimmermann, 2001); Neal, McCray, Webb-Johnson, & Bridgest, 2003), authority of educator content knowledge and instructional practices on Black students' views of school (Songer, Lee, & Kam, 2002; Tate, 2001); influence of parental views on their children's academic interests (Barton et al., 2001;

Fusco, 2001; Fusco & Barton, 2001; Luft, 1998); hindrance of stereotypic images of scientists perceived by students (Chambers, 1983; Parsons, 1997; Rubin, Bar, & Cohen, 2003); and persistence of negative self-perceptions held by Black students regarding their abilities in science (Brickhouse, Lowery, & Schultz, 2000; Brickhouse & Potter, 2001; Brown, 2006; Luft, 1998; Seiler, 2001).

For this specific study, the researcher sought to answer the following questions: What perceptions of scientists do Black students majoring in science possess? What perceptions of scientists do Black students majoring in non-science fields possess?

Overview of Literature Regarding Perceptions of Scientists

A number of research studies have been conducted in science education to discover individuals' perceptions of scientists. Studies have revealed that prior to the twentieth century, a multitude of images (both visual and verbal) were given to represent scientists (Chambers, 1983; Schibeci & Sorensen, 1983). Depictions varied with regard to the scientists' characteristics as illustrated by physical attributes (i.e., madman, eccentric, fashionable), selected profession (e.g., professors, chemists, and magicians), and chosen work setting (i.e., in the laboratory or outside in nature). However, the diversity of such images of scientists were not observed during the 1950's and subsequent decades (Barman, 1999; Chambers, 1983; Finson, Beaver, & Cramond, 1995; Mason, Kahle, & Gardner, 1991; Rosenthal, 1993).

Chambers (1983) conducted 11 years of research (1996-1977) to evaluate the age during which children conceptualized their perceptions of scientists; work which ultimately resulted in the Draw-a-Scientist Test (DAST). The DAST was administered to 4,807 students, kindergarten through fifth grade, by their classroom teachers. Participants were

located in Quebec, Ontario, Texas, Oklahoma, Connecticut, New York, and Vermont. The students were instructed to "draw a picture of a scientist." For a control measure, 912 of the participants were asked to "draw a person" prior to completing the DAST. Before evaluating the illustrations, the researcher identified and described seven elements reflective of the "standard image" of a scientist. The seven factors included the presence of: a lab coat, eyeglasses, facial growth of hair, symbols of research, symbols of knowledge, technology, and relevant captions. Students' images were analyzed based on these aspects and scored from one to seven to quantify the presence of the standard image.

Results from his study revealed that almost none of the standard images were present in the kindergarten and first grade students' pictures. Most students at the second grade level exhibited two elements in their drawings. Trends such as these continued for subsequent grade levels. Ultimately, Chambers (1983) observed that fifth graders' images depicted three or four factors related to the standard image of scientists. He also evaluated a small sample of adults which revealed that four or five elements were illustrated in their DAST drawings. Chambers (1983) concluded that the average number of elements representative of the standard perception of scientist increased with grade level. Additionally, he identified that conceptions of scientists which aligned with the standard image described by Mead and Matraux (1957) appeared during the second and third year of education.

Rosenthal (1993) used the Draw-a-Scientist Test to evaluate and compare views of scientists held by college students majoring in liberal studies (n = 76; 95% of whom planned to become elementary teachers) with those of science (biology) majors (n = 90). Though Rosenthal observed that the dominate image of scientists were White males, wearing eyeglasses and lab coats, and working in a lab setting with chemical equipment, she

identified that 41% more liberal studies majors than science majors depicted such images reflective of the standard elements. She rationalized that the science majors studied the discipline, had more contact with scientists, and were more apt to represent variety in their images (Rosenthal, 1993).

To improve objectivity, inter-rater reliability, and understanding of individuals' perceptions of scientists as measured by the Draw-a-Scientist Test, Finson, Beaver, and Cramond (1995), developed and field-tested the Draw-a-Scientist Test Checklist (DAST-C). A total of 47 eighth grade students participated in the study for instrument development. Treatment students (n = 24) participated in a career-oriented interdisciplinary program for science. They were exposed to a number of activities, faculty members, and projects pertaining to the discipline. Students in the control group (n = 23) participated in their typical eighth grade science curriculum.

The DAST-C outlined the stereotypes identified by Mead and Metraux (1957) and Chambers (1983) research. Authors of the DAST-C included the seven elements noted by Chambers as well as additional measures. After revisions, they added eight alternative images for scientists. Alternative images included elements such as gender (which was usually depicted as male), Caucasian (few drawings represented non-White individuals, indications of danger, presence of light bulbs, mythic stereotypes (e.g., Frankenstein, Mad/Crazed), indications of secrecy (e.g., signs or warnings, "Private", "Keep Out"), scientist working indoors, and middle-aged or elderly scientist. Finson, Beaver, and Cramond (1995) also added the open comments section, though it was not included in the scoring of the instrument, which allowed scorers to make remarks such as the scientists' dress, facial expression, and type of work. Scoring of DAST drawings using the DAST-C allowed

researchers to check off the number of stereotypical elements present in illustrations. One could add the number of checkmarks to obtain a total score for the image; the higher the score, the more stereotypical the representation (Finson, Beaver, & Cramond, 1995).

Over the years, research was also conducted to assess the perceptions of scientists depicted by students from diverse racial backgrounds. In an effort to better understand the underrepresentation of Black females in science, Parsons (1997) conducted a study that evaluated this demographic's views of scientists. The author individually interviewed a sample of 20 participants for approximately 45 minutes. During the interviews, students completed the Draw-a-Scientist Test and were asked questions relating to their sketches upon completion of the instrument. Analysis of verbatim interview responses revealed that 55% of the participants illustrated their scientist as a White male, 20% as Black male, 10% as Black female, and 5% as White female. In addition, Parsons (1997) identified that the differences in the participants' drawings for the White and Black scientists aligned with dominant (White) cultural ethos and Black cultural ethos respectively (Boykin, 1983). Parsons (1997) argued that a Black students' representation of a scientist as a Black person may have represented their internalization of the nine dimensions of Black cultural ethos: spirituality, harmony, movement, verve, affect, communalism, expressive individualism, orality, and social perspective of time (Boykin, 1983, 1986). Acceptance of such views conflict with ideas expressed in dominant cultural ethos, White male aspects often perpetuated in school science and the scientific enterprise. Conflict between the cultural ethos of Blacks and that of stereotypical scientists (i.e, White males) may prohibit Black females from entering the profession.

