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Charting Pathways to Success: A Longitudinal Study into the Role of Science in the Lives of High-Achieving African-American High School Seniors

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An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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Doctor of Philosophy
in Educational Studies
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Abstract

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By Courtney E. Tucker

As the U.S. economy becomes more global, and its demographic make-up shifts; increased attention has been placed on the underproduction of scientifically and technologically trained U.S. citizens by government officials and business leaders. This underproduction can be attributed to the continued underrepresentation of minorities, particularly African Americans, in the sciences. Although, researchers have identified a variety of historical, cultural, and social explanations for the lack of African Americans in science careers, increasing the number of African Americans pursuing careers in science or science-related fields remains a challenge for science educators and policy makers.

This study explores the effect of science experiences on students' career decisions and future goals. Specifically, it considers how "high-achieving" African-American high school students, who have participated in at least one science intervention program, draw on their lived experiences to formulate definitions of science and visions of success. The study was conducted as a Narrative Inquiry that explored five African-American students' perceptions of science in three ways: as it influenced their formal schooling, as it shaped their everyday interactions, and as it interacted with their future goals. Data were collected over three years and included interviews, application packets, and demographic survey. Individual narratives of the five "high-achieving" African-American students' were constructed. These narratives provide insightful and critical assessments of their formal and informal experiences in science. Key understandings about the students' perceptions of science emerged.

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Chapter 1: Situating the Narrative Inquiry

Introduction

As the darkness gave way to light, Darren Benjamin, a six-foot, African-American male appeared on the stage. He stood in front of his high school peers, family, friends, and strangers to present a four-minute glimpse of who he was, where he had been, and where he was going. The tears in his eyes and the emotion in his voice drove the packed auditorium to bursts of applause and tears. Their emotion carried over into the private spaces of 200,000 individuals, who would watch his speech with silent pride on various internet sites. Here was a young man for whom "Life Ain't Been No Crystal Stair;" a young man who succeeded in becoming the first African-American male valedictorian of his community in over a decade. He climbed stairs of racial profiling, family illness, armed robbery, death of a family member, and drug enticement. Despite the steep climb, he stood on that stage with a 3.9 GPA in Science and one million dollars in college scholarships. He could have chosen any major, but despite encouragement from teachers and mentors, he decided not to pursue a degree or career in science.

In his April 27, 2009 remarks to the National Academy of Sciences, President Barack Obama described traits he considered necessary for scientific discovery. As he concluded his remarks, he stated that "…scientific discovery takes far more than the occasional flash of brilliance...Usually, it takes time, hard work, and patience…" Darren Benjamin represents a group of academically capable and motivated African-American high school students who have shown a commitment to education and have demonstrated this commitment in the course-taking patterns that President Obama considered necessary for scientific discovery. Many are labeled as "academically talented," and have been

exposed to upper-level science and math classes, informal science learning experiences, and a number of potential science mentors. In 2008, after an extensive review of the literature, Taningco, Mathew, and Pachon (2008) concluded that the majority of the minority students who chose an undergraduate major in science, technology, engineering, or math field were considered academically talented. ”Academically talented” students like Darren are most likely to matriculate successfully through the experiences required for scientific training.

As the economy becomes more global, and the demographic the make-up of United States shifts; more and more attention is being drawn to the number of homegrown scientists the United States is producing. Research suggests that the United States may not be producing enough scientifically and technologically trained individuals to meet the demands necessary for the next century. The nation’s ability to remain globally competitive, retain jobs, and have a high standard of living is linked to its ability to produce scientists (Business Roundtable, 2005; National Academies, 2007). Research has shown that the U.S. is falling behind India and China in terms of scientific innovations (DeHaan & Narayan, 2008) and that more companies are situating research and technological jobs overseas (Lieberman, 2004). During this same time period, the United States has failed to produce a number of undergraduates and graduates in science that is comparable to other mature and newly-minted industrialized nations (National Academies, 2007).

Statement of Problem

Numerous studies document the gaps in postsecondary participation and attainment between various racial, ethnic, gender, and income groups. Results from these

studies raise concerns about the ability of the United States to maintain high levels of academically-capable, experienced, and motivated African-American high school students, like Darren, who choose to select futures inside of the fields of science and technology.

A number of researchers have addressed the lack of K-12 students entering science fields and have examined the variables that influence student disengagement; including a lack of mentorship, relevance, content knowledge, language, equity, and self-efficacy (Aikenhead, 1996; Bellisari,1991; Elchinger, 1997; Jones 1997; Larson, 1996; Lee, 1995; Pearson, 1994; Roth, 1993; Sloat,1993; Tobin, 1988;). These studies have provided stimulus for publications and programs, such as the National Science Education Standards, and K-12 initiatives funded by governmental organizations, such as the 2004-2006 National Science Foundation (NSF) study on the effect of interventions on student outcomes, the Integrative Graduate Education and Research Traineeship Program, and the Howard Hughes Pre-College and Undergraduate Science Education Program.

Concerns about future prospects for its workforce led the Department of Defense to commission and publish a 2010-2014 STEM education and outreach strategic plan. This level of urgency and concern shown toward education by the Department of Defense has not been seen since the 1958 passing of the National Defense Education Act, triggered by Sputnik. Encouraging more students like Darren to consider a long-term interest in science will not only increase the pool of scientists, but will also add voices that can address different views and issues in the field.

To produce a global workforce capable of competing in the global market, the number of individuals in science must not only increase, but also must be representative

of the entire U.S. population. Numerous studies document the gaps in postsecondary participation and attainment between various racial, ethnic, gender, and income groups, which raises concerns about the ability of the United State to maintain high levels of competiveness in the global market (National Commission on Excellence in Education, 1983; National Science Board, 2010).

Examining the field of science only magnifies the gaps already present in postsecondary participation. Women and most minorities continue to be under-represented in the physical sciences, technology, and engineering (National Science Board, 2006; 2010). In 2006, African Americans, in particular, earned 8.3% of the bachelor's degrees, 6.6% of master's degrees, and 2.5% of doctoral degrees obtained in science or a science-related field (National Science Board, 2010). These statistics are especially alarming when one considers that African Americans comprise at least thirteen percent of the U.S. population.

Even though the number of undergraduate degrees in science awarded to underrepresented racial and ethnic minorities increased from 10% to 17% over the last decade, the numbers do not reflect their percentage of the population. Moreover, the number of degrees awarded to underrepresented groups is minute when compared to those earned by Whites (Atwater, 2000). Additionally, even though African Americans are obtaining degrees in science, only small percentages ultimately pursue careers in science (Brown, 2000; May & Chubin, 2003). From 1980 to 2007 the number of African Americans in the science workforce increased only slightly, from 3% to 5% (National Science Board, 2010). African-American physicians comprise only 4% of the medical work force (Association of American Medical Colleges, 2010). Even with reform

initiatives and presidential mandates, African Americans have failed to achieve equitable results in science degrees or careers.