Methodology

Participants

This study involved 48 Black students majoring in various programs located at a large, predominantly White university located in the southern region. The participants were divided into two groups for comparison: science majors and non-science majors. The science majors group consisted of 17 participants (one male and 16 female) with an average age of 20.6 years and an average grade point average of 3.32 on a 4.0 scale. The non-science majors group was composed of 31 participants (eight males and 23 females) with an average age of 21.7 years with an average grade point average 3.18 on a 4.0 scale. For this study, participants were recruited using a variety of methods including researcher contact with student organizations on campus and solicitation of participants at common campus locations (i.e., library and student union).

Students majoring in science declared their areas of study as biomedical science (65%), chemistry (11%), chemical engineering (6%), exercise science (6%), biology (6%), and pre-medicine (6%). The non-science majors' group was composed of 31 participants (eight males and 23 females) with an average age of 21.7 years with an average GPA of 3.18 on a 4.0 scale. Individuals in this group selected their college majors as education (16%), business (13%), mass communications (10%), political science (10%), accounting (10%), psychology (7%), criminology (6%), social work (6%), creative writing and or history (3%), interdisciplinary social sciences (3%), English (3%), audiology (3%), marketing (3%), management information systems (3%), and undecided (3%).

Data Collection & Analysis

Data was collected using the Draw-a-Scientist-Test (DAST) for all participants and one-on-one, semi-structured interviews with volunteers. The DAST is an instrument that aims to assess participants' perceptions of scientists. Each participant was provided with a piece of unlined white paper with the following phrase written at the top: "Draw a picture that represents your image of a scientist." Subjects were also provided with a 24- pack of colored pencils to enhance their sketches if they desired. The time requirement for the DAST was a minimum of 20 minutes. The DAST drawings were evaluated according to the protocols outlined in the Draw-a-Scientist Test Checklist (DAST-C). The DAST-C provides an outline of 15 stereotypical elements of scientists and an additional section for open comments. Researchers mark one checkmark for each element present in an illustration. Marks are summed to obtain a DAST-C score. The greater the number of marks denoted by the DAST-C, the more stereotypes observed in the depiction of a scientist.

After completion of the DAST, participants were asked if they were willing to continue in the study with a one-on-one interview with the principal investigator. For subjects who agreed to participate, the principal investigator collected contact information and scheduled times to interview. The principal investigator used an interview guide to conduct the semi-structured interviews. Refer to APPENDIX for a copy of the interview guide. In addition, interviews were audio-taped and transcribed for data analysis. Interviews began with a discussion of the participants' drawing from the DAST-C as a lead in to topics related to experiences in kindergarten through twelfth grade science, decisions on selecting science as a college major, and ideas for future career goals. Transcriptions were analyzed for

themes in participants' responses. The group of interview volunteers included 14 participants, one male and 13 female. Table 1 provides additional information about the interview volunteers.

Table 1

Information for Interview Participants[10]

Science Majors	
Jennifer	Female; African American; 20 year-old junior; chemistry major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Edith	Female; African; 21-year-old senior; biomedical science major; had a 3.26 Grade Point Average; grew up in a mostly White, suburban neighborhood; did not belong to any ethnic organizations
Stacey	Female; African American; 21-year old senior; chemistry major; had a 3.3 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Stefanie	Female; African American; 20 year-old junior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mixed race, suburban neighborhood; belonged to two ethnic organizations
Roni	Female; African American; 21 year-old senior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mixed race, urban neighborhood; belonged to one ethnic organization

[10] The names presented in this work are pseudonyms to protect participants.

Table 1 (continued)

Pamela	Female; African; 19 year-old junior; biomedical science major; had a 3.1 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations
Angie	Female; African American; 21 year-old senior; biomedical science major; had a 3.4 Grade Point Average; grew up in a mostly Black, rural neighborhood; belonged to two ethnic organizations
Allison	Female; Black; 20 year-old junior; exercise science major; had a 3.1 Grade Point Average; grew up in a mixed race, rural neighborhood; belonged to two ethnic organizations
Non-Science Majors	
Lola	Female; African; 31 year-old junior; English major; had a 3.4 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to two ethnic organizations
Lily	Female; African-Caribbean American; 22 year-old senior; creative writing major; had a 3.0 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations
Wesley	Male; African American; 23 year-old senior; criminology major; had a 3.0 Grade Point Average; grew up in a mostly Black, urban neighborhood (ghetto); belonged to two ethnic organizations

Table 1 (continued)

Kimberly	Female; African American; 20 year-old psychology major; had a 3.4 Grade Point Average; grew up in a mostly Black, suburban neighborhood; belonged to one ethnic organization
Jane	Female; West Indian-Caribbean Black; 22 year-old; started the study as an early childhood education major, but changed to a biomedical science major; had a 3.0 Grade Point Average; grew up in a mostly White, suburban neighborhood; belonged to one ethnic organization
Kayla	Female; African American; 20 year-old; psychology major; had a 3.8 Grade Point Average; grew up in a mixed race, suburban neighborhood; did not belong to any ethnic organizations

Findings

For the 48 participants who completed the DAST, drawings were first categorized based on the gender of the scientist represented. The gender of the scientist was classified as male, female, "dual-gender", and "non-human." Dual-gender was the term used to classify images that represented half of the scientist's face as male and the other half of the scientist's face as female. Male gender was indicated by short hair and in some instances facial hair. Female gender was represented by long hair, eyelashes, and in some instances lipstick and breasts. The non-human term was developed because several of the participants' drawings

did not represent the scientist as a person instead they sketched objects or elements representative of the participants' perceptions of a scientist (i.e., beakers, test tubes).

After sketches were separated based on gender they were then categorized based on race as indicated by skin color. Scientists were classified as White if participants enhanced their drawings with lighter colored pencils for skin color. Considering researcher could not determine the specific race of scientists colored with brown skin as being a specific racial group (i.e., Black, Asian American, or Hispanic American), such images were termed as non-White. In addition, there were instances when participants distinguished half of the scientists' skin as one race and the other half as another race. These participants wanted to draw their scientists to reflect more than one race of people. As such, the term multi-racial was used for these drawings. Finally, there were drawings that did not express an assigned race for the scientists. These drawings were labeled "indeterminate."

The researcher provided the participants with unlined white paper; therefore, evaluation of drawings did not allow for the differentiation between instances when participants elected not to assign a race to their scientists and left it blank or when participants wanted the scientists to be Caucasian and left the drawing the color of the white paper. Illustrations of scientists in this category were labeled as indeterminate, a term used by Rosenthal (1993) to account for instances when the evaluator was unable to determine scientists' gender based on participants' sketches. Though the term is used with regard to gender in the aforementioned study, it is an appropriate label race because it provides a description for drawings that can not be classified in a specific racial group. These drawings were not eliminated from the findings. They were not identified as representing a specific race or absence of race, but were classified as indeterminate.

The findings are reported for the science majors and non-science majors groups. Table 2 depicts the percentage of drawings representing the different race and gender classifications for the scientists. The findings are reported by group.

Table 2

Percentage of Scientists Represented By Group

Type of Scientist	Science Majors	Non-Science Majors
Human Representations		
White Male	24	19
White Female	24	3
Indeterminate Male	18	23
Indeterminate Female	0	6
Multi-Racial Female	12	6
Multi-Racial Male	0	0
Multi-Racial Dual-gender	12	0
Non-White Male	0	23
Non-White Female	0	19
Non-Human Representations		
Other (Cross w/ crown of thorns; symbols of science; plant)	12	3

Comments from participants' interviews were categorized according to the scientists' race, gender, work, family status, and mental qualities. Table 3 provides labels and details of

the categories that emerged from the participants' responses with regard to their DAST sketches. The data are reported using participants' actual words as indicated by double quotations. The findings are reported based on the two groups of participants, science majors and non-science majors.

Table 3

Categories and Descriptions of Coding System

Category	Description
Race	Phenotypic expression of scientists' ethnicity
Multi-racial	The scientist represents any racial demographic
Black	The scientist represents those of African descent
White	The scientist represents those of European descent
Gender	Sexual distinction between male and female
Male	The scientist represents men
Female	The scientist represents women
Dual-gender	The scientist represents both men and women
Work	The field of study the scientist works in or the type of work he or she performs
Family Status	The type of familial unit the scientist possesses or belongs to
Single	The scientist is unmarried
Married	The scientist is married
Parent	The scientist has at least one child
Sibling	The scientist has at least one brother and or sister

Table 3 (continued)

Mental Qualities	Aspect related to the scientist's mental functioning (e.g., thought process, personality, attitudes)

Science Majors

Scientist Represented as a White Male

Four of the 17 participants completed their drawings to represent a scientist as a White male. In three of the four images, the scientists were characterized as having blue eyes. The fourth drawing did not indicate a specific eye color for the scientist. Two of the scientists depicted a "mad scientist" figure with unkempt hair. Elements common among all four drawings included the representation of the scientists as wearing lab coats and goggles or glasses. Two of the scientists were shown holding or working with chemicals. These two drawings included other elements of chemistry including test tubes, beakers, an eye wash station, and safety signs. One picture illustrated the scientist as a biologist instructing his class on mitosis. He asks, "Who can correctly explain the different stages of mitosis? Anyone?" This scientist carried a clipboard with notes on mitosis. The final scientist was not drawn expressing a specific field of science. Two of the four White male scientists were drawn as being middle-ages men as indicated by the wrinkled faces and balding hair.

In her interview, Edith, a biomedical science major, indicated that her scientist was White when she was questioned about the scientist's race. She responded that, "Yeah. She's white. I don't know. When I first thought of it, I thought of a White crazy guy. So, I put it as White." Pamela, also a biomedical science major, made comments that corresponded with Edith's. She declared that, "Um, the scientist is…he is White, Caucasian."

Scientist Represented as an Indeterminate Male

As previously addressed, because the participants were given unlined white paper, the researcher could not differentiate instances when the participants did not want to define their scientists' race and left the drawing uncolored from occurrences when the participants wanted the scientist to be Caucasian and left the paper white. The researcher was only able to resolve this discrepancy with the participants who volunteered to participate in one-on-one interviews. Findings from the analysis of interview transcripts regarding participants' DAST drawings are presented following analysis of DAST images.

Of the 17 participants from the science majors group who completed the DAST, the researcher only identified with certainty that three sketched their images of a scientist to represent an indeterminate male. All three of the drawings with indeterminate males depicted middle-aged or elderly individuals, as reflected by their wrinkled faces and balding hair. Two of the three men were completely bald and one was balding in the center of his head. In addition, two of the scientists were drawn wearing eyeglasses or goggles. All three of the indeterminate scientists were depicted in an environment with tools of chemistry. They were surrounded by test tubes, graduated cylinders, and beakers bubbling with liquid. Only one of the scientists drawn in this group was shown wearing a lab coat.

Scientist Represented as a White Female

From the science majors group, four of the 17 participants represented their scientists as a White female. Three of the four drawings show the female wearing a lab coat or apron. Two of the females were wearing dresses while the other two are wearing pants. Three of the four pictures showed the White female scientists in a lab environment while the fourth does not depict the scientist doing any specific type of work. The lab settings expressed included

elements of chemistry such as test tubes, flasks, and beakers. One of three also included aspects related to astronomy, such as a model of a space ship. The scientist in the picture with astronomy symbols conducted a countdown, "5, 4, 3…" All four of the White female scientists were shown wearing eyeglasses or goggles.

Scientist Represented as a Multi-racial Female

While two of the 17 participants in the science majors group represented their drawings as female scientists, they identified their scientists' race as being multiracial or representative or women from all racial backgrounds. Both of the Multi-racial female scientists were drawn wearing a lab coat. One of the scientists was illustrated as a "mad scientist" with unkempt hair that is blue in color. She had on a pink lab coat and pink skin tone. The participant indicated that she drew the scientist pink because it was her favorite color, but pink represented any racial or ethnic group. The other scientists' skin was colored a brown hue; however, the participant included the following note next to her sketch, "Don't take the color into consideration…wanted it not colored so this scientist can represent anybody, any RACE!"

During an interview and in response to a prompt to describe her scientist in detail, Jennifer, a chemistry major, indicated the following explanation for her scientist being expressed as a multi-racial individual:

> Um, I didn't give her a color because there are so many different types of scientists and I didn't just want to make her brown or white or peach or anything like that. She's just kind of the color of the paper which represents all colors…

In her drawing, Nicole represented her scientist as having pink skin. She explained her selection of the pink color in her interview. She indicated that,

> Um, well um I chose a pink scientist because my favorite color is pink. I was going a Black scientist at first, but because you know, science is when you think of it, you think about white scientists, but I feel like a scientist can be any color whether it's blue or purple or any other color. So, that's why I chose pink and it's my favorite color.

Represented as a Dual-gender/Multi-Racial Individual

Two of the 17 drawings analyzed sketched a scientist as a dual-gender, multi-racial person. Each of these drawings expressed an individual's head with half of his face as being male and the other half of her face as being female. The male side had short hair while the female side had long hair. On one of the drawings, the male side also had facial hair. In addition, each picture was drawn with half of the figure enhanced by one skin tone and the other half with a darker skin tone. One participant also sketched her drawing to show one side having a blue eye color and the other half possessing a brown eye color. Neither artist elected to draw the rest of the scientists' body. In one of the images, the scientist is drawn in proximity to the Earth and the caption, "Change the World" is written around the top of the planet. The scientist in the other picture was not represented in any particular setting or performing any specific task.