Researchers have conducted a number of studies that explore the persistence of African-American students in science at the post-secondary level, but few address how these students made decisions to enter science while at the secondary level. Those that do address the lack of continuation in science at the secondary level categorize students in terms of achievement, language, motivation, views of science, and academic preparation. Missing from this body of literature is how the formation of life objectives and goals influence secondary students' participation in science activities and their selection of an undergraduate major.

Research Questions

This study seeks to explore how African-American high school students, who have records of "high academic achievement" and have participated in at least one science intervention program, draw on their lived experiences to formulate definitions of science. They used these definitions of science to determine whether science would be a part of their successful future selves. By having participants discuss experiences at two different time points, which coincide with their transition from secondary to post-secondary institutions, the stability of definitions over time, space, age, and positionality will be explored. To this end the present study addresses the following questions:

1. What are high school students' definitions of science?
2. What are high school students' visions of success for their post-secondary education and careers?
3. How do high school students' definitions of science and visions of post-secondary success diverge and converge?

4. How do high school students' definitions of science and success evolve over time?

Significance

The usefulness of obtaining a science degree and pursing a career in science is underestimated. Over the next decade, science policy makers predict that the number of jobs in science and science-related fields will increase sharply (National Science Board, 2010). This increase reflects a global trend toward a more knowledge-based economy, with science at the forefront. Individuals with scientific training will be in a position to possess desirable middle class jobs (Buerhaus, Auerbach, & Staiger, 2007; Ingersoll, 2007).

Over the past few decades, policymakers have taken key steps to make up for the lack of U.S. students entering science professions. In 1990, employers tripled the number of their foreign-born employees when congress passed the 1990 Immigration Act. As a result, foreign-born individuals have become the backbone of science development in the United States. In 2003, foreign-born talent accounted for 50% of the engineering and computer science workforce, and 37% of the physical science workforce (National Science Board 2010). As a result, the desire to have a highly populated science pipeline has been, and continues to be, at the forefront of educational, congressional, presidential, and industrial goals.

Recently, President Obama pronounced a commitment to science education by initiating an *Educate to Innovate* campaign, a collaborative effort between the policy and economic sectors to motivate and inspire young Americans to excel in math and science. The campaign includes: a White House science fair, media blasts, national science competitions, a National Laboratory Day, and numerous formal and informal educational

experiences sponsored by leaders in the business world. The premise of this White House-led and private sector-sponsored initiative is that current K-12 students will develop sustained interest in science when presented with unique new opportunities in the field. The hope is that the initiative will increase opportunities, access, and performance on K-12 science assessments; and ultimately will result in an increase in the number of individuals pursuing careers in science and the ability of U.S. citizenry to examine critically science policy issues. If the federal government and private industry are providing funding for these activities at a time when financial resources are minimal, then new research must determine the outcomes of these new science experiences. This research will examine the influence of new opportunities, access, and skills on capable students' decisions to enter the pipeline to that leads to a career in science.

Glaringly absent from the pipeline are underrepresented minority students, such as African Americans. Several studies have explored the persistence of students, particularly African-American students, through the science pipeline (Chubin, May, & Babco, 2005; Maton & Hrabowski, 2004; Pearson & Fechter, 1994; Russell 2005; Wyer 2003). However, these studies continually see science as the biggest issue. This research places African-American students in the pipeline first, and then explores the multiple ways science plays out in their lives. By examining the lived experiences of African-American students *in conjunction* with their views in science, educators and policymakers can develop a better understanding of factors influencing pipeline direction. Hubbard (1999) asserted that exposing the lived experiences of African-American students is one of the most helpful methods for understanding their actions and attitudes.

African Americans are already marginalized in American society. It is imperative that a significant number of African Americans apply for and obtain employment in the growing scientific field, not just to help alleviate the dependence of foreign workers, but also to combat social and economic oppression. African Americans can no longer leave inquiries about issues relevant to their livelihood to others in the field of science. Essential issues, such as environmental racisms, must be addressed, at least partially, with the voices of African-American scholars. This research will shed light on how the knowledge that science education and science careers can enhance social and economic mobility may influence the future goals of "capable" African-American high school students and, possibly, keep them from "leaking" out of the science pipeline.

Organization of Dissertation

This dissertation discusses, in detail, how five African-American high school students, who have records of "high academic achievement" and have participated in at least one science intervention program, draw on their lived experiences to formulate definitions of science. By looking at participants' definitions of science in the context of their lived experiences and future goals and objectives, it is possible to postulate how participants view various science experiences immediately and over time. One goal of this study is to provide a foundation for developing science experiences that empower participants to help themselves and others, not just for a moment, but a lifetime. In particular, this study concentrates on the lack of minority participation in science and science-related careers.

Chapter two presents a review of the literature about understanding African-American students' experiences in K-12 by looking at four key areas: major factors

influencing the education of African-American students in K-12; major issues in science education; African-American students in science at the K-12 level; and African-American students' futures in science. Chapter three provides a detailed description of the conceptual framework and of Narrative Inquiry, the methodological tool utilized in this study. The chapter also presents a summary of the data analysis framework employed in this inquiry. Chapters four and five detail the findings of the study. Chapter four presents participants' portraits or narratives, and in chapter five snapshots of science experiences within the context of participants' retelling of their lives are given through the presentation of composites of science. Chapter six includes a discussion of the role of science in students' visions of their futures.

Chapter 2: Understanding African-American High School Students in Science

Recent federal mandates and national initiatives have shaped much of what students experience in science education today. Hence, this study is limited to studies published between January 2000 and the present, because this timeframe allows for the implementation of the National Science Education Standards and contains multiple years of "high stakes" science education. In cases where historical relevance is needed to understand the current climate, relevant literature was referenced. Also, since this research draws on the experience of U.S. high school students, only studies involving American students are included. Lastly, participants self-identified with underrepresented groups of color. This limits the author to investigating studies that involved students of color. After a brief overview on the educational experiences of African-American youth, the literature is organized to answer three broad questions of investigation:

1. What are the major issues in science education?
2. What is happening to African American students in science at the K-12 level?
3. What choices are African American students making for science career and post-secondary objectives?

Major issues in Science Education

Science policy makers believe that K-12 science education should focus on the preparation of the next generation of scientists. Starting in the 1990s, science educators shifted their focus for K-12 science education to developing a scientifically literate society. While the foci of science policy makers and educators appear to be different on the surface, they actually are striving for the same goal: to create life-long learners and consumers of science.

In 1985, the American Association for the Advancement of Science (AAAS) adopted an initiative to increase scientific literacy for all Americans, *Science for All* (AAAS, 1989). The association named this initiative *Project 2061*. According to the tenets of *Project 2061*, the goal of a quality science education was to prepare a science literate citizenry. AAAS published, *Benchmarks for Science Literacy*, the standards for accomplishing this goal in 1994. A short time later, in 1996, the National Research Council (NRC) published the National Science Education Standards (NRC, 1996), an effort that paralleled the publication of national mathematics standards. Following these publications, reform efforts drew increasing attention to enhancing science education for those students who had been underrepresented in science. At the time, and presently, underrepresented groups in science included women, ethnic minority students, students of low socioeconomic status, and students with disabilities.

The National Science Education Standards articulated that the NRC's goal was to "produce more people with better knowledge of key concepts… [who were] prepared to act like "real" scientists" (p. 268). The reform efforts were meant to increase the overall number of students going through the science pipeline. The NRC attributed the low numbers of students in the pipeline at the time to a lack of quality learning experiences inside and outside of the classroom. Therefore, most of their efforts targeted the number of opportunities to which students have access. However, a number of science education researchers have critiqued this approach.

Rodriguez (2001), for example, contended that the ideology of the standards does not align with a view of excellence and equity that challenges the status quo. He argued that the articulation of the standards values one particular viewpoint over any others.

Students were asked to develop knowledge and skills prescribed as necessary by a highly acclaimed group of scientists, science educators, and science teachers. Students had to adopt the skills that were pertinent to this group of individuals, not necessarily themselves or their community. In addition, Rodriguez (2001) made the claim that by establishing the *Science for All* initiative, there was an implication that underrepresented students, such as African Americans, were "lacking" and needed to catch up with their successful White counterparts.

Mutegi (2011) further problematized this notion of *Science for All*, specifically for African American students. Instead of serving as a rallying point for African Americans, Mutegi characterized the initiative's principles as efficacious, misleading, and dangerous. While pointing out that the knowledge capital that African-American students can gain through a science education is necessary, Mutegi argued that reform efforts validated and reinforced the worldview of colonizers by approaching science from a cultural transmission perspective. Educators and industry leaders expect African-American students to acquire the best products of the intellectual culture of science, but not push to destroy the colonial structure in which the intellectual capital originates. Science education does not encourage students to address social disparities through an understanding of their positionality in society. Rodriguez (2001) and Mutegi (2011) are united in their position that science education reform efforts continue to replicate societal disparities by serving as a tool to level the uneven playing field, not eliminate the ill-constructed field all together.

African-American Students in Science at K-12 level

Critics have long argued that science historically has been situated within a "culture of power" (Barton & Yang, 2000; Harding, 1998). For example, some critics have suggested that the way educators introduced science into the schooling process perpetuated the underachievement and underrepresentation of African-American students in science. Historical influences on science education have contributed to inequities experienced by many African-American students. Despite decades of reform, the legacy of inequity largely shapes science classrooms and the experiences that African-American students have with science. Moreover, Parsons (2008) argued that society continued to deny African Americans access to science knowledge and careers because of political, social, and economic factors.

Atwater (2000) described the inequitable science educational opportunities available for African-American students that Parson (2008) discussed, and addressed the urgency to right these inequities. The author critiqued both the foundation of science education and the aims of science education research about African Americans. Atwater believed that science education was inadequate because of low teacher expectations, inadequate science knowledge and skills of teachers, teachers' poorly-clarified professional and cultural beliefs and values, and a lack of focus on the knowledge and skills outlined in *Science for All Americans*. Atwater clearly subscribed to an understanding of science that privileged science. While laying out numerous concerns and problems in science education for African-American students, Atwater seemed to fall prey to the same elitist mentality that she sought to change when she declared, "it is only their science knowledge that will assist them to alter their worlds" (p. 160). This question

may be exactly what capable African-American high school students are considering when they make choices about courses, careers, and post-secondary objectives: what is the most expedient way to alter their world?

A rich set of research studies provides examples of interventions designed to alleviate the concerns and inequities Rodriguez (2001) and Atwater (2000) described. One lens that researchers have found helpful in examining low achievement and underrepresentation in science is cultural congruency. According to Parsons (2008), cultural congruence addresses the mismatch between the values, beliefs, and practices promoted in school versus those at home and in the community. By approaching science education through the lens of cultural congruency, educators and researchers focus on ways to connect science to the lived experiences of students in meaningful and empowering ways. Teachers should strive to build upon the lives of students in the science classroom, to help students achieve academic success and scientific literacy.

Barton (1998) investigated the call for *Science for All* by examining how urban homeless students represented science and formed an identity within science. The researcher utilized a critical feminist framework to arrive at conclusions similar to Parson (2008). Barton concluded that the learning of science must be a reciprocal relationship, in which science is placed and found in students' lives. The study took place in a homeless shelter located in a depressed urban center in the northeast part of the United States. The researcher utilized an interactive ethnographic teacher-researcher methodology to collect data at the center twice a week. Barton declared "if all students are to participate in science in genuine ways, then teachers need to find ways to value the diverse ways of knowing brought to class by the students" (p. 391). Also she stressed that "educators

must begin to view their own classrooms through the eyes of a child who is hungry, who is sick, and who cries deeply inside for love, support, and stability" (p. 391). Barton advocated for a science education that considered the overall health and well-being of students, by allowing students' funds-of-knowledge to be the main priority in shaping what occurred in the classroom.

With the constraints of testing, benchmarks, and national standards, some teachers find it extremely difficult to develop a class around student ideas, beliefs, and environments. Students' success depends on achieving a certain level of assimilation. The willingness of a student to assimilate determines who hears their voice, shapes opportunities created for them in the classroom, and influences their exposure to scientific experiences. So, one must ask whether students who are successful in science courses during pre-college years, especially those from low socioeconomic or minority groups, grasped the material and learned how their culture influences science, or simply completed steps necessary for academic success.

Using critical ethnography, Basu and Barton (2007) investigated the relationship between "funds of knowledge" and the development of sustained interest in science. The study took place at a recently-established middle school located in a large urban center in the northeastern United States. The school was located in a neighborhood that housed residents primarily of African American, Dominican, Puerto Rican, and other Latino origins. Ninety percent of students were on free and reduced lunch. At the time of the study, the school was categorized by the district as a "poor performance" school. Participants in the study were six and seventh grade students from "high-achieving" sections (tracked in top sections and performed on grade level for reading and math). The

researchers, expanding on Barton's (1998) initial results with homeless students, reported that a sustained interest in science occurred when experiences (1) connected with students' envisioned future, (2) supported valued social relationships, and (3) supported students' sense of agency for the purpose of science.