In her interview, Allison expressed dual-gender, multi-racial views for her scientist. Regarding the race, she responded that, "I put half brown and half white. Different nationalities." Analysis of her drawing revealed that the brown half of the drawing

represented a man (as noted by his short hair cut) and the white half depicted a woman (as expressed by her long hair).

Scientist Represented as Multi-Racial & Non-Human

Two of the 17 participants who completed the DAST instrument elected not to represent their scientists as a person. Instead, they used objects of science and other personal symbols to illustrate their views. One participant identified in her sketch similar elements of science found in the other drawings. She included flasks, test tubes (some of which were broken), and beakers. She also drew strands of DNA molecules and a glass slide with a specimen under a cover slip. Finally, she sketched a flame, the sun, and the sky. The other participant whose picture was labeled Non-Human expressed her image of a scientist by drawing a brown cross with a crown of thorns on the top. The cross was glowing as shown by yellow and orange lines emanating from it. On her drawing, the participant noted that, "Christ is the Greatest Scientist of them all!"

Similarly, another chemistry major, Ann, responded in a manner that also reflected a multi-racial representation of scientists. She wanted to ensure that the researcher understood that science is represented by individuals from all racial backgrounds. Ann replied that:

> So when you said scientist, um, I believe everyone can be a scientist in their own way because you're always hypothesizing, trying new things, so on and so forth, I guess… Science has no race, ethnicity, or gender. It's just like math. You know, it's it's own language basically.

Non-Science Majors

Scientist Represented as a White Male

For the non-science majors group, 31 participants completed the Draw-a-Scientist Test (DAST). Of the participants, six individuals depicted their scientists as White males. Five of the six scientists were represented as wearing lab coats and eyeglasses or goggles. Two of the scientists were middle-aged or elderly as represented by wrinkled faces. One of the scientists was expressed as a "Mad Scientist" as indicated by his wild hair and alarming expression on his face. In addition, this scientist had a sign that read, "Patients Beware" above his head. Half of the scientists drawn as White males were pictured with chemistry supplies surrounding them. These men had test tubes, flasks, and beakers either on a table in front of them, in their hands, or in their pockets. One of the scientists depicted as White male was shown thinking of mathematical equations as expressed in a caption above is head, "(+), π, xyz, (-) 123…(/)." Three of the scientists were also illustrated with writing utensils (e.g., pens and pencils) in the front pocket of the lab coat.

Scientist Represented as a Non-White Male

Seven of the 31 sketches depicted Non-White male scientists. The drawings of these individuals were enhanced with skin tones that ranged in complexion from light brown to very dark brown. As such, the researcher was not able to differentiate specific racial or ethnic backgrounds for the scientists; however, one drawing did have the caption, "Typical perception of a scientist…Asian." This category of scientists had findings similar to the White scientists. Six of the seven images illustrated scientists wearing lab coats. Conversely, only one of the Non-White scientists represented was shown wearing goggles. While most of the scientists were not drawn doing work in any specific field of science, three were shown

with chemistry materials. They were shown near flasks with exploding chemicals and racks of test tubes. The scientist labeled as "Asian" was drawn holding a chart with a picture of a DNA molecule.

During the interview, Wesley, a criminology major and the only male interview participant, identified his drawing as an Black male ballistics scientist. Similarly, Kimberly, a psychology major, also stated that her scientist was a Black male. Specifically, she commented that her scientist was, "Um, he light-skinned I guess…" While Wesley and Kimberly depicted Black men in their drawings, the other participants represented differing images of scientists.

Represented as an Indeterminate Male

From the non-science majors group, seven individuals sketched their scientists as Indeterminate males. Since these participants elected not to enhance their drawings with colored pencils, the researcher could not classify the specific racial or ethnic background of the scientists; however, other findings were apparent in these drawings. Three of the seven Indeterminate males were depicted as middle-aged or elderly men as expressed by the wrinkles on their faces and or balding hair. Two of the seven images illustrated the male as a "Mad Scientist" based on unruly hair that pointed toward the ceiling. Five of the scientists had on lab coats and four of them wore goggles. In addition, three of the males were shown wearing neckties. One of the ties had mathematical information written on it, "π…3.14...Pie." This same scientist was the only one drawn in an academic environment. He was illustrated next to a bench with bubbling flasks and beakers. Above his work table there was a framed picture of a person with the label "Einstein" on it. Finally, he has books labeled Calculus, Chemistry, and Physics beneath his table. One of the scientists in the Indeterminate male

category was shown with a stethoscope around his neck and the title "Dr. Benson" next to his head. Another scientist was illustrated with a question mark on the front of his shirt and several captions above his head, "I wonder…What if?...How does this work/apply?...Questions, thoughts, ponder, challenge, study."

Scientist Represented as a White Female

Of all the sketches completed by the Non-Science Majors group, only one of the pictures represented the scientist as a White female. This woman was drawn wearing a lab coat and goggles. She had pens in her front coat pocket. She was depicted standing next to a table with a book and flask on it.

Scientist Represented as a Non-White Female

The majority of the female scientists represented by the Non-Science Majors group were shown as Non-White females (six). These pictures were enhanced with dark brown colored pencils. Most of the women were shown with long hair while one was drawn with a short afro. Five of the females were depicted wearing lab coats and three had on goggles. Only two of the women were shown doing a specific type of science while the others were drawn without being engaged in any activity. One of the Non-White females was working in a chemistry lab. She was holding a beaker with a thermometer in it. The other was shown holding a stick in one hand and book titled *Law of Gravity* in the other.

From the interviews, Lola, an English major, provided a vivid image of her Black female scientist. Lola stated that, "I drew a Black woman**,** in her, maybe early forties with an afro and gold earrings… she looks aged around the eyes maybe a little." Kayla, a psychology major, also expressed that she drew her scientist as a Black female.

Scientist Represented as an Indeterminate Female

Two pictures of female scientists were labeled as Indeterminate as participants did not color their drawings to indicate a racial or ethnic background. The scientists were identified as female based on their long hair and feminine characteristics and or features (i.e., lipstick, earrings, breasts). Both of these women were shown wearing lab coats, but neither of them had on goggles or glasses. One of the females was illustrated standing next to a table with a beaker boiling on a hot plate. The notations "H_20= water" and "CO_2" were written above her head. The other woman was not shown engaged in an activity. During the interview, a participant made comes that expressed that her scientist was an indeterminate female. Regarding the gender of her scientist, Jane remarked that,

> Um, it's a female. I did that because your first, well my first thought when you think of a scientist is probably male, so I made a point to draw a female. So, I think that's the most important part of my picture, the gender.

However, when asked about the scientist's race, Jane stated, "I don't know. Cause when I…I don't place importance on stuff like that so I wouldn't know what to make it."

Scientist Represented as an Indeterminate Person

Catherine, a creative writing major, did not want to assign either a race or a gender to her scientist. She preferred her drawing to represent anyone who wants to be a scientist; therefore, her scientist was multi-racial and dual-gender. Her rationale for this was that, "Um, I was trying to make like an average person. Someone who didn't look this, who wasn't totally female, totally male." When asked if the scientist was of a particular race, Catherine replied that, "No, it's just a person who asks a lot of questions and most of the time they actually go out and try to find the answers to them." Though her comments expressed an

individual who was not totally female and not totally male, her drawing depicted a male figure as expressed by a person with short hair and long pants. Prior to the interview, the researcher coded Catherine's scientist as male gender during her review of DAST drawings using the DAST-C.

Scientist Represented as Non-Human

For the Non-Science Majors group, only one image of a scientist was labeled as "Non-Human". This participant chose to represent a scientist by drawing a picture of a plant. The specific type of plant was indistinguishable to the researcher. The plant was drawn using a purple colored pencil.

Draw-a-Scientist Test Checklist (DAST-C)

Descriptive and inferential statistics were also used to analyze the participants' illustration of stereotypical images in their Draw-a-Scientist Test (DAST) sketches via the participants' scores on the Draw-a-Scientist Test Checklist (DAST-C). The DAST-C was used to assess DAST drawings for representations indicative of common stereotypes of scientists. Individuals' drawings were evaluated on 16 stereotypical elements expressed for scientists. One point was assigned to each stereotype represented in the drawing. The percentages of participants expressing stereotypical views, mean scores for the DAST-C, and results of the Levene's test of Variances and the independent samples test.

First, the number of responses for each stereotypical category were summed and divided by the total number of participants in the science majors' category to obtain the percentage of respondents who drew images representing that particular stereotype. Table 4 provides an outline of the DAST-C with the percentages of science majors and non-science majors responding to each stereotypical element. Second, Table 5 outlines the mean scores

on the DAST-C for the science majors (coded as SM) and non-science majors (coded as NSM). The mean represents the average number of stereotypical elements represented in the participants' drawings. Findings revealed that both groups, science majors and non-science majors, represented an average of four stereotypes in their drawings of scientists. These results indicate that overall, both groups participants held 25% of the stereotypical views of scientists.

Table 4

Percentages of participants by group indicating stereotypical elements

Stereotype	Science	Non-Science
1. Lab Coat (usually but not necessarily white)	53	84
2. Eyeglasses	65	43
3. Facial Growth of Hair (beards, mustaches, Abnormally long sideburns)	24	23
4. Symbols of Research (scientific instruments, lab equipment of any kind)	47	32
5. Symbols of Knowledge (principally books, filing cabinets, clipboards, pens in pocket, etc.)	35	26
6. Technology (the "products of science)	12	0
7. Relevant Captions (formulae, taxonomic Classification, the "eureka!" syndrome)	29	23
8. Male Gender	41	61

Table 4 (continued)

9. Caucasian	53	23
10. Indications of Danger	6	6
11. Presence of Light Bulbs	0	3
12. Mythic Stereotypes (Frankenstein creatures, Jekyll/Hyde figures, "Mad/Crazed")	12	13
13. Indications of Secrecy (signs or warnings of "Private", "Keep Out", "Do Not Enter", "Go Away", "Top Secret", etc.)	0	3
14. Scientist Doing Work Indoors	35	32
15. Middle Aged or Elderly Scientist	24	26
16. Open Comments		
• Smiling Face	59	26
• Chemist	53	26

Table 5

Mean Scores for Draw-a-Scientist Test Checklist (DAST-C)

Total Score	Group	N	Mean	Std. Deviation	Std. Error of Mean
	SM	17	4.35	3.10	.75
	NSM	31	4.03	2.34	.42

The Levene's test to measure the normality of the variances for the science majors' and non-science majors' scores revealed that the two variances were not significantly different (.24 > .05); they were approximately equal. As such, equal variances can be assumed. Based on the significance value of .69, there was no significant difference in means for the science majors and non-science majors on the DAST-C; each group illustrated approximately the same number of stereotypical images in their drawings of scientists. This finding was contrary to what the researcher anticipated because the hypothesis was that the science majors would sketch less than 50% of the stereotypes of scientists and the non-science majors would illustrate greater than 50% of the stereotypes. However, the means of the groups were similar, 4.35 (27% of the stereotypes) and 4.03 (25% of the stereotypes) respectively. These numbers indicated the science majors sketched 2% more stereotypes than the non-science majors.

Finally, reliability analysis for DAST-C was also computed using SPSS. For the first 15 (the 16th item was the additional comments section) items evaluated by the DAST-C, the calculated Cronbach's alpha was .69. This number indicated that the reliability coefficient did not successfully meet the standard of .70. As such, if the instrument was re-cast and re-administered to the same participants, their scores on the DAST-C may differ from those observed in this present study. In response to this finding, the researcher employed interview strategies to elucidate participants' perceptions of scientists.

Discussion of Findings

Analysis of the participants' sketches for the Draw-a-Scientist Test (DAST) and Draw-a-Scientist Test Checklist (DAST-C) revealed a number of differences between the science majors and non-science majors concerning their perceptions of scientists. Findings

exposed that the science majors completed drawings that reflected a limited, less multi-cultural perspective of scientists. Their illustrations primarily represented White men. As expressed in their interview findings, the science majors often drew pictures that reflected their past or current science teachers and or professors; the majority of whom are White males and females. Science majors were less likely to draw pictures of themselves or individuals who looked like them to illustrate a scientist. For example, Pamela indicated that her scientist represented her current chemistry professor, a White male. Pamela's statement suggests the possibility that science majors have had years of exposure to scientists who were unlikely to be Blacks; their perceptions of scientists were that of who instructed them. These findings were counter to Rosenthal's (1993) study of science majors' and liberal arts majors'. She found that liberal arts majors were more inclined to sketch stereotypical images of scientists while science majors' representations were more diverse. The present researcher attributes this disparity in results to the population of participants in the study, all Black college students in comparison to Rosenthal's racially diverse participants.