Long-term interest in science is loosely defined as engagement, enhancement, or extension of course material. The authors did not address the fact that student interest could be limited to a particular activity, event, or day. Also, is the researchers assumed that the incorporation of culture into the classroom and curriculum was enough to sustain student interest through years of "forced" schooling. It is possible that some students would value and appreciate science, but would choose not to continue in the science pipeline; even though, according to the authors' standards, they demonstrated sustained interest throughout their high school career.

Additionally, Elmesky and Tobin (2005) studied how African-American students' cultural resources; such as social interaction patterns, body movement, and oral expression from home and the community; influenced their experiences in the science classroom. Through critical ethnography, like Barton and Basu (2007), Elmesky and Tobin found that expectations and norms necessary for participation in a science classroom were at odds with the social and/or cultural capital that students desired. Respect became the most important capital within the classroom. Through the eyes of student researchers, Elmesky and Tobin outlined experiences were students built and exchanged social and/or cultural capital. Among African-American students, maintaining capital was more important than abiding by school or science classroom norms. While the authors' findings provide valuable insight about students who elect not to engage in

science classroom discourse, they neglect those students from similar background who do. The possibility exists that these students, despite their academic achievement, may possess the exact same thoughts and feelings as the students who have abandoned academic success in science.

Research studies that address the cultural connections between students and science are not limited to studies that only address curriculum and behaviors. Numerous researchers have conducted inquiries that studied youth from linguistic minority backgrounds, who experience marginalization in science (Brown, 2004; Brown 2008; Brown, Reveles, & Kelly, 2005; Lee, Deaktor, Cuevas, Hart, & Enders, 2005; Lee & Fradd 1998; Moje, Collazo, Carrillo, & Marx 2001; Seiler, 2001). Brown (2004) examined students' discursive identities within the formal science classroom. The study occurred in large urban school in Southern California, where 54% of the student population lived below the poverty line; and the school was ranked the lowest possible for performance. The researcher was also the teacher of the students. Data were collected for the entire 1999-2000 school year, and student assistants videotaped all class. The two classes involved in the study were Introductory Biology (87 9^{th} and 10^{th} grade students), and Life Sciences (89 9^{th}, 10^{th}, and 11^{th} grade students, the latter two having failed an introductory course).

Brown (2004, 2006) revealed that some ethnic minority students struggled and did not identify with science discourse in the context of four different discursive identities: opposition status, maintenance status, incorporation status, and proficiency status. Brown called for educators to integrate the natural discourse of students into science instruction. He suggested that it may not be realistic to expect students to adopt the language of

science education, because the dominant culture has developed and institutionalized the scientific culture. Students who choose to pursue post-secondary degrees and careers in science will have to communicate in the dominate language of science with fluency. Also, to interpret and alter science policy, students will have to understand the appropriate terminology and compose text in the dominant discourse. Unfortunately, linguistic integration appears to be reserved for those on the "right" side of the color line.

African-American Students' Futures in Science

Tate (2001) explained, "In today's world, economic access and full citizenship depend crucially on math and science literacy" (p. 1015). Russell and Atwater (2005) concurred with Tate, and asserted that "increased participation in science or science-related careers can offer African-American students opportunities for both social and economic mobility, especially as many of these students are disenfranchised, oppressed, and marginalized as a large part of this nation's lower class" (p. 691). With new scientific advancements across the globe come new opportunities for employment, and African-American students with scientific backgrounds will have increased access to high-status and high-paying jobs created in this global economy. Barton and colleagues (2003) reminded us

> To know science-and to be deemed as one who knows science-is a uniquely powerful stance. Science education is political. It promotes particular images of power, knowledge, and values by rewarding particular forms of individual and institutional behavior. (p. 68)

Whether through economic stability or social status, science is one sure way to provide students with the tools necessary to access the "culture of power" that exists in society.

Educators, researchers, and policy makers have expressed concerns about the lack of interest and participation in science amongst high school students. *Science*, one of the

most important journals amongst researchers, graduate students, undergraduates, and career scientists, now regularly features articles on generating more interest amongst students for careers in science. The journal publishes a section, titled *Focus on Careers*, which highlights different career options and paths in various scientific fields.

Despite support from educators, researchers, and policy makers, students from underrepresented minority populations face many obstacles that can hinder their ability to successful complete science coursework; which, in turn, limits their ability to obtain terminal degrees in science (e.g., Ph.D. and MD) (Chubin, May, & Babco, 2005; Maton & Hrabowski, 2004). Students based their college and career related decisions on the interests they develop during their educational experiences in elementary and secondary school. Unfortunately, educators have not succeeded in fostering in students an interest in science. As a result, researchers have sought to understand and identify the factors that influence students' science career aspirations and identities.

Similarly, Schreiner and Sjøberg (2007) focused on how present climates and cultures influence how students see/value science lessons and the role of science and technology (S&T) in society. In the introduction to the study, the authors posited that "the problem is not a general decline in interest in and respect for S&T as such, but rather a decline in the willingness to opt for S&T related studies and careers" Schreiner and Sjøberg, 2007, p. 1). According to the authors, a students' choice not to continue on a science trajectory does not mean that they have lost their interest in and respect for the field; it simply means that they are opting to pursue different interests. Many view education as a means for self-actualization and for fulfilling and developing one's personal talents and abilities. Hence, how do students' views of education influence their

career choice and engagement in science experiences? Giddens (1991) explained that one's identity is not assigned but chosen and developed. Each person must determine their own identity and must follow their own path to determine who they are and who they will be. Questions shift from "what do you what to be?" to "who do you what to be?"

Schreiner and Sjøberg (2007) found that in all countries, including both modernized and underdeveloped nations, youth expressed a positive view of S&T. However, students' views of the subject matter did not translate into long-term commitment to degrees and careers in science. The authors asserted, "Western youth see numerous options for their educational choice, and their interests plays a key role in their decision. As long as science is not the most interesting subject, they will choose not to pursue it further" (Schreiner and Sjøberg, 2007, p. 8). More research needs is necessary to determine what leads students to select career paths outside of the scientific fields.

Schreine and Sjøberg (2007) focused how students viewed science in the present, while Brickhouse and Porter (2001) examined how students viewed science across time. Brickhouse and Porter followed two young women of color from middle school to high school. As the women progressed through their secondary education, the authors examined how their scientific identities were framed and shaped. The authors found that the subjects' educational decisions were rooted in personal, cultural, and economic factors by comparing and contrasting what motivated the students to participate in science within various contexts. Getting the right grade drove the subjects' work ethic in the classroom, while they participated in the Science Olympiad because of its relevance to their personal interest. Much of what educators and researcher define as student

interest in the classroom may be driven by true interest or the desire for a certain outcome.

In a quantitative study, Jones et al. (2000) investigated the attitudes and experiences of middle school students. For the analyses, the data are aggregated according to gender and implications/contexts discussed. Jones et al. reported a continued perpetuation of gender differences in science experiences, attitudes, perception of science course, and career choices. The authors predicted persistent problems for the science pipeline if the gender differences are not addressed with a strong sense of agency. Also, the researchers concluded that teachers must take responsibility for presenting science as a field that is equally appropriate for boys and girls.

In addition to gender issues, studies have found that the following key components influence students' science career aspirations and identities: self-efficacy, interest, motivation, ethnic identity, academic achievement, socioeconomic status, instructional quality, home environment, role models, view of nature of science, and support for goals. Until educators begin to make significant gains in the number and type of students considering a career in science, the pipeline outcomes will remain the same. The noticeable lack of underrepresented minorities and women will continue, as Jones et al. (2001) predicted.

Some reports state that minority students who enter science undergraduate degree programs are unprepared for the competitive and intellectual rigor of the field. Despite being as talented as their nonminority counterparts, minority students often do not persist through their undergraduate program, which leads to the miniscule number of minority PhDs (Summers & Hrabowski, 2006). These challenges have led to the development of

numerous enrichment and scholarship programs, such as the Meyerhoff Scholarship Program at the University of Maryland-Baltimore County (UMBC), designed to increase the number of science undergraduates and PhDs (Barlow & Villarejo 2004; Maton & Hrabowski 2004; Summers & Hrabowski 2006). Campbell (2000) noted that in spite of significant efforts by NSF, other government agencies, universities, community-based organizations, and the corporate sector; non-Asian minorities continue to be underrepresented in science and science related fields by significant amounts. To date, no program, policy, or initiative has resulted in a considerable decrease in the science degree attainment gap between Whites and minorities. Due to the persistent attainment gap and the crucial role that science plays economic and political growth, it is necessary to understand the myriad issues that influence students', particularly minority students', interest, engagement, and success in science.

Carlone and Johnson (2007) developed a model of science identity to examine how fifteen "successful" women of color internalized their post-secondary science educational experiences. The authors attributed the way the individuals made meaning of science experiences and the way that society structured possible meanings to positionality in society to how science identies were formulate amongst the women. Participants discussed their science interactions and experiences while at the University. The women attributed their persistence in obtaining terminal science degrees to their ability to find spaces for support, encouragement, and affirmation both within and outside of the university. These spaces included minority student organizations, professional organizations catering to minority professionals, on-campus support groups/counseling, church families, and undergraduate/other university mentors. The authors concluded that

if African Americans received more invitation, praise, accolades, and recognition from individuals in science they would persist through the science trajectory.

Carlone and Johnson (2007) also noted that the women sought altruistic careers in science. The finding that interest in science can be associated with philanthropic career goals is in line with Jones et al. (2000), where the subjects preferred careers in science aesthetics and biology. Carlone and Johnson's study highlights the fact that when African Americans choose to persist in the science pipeline, they often do so to for philanthropic reasons.

Concluding the Narrative: Additional Areas for Exploration

The literature presented in this chapter provides a historical overview of science education and provides a context and background for understanding how K-12 science instruction can hinder science achievement and career attainment for African-American students. This chapter detailed a wealth of empirical research that examined the cultural and linguistic disconnect between African-American students and science. Despite this proven disconnect, small amounts of students have maintained an interest in science and progressed along the science pipeline.

This body of literature supports the argument for examining how African-American high school students choose to incorporate science into their present and future versions of themselves. By uncovering these factors, educators can develop interventions and curricula that will increase the number of students obtaining science or science-related undergraduate degrees by targeting those that are "most capable."

Existing research has concluded that minorities have been underrepresented in the science field because of historical issues of educational inequality, perceptions of access,

and relevance. Research must not explore how students who can excel in science at the high school level understand the role of science in their future. The purpose of this study is to give African-American high school students a voice in science education research and policy. Their voices will highlight what is important to them in science through their lived experiences.

Chapter 3: Methodology for Gathering Data and Co-Creating Participant Portraits

High school students' experiences in science education, as well as their post-secondary and career goals, are the general concepts that frame this study. These concepts also are used as "points of departure" for formulating interview questions, examining data sources, and analyzing data. Initially, the study was grounded in a transcendental phenomenological approach to identify and explore critical incidents, factors, and experiences related to past, current, and future involvement of high school students in science experiences. This phenomenological approach initially was chosen because it allowed for the meaning of the experience to be given primacy during the process of data collection and analysis (Moustakas, 1994).

In transcendental phenomenology, the researcher emphasizes the desire for participants to recreate experiences, be guided by their intuition, and give meaning rather than utilize their perceptions, beliefs, and knowledge of the phenomenon from prior experience and professional studies (Moustakas, 1994). The researcher identifies causal conditions, strategies, contexts, and consequences related to the phenomenon or experience being studied in phenomenology. These causal conditions, strategies, contexts, and consequences are then clustered in to meaning units and themes. The resulting synthesis of the units and themes are developed into descriptions of the meanings and essences of participants' science experiences.

As the study progressed, however, I shifted the methodology from phenomenology to Narrative Inquiry. In Narrative Inquiry, experiences occur over time, places, and social interactions between people and the society that surrounds them and

influences their behavior (Clandinin & Connelly, 2000). Narrative Inquiry is a combination of the stories that are lived and told by the participants. I became interested in not just the science experiences of the participants, but also in how these science experiences were shaped in participants' stories of their lives.

This chapter begins with a brief discussion of what is means to do Narrative Inquiry and provides a definition the construct and a conceptual overview of the research methodology. Next, the chapter details the types of data collected and the process of data analysis. Lastly, the chapter outlines how the researcher addressed issues of reliability, validity, and positionality.

What it means to do Narrative Inquiry

Narrative. In *Step Across This Line,* Salman Rushdie (2002) declared, "stories are the tracks we leave" (p. 85). In the retelling of lived experiences, individuals provide tracks that lead to the present and future. These tracks are sometimes very clearly defined, and at other times, they are faint and distant. No matter where or how they appear, understanding how these tracks are placed and where they lead is essential to comprehending the decision-making process, positionality, figured worlds, culture, motivation, and boundaries of an individual. One way to uncover the tracks that an individual has laid is to examine narratives that are constructed around particular experiences or journeys that one has chosen or is forced to take.