In contrast to the science majors' drawings, the non-science majors depicted broader, more multi-cultural perspectives of scientists. The non-science majors were more inclined to draw images of themselves as scientists. For example, Wesley illustrated his Black male image as a ballistic scientist; Wesley is criminology major. Additionally, Lola sketched a picture of a Black woman with an afro and gold hoop earrings. She indicated that her scientist was around 40 years of age. Lola is a 31-year old who wears her hair as an afro and had on hoop earrings the day of the interview. Findings such as these suggest that the non-science majors used a variety of reference points that impacted their images of scientists. Such influences included their personal interests and characteristics, friends, family, and

media. Results surrounding influences on participants' perceptions of scientists are consistent with data obtained by previous researchers. They also indicated that media and societal factors heavily impacts individuals' images of scientists (Barman, 1999; Chambers, 1983; Finson, 2003).

From the science majors' DAST sketches, it was interesting to find that none of the participants illustrated their scientists as a Non-White male or female. Though the Multi-racial female scientists represented all racial and ethnic demographics of people, none of the participants declared their scientists as being members of a racial or ethnic minority group. Again, this finding reflects that the science majors were less inclined to draw themselves or someone of the racial group as the scientist. Such results are consistent with past research assessing the race of scientists illustrated by participants completing the DAST. Previous researchers have identified that individuals stereotypically represent a scientist as a White male with limited illustrations depicting a person of color (Finson, 2003; Fung, 2002; Mason, Kahle, & Gardner, 1991; Parsons, 1997). Images sketched featuring White male scientists are observed by participants of all races; Black students were inclined to draw Caucasian men rather than Black male scientists (Finson, 2003; Parsons, 1997).

Finally, the finding that the average number of stereotypes represented by the participants was four is consistent with previous research studies. Earlier studies using the DAST to assess individuals' perceptions of scientists indicated that the number of stereotypes depicted in images increased as individuals progressed through school (Chambers, 1983; Schibeci & Sorensen, 1983). While most second-grade students illustrated two images and fifth graders expressed three or four, adults were observed to include four or five elements,

similar to findings for the science majors and non-science majors in this study (Chambers, 1983; Schibeci & Sorensen, 1983).

Limitations & Implications

Limitations

The work presented in this study exhibited several limitations. A set of limitations pertain to the generalizability of the findings regarding the selectivity based on race of participants and institution where the study occurred. For example, the researcher incorporated purposeful sampling and only collected data from Black college students Random sampling would have helped to improve the generalizability of the results. Though the researcher justified this restriction for participants due to the fact that Blacks are underrepresented in the sciences and factors needed to be explored to understand the low numbers, a more diverse sample of participants may produce additional findings.

The geographic region in which the study occurred was a third limitation. Data collection was limited to Black college students in one region of the United States at one university setting. Being that the study took place in the Southern area of the country, specifically at a predominately-White university, findings may not be indicative of the rest of the country. For future exploration, the researcher would expand the study beyond the South to other regions as well as different academic settings. The researcher would sample students at historically Black colleges and universities as well. A fourth drawback to the study was that the researcher was unable to recruit a large number of male participants. Therefore, data collected did not allow for inferences to be made about the sample regarding the gender of the participants involved in the study. The sample predominately consisted of females.

The restriction of the participants' Grade Point Average was a fifth limitation to this study. The researcher established a limit of a 3.0 for the academic GPA for the participants. Though this designation was to account for the stereotype that Blacks are not smart enough to participate in science, the researcher acknowledges that the GPA restriction eliminated a number of students from the study who may have volunteered to participate. A sixth limitation for this study was the nature of the interview questioning. Analysis of interview data revealed instances when the researcher used closed-ended inquires in her questioning of participants. In contrast to open-ended questioning, closed-ended inquires may influence interviewees' responses.

Implications

Findings suggest that participants' perceptions of scientists were impacted by the images they encountered regarding scientists. Despite the fact that the science majors who participated in this study were Black, the majority of them accepted the image of a White male scientist and expressed these views in their drawings. This result is an issue because it supports the notion that racial stereotypes of scientists are evident and persistent in individuals' perceptions. It speaks to the fact that media influences and continued low percentages of people of color in science disciplines affects how students internalize and express their views of who is able to be a scientist. When perceptions reveal that individuals do not view Blacks as scientists, society will continue to perpetuate the stereotype that Blacks are not present in the discipline. Consequently, findings express that the future workforce is not scientifically literature. One aspect of the nature of science and scientific literacy recognizes that science is culturally and socially embedded. As such, everyone,

regardless of race, is capable of being a scientist (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002).

Finally, findings from this study imply that not only is it important to assess students' racial identity and perceptions of scientists and their potential impact in the classroom, it is also vital to evaluate the research and practice of teachers and administrators. The fact that science majors primarily represented illustrations of scientists as White men which reflected their experiences with science teachers and professors indicates that the teaching profession needs racial diversification. Few participants in the study expressed that they had been educated by an Black science teacher or professor; they indicated that their science instructors were mostly White males and females.

References

Abrams, L., & Trusty, J. (2004). African Americans' racial identity and socially desirable responding: An empirical model. *Journal of Counseling & Development, 82*, 365-374.

Atwater, M. M. (2000). Equity for Black Americans in precollege science. *Science Education, 84*(2), 154-179.

Bamberger, G. (1987). *Occupationnal choice: The role of undergraduate education.* Unpublished Ph.D. Dissertation, University of Chicago, Chicago.

Barlow, A., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 41*(9), 861-881.

Barman, C. R. (1999). Students' views about scientists and school science: Engaging K-8 teachers in a national study. *Journal of Science Teacher Education, 10*(1), 43-54.

Barton, A. C., Hindin, T. J., Contento, I. R., Trudeau, M., Yang, K., Hagiwara, S., et al. (2001). Underprivileged mothers' perspectives on science. *Journal of Research in Science Teaching, 38*(6), 688-711.

Barton, A. C., Koch, P. D., Contento, I. R., & Hagiwara, S. (2005). From global sustainability to inclusion education: Understanding urban children's ideas about the food system. *International Journal of Science Education 27*(10), 1163-1186.

Basalla, G. (1976). Pop science: The depiction of science in popular culture. In G. Holton & W. A. Blanpied (Eds.), *Science and its public* (pp. 261-278). Dordrecht-Holland: Reidel Publishing Co.

Basu, S. J., & Barton, A. C. (2005). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching*, 1-24.

Bogdan, R. C., & Bilken, S. K. (1998). *Qualitative research in education: An introduction to theory and methods* (3rd ed.). Boston, MA: Allyn and Bacon.

Boykin, A. (1983). The academic performance of Afro-American children. In J. Spencer (Ed.), *Achievement and achievement motives* (pp. 321-371). San Francisco: W. Freeman.