Narratives are similar to road markers that an individual encounters when embarking on a road trip. They are constructed and retold in numerous ways. At different points along a person's life span, the narrative may transform into a different color, size, or shape. Sometimes the narrative can propel a person to the next stop; and at other times,

it can slow down or even impede the journey. Lastly, narratives are only a symbol that represents a larger event, space, or consequence. Just like road markers, narratives are not necessary, but can serve as a guide for all those on similar journeys and provide insight to those who want to understand or consider the path.

One cannot adequately examine narrative without considering the culture and identity of the individual constructing or retelling the narrative. An individual's culture is not always easy to describe. Much like waves in the ocean, culture can take multiple forms. At different times, certain cultural aspects are revealed and others hidden, and they become diluted as they come ashore. Identity, on the other hand, is akin to the Grand Canyon; each crevice represents a different space and time in an individual's life. The colored layers of the Canyons represent the multiple selves that can appear at any given time. These selves have been shaped, molded, and colored by various atmospheric conditions. The Grand Canyon and the ocean appear on maps that contain roads and road makers. To get to a destination, one must pass the Grand Canyon and ocean while utilizing road markers. As narratives are constructed, identity and culture are revealed. It partially answers the questions: Who am I? Whose am I? Who do I want to be? Where do I want to go? How am I viewed? What's important to me? What is it to me? How does it shape my past, present, and future? What do I reveal to and for whom? The journey creates the individual, and they become the frontiers or landscape that is traveled across (Rushdie, 2002).

Narrative Inquiry. One methodology for writing narratives about an individual's lived experiences is Narrative Inquiry. John Dewey, one of the most forward thinking scholars in the field of education, has had a significant influence on the evolution of the

Narrative Inquiry. Dewey's (1916) philosophy of experience is paramount to understanding the possibilities of narrative inquiry. Dewey saw experience as a combination of active and passive elements. He stated that "we do something to the thing and then it does something to us in return" (Dewey, 1916, p.139). For Dewey, experience was an interaction, both personal and social. Continuity was another criterion of experience for Dewey. Clandinin and Connelly (2000) defined continuity as "[the] notion that experiences grow out of other experiences, and experiences lead to further experiences" (p. 2). In Narrative Inquiry, each experience is on a continuum of time that moves back and forth between the personal and social in numerous different settings.

Narrative Inquirers work in a *three-dimensional narrative inquiry space*, which is derived from Dewey's view of experience (Clandinin & Connelly, 2000). The three-dimensional space facilitates a cyclic action that allows inquirers to travel "inward, outward, backward, forward, and situated within place" (Clandinin & Connelly, 2000, p. 49). The first of the three dimensions is *interaction*, where individuals reflect on the relationship between personal and social. The second dimension is *temporality*, which examines experience across time: past, present, and future. Last, is the dimension of *situation*, which considers experience in the context of a place, or a series of places. By utilizing the three dimensions of experience developed by Dewey (interaction, temporality, and situation), Narrative Inquiry enables researchers to construct stories that represent the totality of an experience and not just the experience itself (Clandinin & Connelly, 2000).

Narrative Inquiry seeks to understand how individuals describe and perceive their experiences in the context of their lived experiences. Connelly and Clandinin (2006) defined Narrative Inquiry in this way:

> Arguments for the development and use of narrative inquiry come out of a view of human experience in which humans, individually and socially, lead storied lives. People shape their daily lives by stories of who they and others are and as they interpret their past in terms of these stories. Story, in the current idiom, is a portal through which a person enters the world and by which their experience of the world is interpreted and made personally meaningful. Viewed this way, narrative is the phenomenon studied in inquiry. Narrative inquiry, the study of experience as story, then, is first and foremost a way of thinking about experience. Narrative inquiry as a methodology entails a view of the phenomenon. To use narrative inquiry methodology is to adopt a particular narrative view of experience as phenomena under study. (p. 477)

Researchers who engage in narrative inquiry do not live outside of the narrative space. They live in it, alongside it, and in relation to participants (Downey & Clandinin, 2010). Narrative Inquirers understand that an experience cannot be broken down into parts without losing pieces of how the experience was produced. No experience within a narrative is a singular unit; each experience shares a relationship with other experiences. As Narrative Inquirers seek to navigate the dimensions of the narrative, they do so with an understanding that their own narrative is as essential to the inquiry process as the narratives of study participants. The lenses of their own narrative influences how the story gets shifted, situated, and told. The main focus of the narrative inquirer is to call attention to the many different stories that lie beside, beneath, behind, and above the story that is being retold. Much like the writers of ragtime music, narrative inquirers recognize that individual parts are merely noise; but when combined together, the parts create memorable and melodic tunes.

Narrative Inquiry emphasizes the fact that the relationship between the researcher and participants is collaborative and acknowledges that the researcher can learn with and from the participants. This positioning of the research participants is important to this inquiry, because its goal is to explore how African-American high school students who have records of high academic achievement draw on their lived experiences in science to formulate academic and professional identities. These research participants have experienced science and reacted to it. Through Narrative Inquiry, I will explore their experiences in science in relation to priorities, activities, and educational and life experiences.

Narrative Inquiry understands that any singular event, happening, or experience is nested within multiple layers of experience and context (Downey & Clandinin, 2010). By utilizing a Narrative Inquiry framework for this research study, I can provide a more holistic picture about the role of science in the lived experiences of research participants.

Setting and Participants

The Summer Intervention Program (SIP) at a southeastern university focuses on enhancing the ability of high-achieving minority students from inner city high schools to gain admission to college and successfully complete an undergraduate degree program. SIP accomplishes this task by providing SAT preparation courses, assistance with college applications, high school course-taking guidance, college-level courses, and workshops on life skills. The program gives special attention to the fields of mathematics and science, because they are areas in which minorities have consistently performed and participated at levels below that of their White and Asian counterparts. Research in science education has documented the decrease in student motivation to pursue science

careers, particularly noting the small number of women and minorities (Campbell, Denes, & Morrison, 2000).

SIP seeks to intervene in the traditional educational experiences of high school students to provide them with experiences that extend beyond their schools and to enhance their general knowledge base, particularly in science and math. At the heart of the program is the desire to influence students' decision-making based on their new and prior knowledge. SIP staff selects participants using several criteria; including teacher recommendations, GPA, a reflective essay, and class ranking. All participants rank in the top ten percent of their high school class and are on track to taking one or more AP science or math courses. Once selected, participants attend monthly seminars from January until May. In June, they attend a six-week enrichment program housed on a university campus in close proximity to their school. Upon successful completion of the program, the program provides opportunities for some students to return to the college campus and participate in laboratory research under the tutelage of college professors during the formal school year and following summer.

Participants include both males and females, but the ratio depends on how many students apply to and matriculate through the SIP program. The number of program participants has ranged from 28 to 40 per year since the program began in 1988. Initially, there were 24 participants in the summer 2009 SIP Program, and all participants participated in the present research study. Of the 24 participants, 10 were chosen for year one of this study, based on the availability of data sources and the diversity of demographics. The sample of subjects included ten participants: four males and six females. During the study, participants outlined their definitions of science and success as

high school students in year one of the study. All participants were contacted through social networking, email, and the use of peer contacts for participation in year three of the study. Of these ten participants, three were Gates Millennium Scholars, two were valedictorians, one was a salutatorian, and one achieved a 1670 on the SAT. In addition all participants received at least two scholarships from community organizations or universities presently attended.

Five of the previous participants agreed to participate in the year three follow-up. The participants included one male and five females. During the course of the study, these five participants transitioned from high school seniors into rising college sophomores. The voluntary nature of participation was a contributing factor to the fact that only five subjects participated in the exploratory study. The other five participants cited their focus on factors related to transitioning from high school to college and participation in pre-college programs as reasons for not continuing in the study. One of the participants in the exploratory study, but not in the final study, did complete the online demographic survey.

Data Sources

To compile a longitudinal study of the role of science in the lives of high-achieving African-American high school seniors, I utilized three different data sources to provide the foundation for this work. The three data sources are participant observation, interviews, and documents. These sources facilitate a comparison across data sources and help to uncover multiple layers of experiences and contexts that affect participants' definitions of science and success.

Participant observations. Participant observations were essential to the collection of data for this study. Dewalt and Dewalt (2002) emphasized that researchers must be transparent, throughout all notes and writings, about their role within the community being studied. The author' must acknowledge that while the level of participation may vary based on research questions and locations, the importance of acknowledging the level of participation remains unchanged.

Also, an integral part of the narrative inquiry approach is the ability to acknowledge researcher bias, beliefs, and opinions by discussing and reflecting on interactions and experiences. While observing participants from Summer 2009 to Fall 2011, my role ranged from observation to complete participation. Because I am a part of the faculty and staff of SIP, I assisted parents and students on move-in day, taught an introductory chemistry lecture and lab course, participated in group outings, facilitated the collection of evaluation materials, and attended various social events at the dormitory. Supporting the SIP community became a means of reciprocity for the access granted to research participants and the community.

Observations occurred at least five days a week during the six-week residential portion of SIP, when participants attended my chemistry course or when I was involved in SIP program activities. At the end of the SIP program, I observed subjects through interactions on group and individual Facebook pages, Twitter messages, graduation exercises, social gatherings, email check-ins, and text messages. I recorded the most meaningful observations in a researcher journal, along with researcher reflections. The recorded observations were crucial to understanding how participants pursued success and science in real time.

Interviews. I used qualitative interviewing to understand the underlying reasons for a participant's decisions to pursue post-secondary science education and careers (Yow, 2005). Specifically, I utilized responsive interviewing techniques, which required that the interviewee and the interviewer become involved in an emerging relationship. The goal was to generate a depth of understanding, while ensuring that the design of the research remained flexible throughout the study (Seidman, 2006). Through responsive interviewing, the researcher aimed to uncover the interviewee's feelings, thoughts, and experiences (Rubin & Rubin, 2005). The responsive interviewing approach focused on the interviewee's feelings, thoughts, and experiences on reconstructing his or her experiences within science.

Each participant was formally interviewed three times over the course of the study, and each interview lasted 30 minutes to an hour. Each subject participated in a single interview during year one. During the initial interview and during dorm check-in, the researcher provided an overview of the study and discussed participant expectations. The participants then had the opportunity to ask questions, express concerns, and provide their written and verbal consent. Participants and parents reviewed and signed the letter of informed consent as required by the Emory University Institutional Review Board (See Appendix B). In year three, a re-acclimation letter was sent, through Facebook. The letter explained the purpose of the research and again gave participants the opportunity to ask questions and express concerns. The location and time of all interviews were conveniently arranged based on the participants' availability. Each interview was recorded digitally and promptly labeled with the participant's name and the date and time

of the interview. A field journal was used to record notes and key points for further questioning, review, and analysis (See Appendix C).

The semi-structured format of the interview allowed the researcher to respond to the interviewee and explore emerging ideas (Rubin & Rubin, 2005). After several pilot interviews, the initial interview guide was clarified, extended, and reordered to align more appropriately with research objectives and generate more in-depth responses from participants (See Appendix A). During the time between year one and year three, informal conversations continued to occur and were documented by the researcher. After reviewing past interview transcripts, participant observations, and responses to demographic surveys, individualized interviews guides were constructed for each participant in year three. During all year three interviews, the subjects read and reflected on participant portraits developed from data in year one. Additionally, each participant had a unique interview guide that pushed for clarity and extension of new and previously documented experiences. At the conclusion of the final interview, all participants were invited to share any thoughts that came to mind after the interview.

Documents. Prior to participating in the interview phase of the research, participants were asked to complete an electronic survey. The survey asked demographic information that included, but was not limited to, college major, recent courses, awards, recent science experiences, and reflections on the science intervention program. The survey included questions from the Scientific Attitude Inventory II (SAI II) (Moore & Foy, 1997); which had four sections from the Relevance of Science Education (ROSE) instrument: future job, opinions about science and technology, my science classes, and myself as a scientist (Schreiner & Sjøberg, 2004). This addition of the questions from the

SAI II and ROSE (See Appendix D and E) allowed the researcher to collect additional information and uncover possible influences on science views, attitudes, and future objectives.

Participant observations, interviews and documents each provided a different medium for participants to describe experiences, reflect on choices, and make meaning of experiences in rich detail. Using these multiple sources enabled the researcher to uncover the essence of the influences on current and future involvement in science activities, post-undergraduate studies, and careers.