Brickhouse, N. W., Lowery, P., & Schultz, K. (2000). What kind of girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*(5), 441-458.

Brickhouse, N. W., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching, 38*(8), 965-980.

Brown, B. A. (2004). Discursive Identity: Assimilation into the culture of science and its implications for minority students. *Journal of Research in Science Teaching, 41*(8), 810-834.

Brown, B. A. (2005). The politics of public discourse: Discourse, identity, and African Americans in science education. *The Journal of Negro Education, 56*(2&3), 205-220.

Brown, B. A. (2006). "It isn't no slang that can be said about this stuff": Language, identity, and appropriating science discourse. *Journal of Research in Science Teaching, 43*(1), 96-126.

Carter, R. T., & Helms, J. E. (1988). The relationship between racial identity attitudes and social class. *The Journal of Negro Education, 57*(1), 22-30.

Chambers, D. W. (1983). Stereotypic Images of the scientist: The Draw-a-Scientist Test. *Science Education, 67*(2), 255-265.

Chang, D. F., & Sue, S. (2003). The effects of race and problem type on teachers' assessments of student behavior. *Journal of Consulting and Clinical Psychology, 71*(2), 235-242.

Cokley, K. O., & Helm, K. (2001). Testing the construct validity scores on the Multidimensional Inventory of Black Identity. *Measurement & Evaluation in Counseling & Development, 34*, 80-95.

Collins, K. W., & Lightsey, O. R., Jr. (2001). Racial identity, generalized self-efficacy, and self-esteem: A pilot study of a mediation model for African American women. *Journal of Black Psychology, 27*(3), 272-287.

Cross, W. E., Jr. (1971). The Negro-to-Black conversion experience. *Black World*, 13-27.

Cross, W. E., Jr. (1991). *Shades of Black: Diversity in African-American identity.* Philadelphia: Temple University Press.

Cross, W. E., Jr. (1995). The psychology of Nigrescence: Revising the Cross Model. In J. G. Ponterotto, J. M. Casas, L. A. Suzuki & C. M. Alexander (Eds.), *Handbook of multicultural counseling* Thousand Oaks, CA: Sage.

Cross, W. E., Jr, & Vandiver, B. J. (2001). Nigrescence theory and measurment: Introducing the Cross Racial Identity Scale (CRIS). In J. G. Ponterotto, J. M. Casas, L. M. Suzuki & C. M. Alexander (Eds.), *Handbook of Multicultural Counseling* (2nd ed., pp. 371-393). Thousand Oaks:CA: Sage.

Duru, M., & Mingat, A. (1979). Comportement des bacheliers: modele de choix de disciplines (High school graduates behaviour, model of the choice of subject when entering university). *Consommation, 26*(3-4), 245-262.

Erickson, E. (1959/1980). *Identity and the Life Cycle*. New York: Norton.

Fadigan, K. A., & Hammrich, P. L. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Journal of Research in Science Teaching 41*(8), 835-860.

Finson, K. D. (2003). Applicability of the DAST-C to the images of scientists drawn by students of different racial groups. *Journal of Elementary Science Education, 15*(1), 15-26.

Finson, K. D., Beaver, J. B., & Cramond, B. L. (1995). Development and field test of a checklist for the draw-a-scientist test. *School Science and Mathematics, 95*, 195-205.

Fung, Y. Y. H. (2002). A comparative study of primary and secondary school students' images of scientists. *Research in Science & Technological Education, 20*(2), 199-212.

Fusco, D. (2001). Creating relevant science through urban planning and gardening. *Journal of Research in Science Teaching, 38*(8), 860-877.

Fusco, D., & Barton, A. C. (2001). Representing student achievements in science. *Journal of Research in Science Teaching, 38*(3), 337-354.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational research: An introduction*. Boston, MA: Pearson Education, Inc.

Gilbert, A., & Yerrick, R. (2001). Same school, separate worlds: A sociocultural study of identity, resistance, and negotiation in a rural, lower track science classroom. *Journal of Research in Science Teaching, 38*(5), 574-598.

Good, T. L. (1987). Two decades of research on teacher expectations: Findings and future directons. *Journal of Teacher Education, 38*, 32-47.

Goodlad, J., & Oakes, J. (1998). We must offer equal access to knowledge. *Educational Leadership, 45*(5), 16-22.

Green, P. (1999). Seperate and still unequal: Legal challenges to school tracking and ability grouping in America's public schools. In L. Parker, D. Deyhle & S. Villeras (Eds.), *Race is...Race isn't: Critical race theory and qualitative studies in education* (pp. 231-250). Boulder, CO: Westview Press.

Griffard, P. B., & Wandersee, J. H. (1999). Challenges to meaningful learning in African American females at an urban science high school. *International Journal of Science Education, 21*(6), 611-632.

Hagrow, A. M. (2001). Racial identity development: The case of Mr. X, an African American. *Journal of Mental Health Counseling, 23*(3).

Helms, J. (1999). Another meta-analysis of the White racial identity attitude scale's Cronbach Alphas: Implications for validity. *Measurement & Evaluation in Counseling & Development, 32*(3), 122-138.

Helms, J. (Ed.). (1990). *Black and White racial identity: Theory, research, and practice*. Westport, CT: Greenwood Press.

Hodge, D., & Gillespie, D. (2003). Phrase completions: An alternative to Likert scales. *Social Work Research, 27*(1), 45-55.

Jayaratne, T. E., Thomas, N. G., & Trautmann, M. (2003). Intervention program to keep girls in the science pipeline: Outcome differences by ethnic status. *Journal of Research in Science Teaching, 40*(4), 393-414.

Lederman, N. G., Abd-El-Khalick, F., Bell, R., & Schwartz, R. S. (2002). Toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39*(6), 497-521.

Lewis, B. F., & Collins, A. (2001). Interpretive investigation of the science-related career decisions of three African American college students. *Journal of Research in Science Teaching, 38*(5), 599-621.

Lockett, C. T., & Harrell, J. P. (2003). Racial identity, self-esteem, and academic achievement: Too much interpretation, too little supporting data. *Journal of Black Psychology, 29*(3), 325-336.

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

Mason, C. L., Kahle, J. B., & Gardner, A. L. (1991). Draw-a-Scientist Test: Future implications. *School Science and Mathematics, 91*(5), 193-198.

Maton, K., Hrabowski, F., & Schmitt, C. (2000). African American college students excelling in the sciences: College and postcollege outcomes in the Meyerhoff Scholars Program. *Journal of Research in Science Teaching, 37*(7), 629-654.

Mead, M., & Metraux, R. (1957). The image of the scientist among high school students: A pilot study. *Science Education, 126*(3269), 383-390.

Miller, D. B. (1999). Racial socialization and racial identity: Can they promote resiliency for African American adolescents? *Adolescence, 34*(135), 493-501.

Montmarquette, C., Cannings, K., & Mahseredjian, S. (2001). How do young people choose college majors? *Economics of Education Review, 21*(6), 543-556.

Moreland, C., & Leach, M. M. (2001). The relationship between Black racial identity and moral development. *Journal of Black Psychology, 27*(3), 255-271.

NCES. (2006). Retrieved August 1, 2006 from http://nces.ed.gov/index.asp.

Neal, L. V. I., McCray, A. D., Webb-Johnson, G., & Bridgest, S. T. (2003). The effects of African American movement styles on teachers' perceptions and reactions. *The Journal of Special Education, 37*(1), 49–57.

NSF. (2006). Retrieved August 4, 2006, from http://www.nsf.gov/

Ogbu, J. U. (1986). Consequences of the American caste system. In U. Neisser (Ed.), *The school achievement of minority children* (pp. 19-56). Hillsdale: NJ: Lawrence Erlbaum Associates, Inc.

Parham, T. A., & Helms, J. E. (1985). Relation of racial identity attitudes to self-actualization and affective states in Black students. *Journal of Counseling Psychology, 32*, 432-440.

Parsons, E. C. (1997). Black high school females' images of the scientist: Expression of culture. *Journal of Research in Science Teaching, 34*(7), 745-768.

Parsons, E. C., Travis, C., & Simpson, J. S. (2005). The Black cultural ethos, students' instructional context preferences, and student achievement: An examination of culturally congruent science instruction in the eighth grade classes of one African American and one Euro-American teacher. *The Journal of Negro Education, 56*(2&3), 183-203.

Phinney, J. (1989). Stages of ethnic identity in minority group adolescents. *Journal of Early Adolescence, 9*, 34-49.

Rascoe, B., & Atwater, M. M. (2004). Black males' self-perceptions of academic ability and gifted potential in advanced science classes. *Journal of Research in Science Teaching, 42*(8), 888-911.

Rosenthal, D. B. (1993). Images of scientists: A comparison of biology and liberal studies majors. *School Science and Mathematics, 93*(4), 212-216.

Rowley, S. J., Chavous, T. M., & Cooke, D. Y. (2003). A person-centered approach to African-American gender differences in racial ideology. *Self and Identity, 2*, 287-306.

Rubin, E., Bar, V., & Cohen, A. (2003). The images of scientists and science among Hebrew- and Arabic-speaking pre-service teachers in Israel. *International Journal of Science Education, 25*(7), 821-846.

Russell, M. L. (2005). Untapped talent and unlimited potential: African American students and the science pipeline. *Negro Educational Review, 56*(2&3), 167-182.

Russell, M. L., & Atwater, M. M. (2004). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a

predominantly White institution. *Journal of Research in Science Teaching, 42*(6), 691-715.

Schibeci, R. A., & Sorensen, I. (1983). Elementary school children's perceptions of scientist. *School Science and Mathematics, 83*(1), 14-20.

Scott, L. D., Jr. (2003). The relation of racial identity and racial socialization to coping with discrimination among African American adolescents. *Journal of Black Psychology, 33*(4), 520-538.

Seiler, G. (2001). Reversing the "standard" direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching, 38*(9), 1000-1014.

Seller, R. M., Rowley, S. A., Chavous, T. M., Shelton, J. N., & Smith, M. A. (1997). Multidimensional Inventory of Black Identity: A preliminary investigation of reliability and construct validity. *Journal of Personality and Social Psychology, 73*, 805-815.

Seyfried, S. F. (1998). Academic achievement of African American preadolescents: The influence of teacher preceptions. *American Journal of Community Psychology, 26*(3), 381-402.

Songer, N., Lee, H.-S., & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching, 39*(2), 128-150.

Tate, W. F. (2001). Science Education as a Civil Right: Urban schools and opportunity-to-learn considerations. *Journal of Research in Science Teaching, 38*(9), 1015-1028.

Tatum, B. D. (2004). Family life and school experience: Factors in the racial identity development of Black youth in White communities. *Journal of Social Issues, 60*(1), 117-135.

Thomas, A. J., & Speight, S. L. (1999). Racial identity and racial socialization attitudes of African American parents. *Journal of Black Psychology, 25*(2), 152-170.

Thompson, V. L. S., & Akbar, M. (2003). The understanding of race and the construction of African American identity. *The Western Journal of Black Studies, 27*(2), 80-88.

Thornton, M. C. (1997). Strategies of racial socialization among Black parents: Mainstream, minority, and cultural messages. In R. J. Taylor, J. S. Jackson & L. M. Chatters (Eds.), *Family life in Black America* (pp. 201-215). Thousand Oaks, CA: Sage.

Tobin, K., Roth, W.-M., & Zimmermann, A. (2001). Learning to teach science in urban schools. *Journal of Research in Science Teaching, 38*(8), 941-964.

Tucker, C. M., & Herman, K. C. (2002). Using culturally sensitive theories and research to meet the academic needs of low-income African American children. *American Psychologist, 57*(10), 762-773.

Tucker, C. M., Porter, T., Reinke, W. M., Herman, K. C., Ivery, P. D., Mack, C. E., et al. (2005). Promoting teacher efficacy for working with culturally diverse students. *Preventing School Failure, 50*(1), 29-34.

USCB. (2006). *United States Census 2000*. Retrieved August 1, 2006. from http://www.census.gov/main/www/cen2000.html.

Vandiver, B. J., Fhagen-Smith, P. E., Cokley, K. O., Cross, W. E., Jr., & Worrell, F. C. (2001). Cross's Nigrescence Model: From theory to scale to theory. *Journal of Multicultural Counseling & Development, 29*(3).

Vinson, T. S., & Neimeyer, G. J. (2000). The relationship between racial identity development and multicultural counseling competency. *Journal of Multicultural Counseling & Development, 28*(3).

Wilson, J. W., & Constantine, M. G. (1999). Racial identity attitudes, self-concept, and perceived family cohesion in Black college students. *Journal of Black Studies, 29*(3), 354-366.

Winston, C. E., Rice, D. W., Bradshaw, B. J., Lloyd, D., Harris, L. T., Burford, T. I., et al. (2004). Science success, narrative theories of personality, and race self complexity: Is race represented in theidentity construction of African American adolescents? *New Directions for Child and Adolescent Development, 106*, 55-76.

Worrell, F. C., William, K., Jr., & Vandiver, B. J. (2001). Nigrescence theory: Current status and challenges for the future. *Journal of Multicultural Counseling & Development, 29*(3).