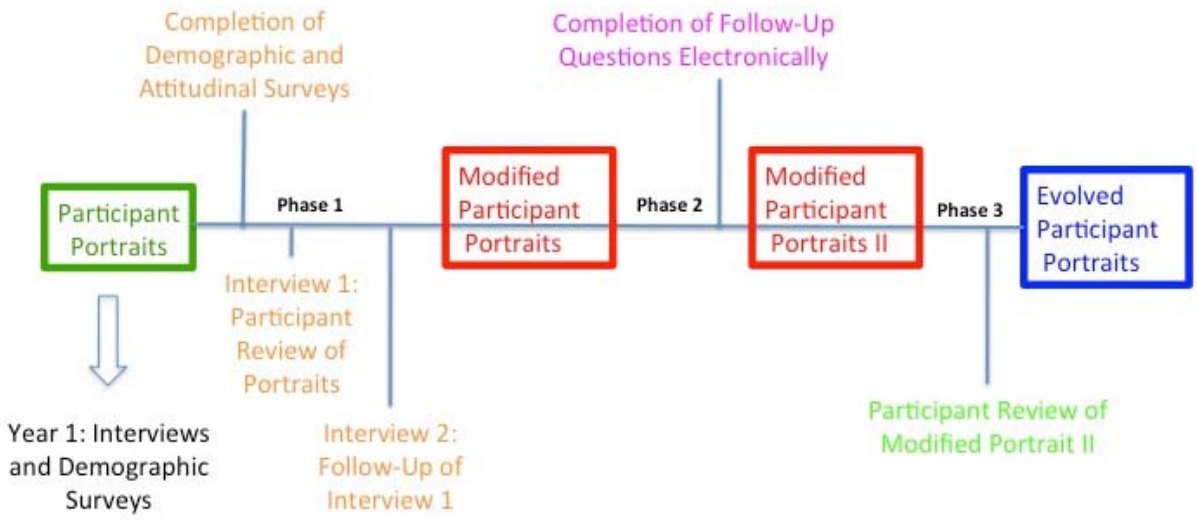
Data Analysis

The data collected from each of the sources: demographic surveys, attitudinal surveys, work samples, participant observations, revised narratives, and researcher journal, and were analyzed for content related to science experiences, post-secondary goals, and career objectives. The development and collection of data from each of the sources is based on the narrative inquiry approach. Each interview was transcribed verbatim from the audio recording.

A significant amount of time was spent rereading transcriptions of interviews to determine narrative threads, tensions, and themes. Then the narrative representation or portrait, a single narrative that unifies the data, was developed. Narratives portraits were then enhanced by the information from collected documents and participant observation. Once the portraits were created, they were shared with participants for additions, comments, and corrections. Figure 3.1 shows a chronological representation of how the data was utilized to construct the final participant portrait in year three. After the portraits were modified, the researcher coded for various strands related to how participants

defined science and their visions for their future. Lastly, the participant portraits from year one and year three were examined, concurrently, for similarities, differences, irregularities, and shifts.

Figure 3.1. Chronological Data Usage Diagram for Year Three



Data Storage

All data was systematically organized, labeled, and readily accessible. Participants were assigned a pseudonym to ensure participant confidentiality. The master pseudonym list was stored separately from the data and made accessible only to the primary researcher. Printed transcripts and initial survey data was stored in a locked filing cabinet. Digital files, including soft copies of transcripts, survey results, and field notes were stored securely on a password-protected personal computer and an external hard drive. Immediately after being downloaded, the original files were deleted from the collection medium. Outside researchers can receive access to all storage systems to review the reliability of the study.

Researcher Perspective

Prior to beginning this study, I taught a three-week chemistry course for the SIP. Also, I taught general chemistry, chemistry of everyday life, and introduction to chemistry at a community college for three years. I have both a Bachelor of Science degree and a Master of Science degree in chemistry, both of which trained me to understand the terminology, structure, and frameworks of science. While working on my degrees, I attended numerous different science-based intervention programs and applied for outside support in the form of monetary support, mentoring, and supplies. Also, I work for a technology center that has provided me with the training necessary to support utilization and evaluation of technology sources employed in the study.

I also forged relationships with program administrators, parents, and counselors in an attempt to better understand the community of the summer intervention program. My relationship with these individuals began in the summer of 2009, when their parents, friends, siblings, aunts, uncles, and/or grandparents dropped them off for a six-week residential program. Many mistakenly thought I was the Resident or Program Director. Looking back, I probably became both of these without even realizing it. As I stood at the check-in table, I just wanted to get IRB forms signed, but parents wanted questions answered, participants sought a motherly presence, and RA's needed an authoritarian figure. As the six weeks continued, I begin conducting initial interviews and teaching an introduction to chemistry class. My presence in the dorms eventually led to my participating on field trips, giving advice, loaning out my laptop, and taking part in "girl time." At the closing banquet, I was brought to tears by a tribute to me and numerous introductions to parents as "my new auntie" or "big sister."

At the beginning of this study, I had five research participants; now I have little brothers, little sisters, and mentees. Through email, Facebook, Twitter, text messages, phone calls, and random visits; these five participants have become human beings. I possess an undeniable commitment to making sure that they become the successful selves that they envision beyond the two-year duration of this study.

Reliability

Reliability in qualitative research deals with whether the data collected and the subsequent results make sense to an outside researcher. Merriam (1998) and Miles and Huberman (1994) offered several different techniques for strengthening the reliability of qualitative studies. Three of these techniques are the investigator's position, triangulation, and audit trail. This study utilized each of these techniques to address issues of reliability. I kept a researcher journal to document or check for researcher bias. Additionally, I maintained a clear chain of evidence during the data collection and analysis process by detailing the steps utilized to ensure the study maintained a structure in line with its narrative inquiry framework. Triangulation occurred by utilizing multiple methods of data collection.

Validity

Internal validity deals with ensuring that researchers are actually measuring what they believe or claim they are measuring (Merriam, 1998). In narrative inquiry, the line between fact and fiction is not clearly demarcated. This study employed triangulation of multiple data sources to address questions of internal validity.

One potential threat to internal validity is the researcher's orientation and identity in the lives of the participants' over time. My role in this study as a former instructor and

present mentor or “big” sister directly influences the type of relationships I developed with the participants. To address this potential threat to the study, I utilized data sources that were minimally influenced by my voice. Also, to ensure that narrative portraits portrayed what participants actually said and meant, drafts of the narrative portraits were shared with participants. In addition, to account for the close relationship I formed with participants, I had a professional colleague review the participant profiles and the database. In his review, my professional colleague made sure the participant profile was developed from the data and not from what I know intuitively about the participant.

External validity deals with whether or not the findings can be applied to new settings or situations. To address questions of external validity, thick descriptions will be provided and atypical and typical participants discussed.

Chapter 4: Presenting Participants Portraits: A Portrayal of Individual Stories of Personal Agency to Create Life-Long Success

This chapter presents the story of how five African-American high school students employed personal agency to determine suitable ways for science to be apart of their future visions of themselves over the course of a three year study. Portraits were constructed from the data. The participant portraits for year one of the study are located in Appendix F. Participant portraits for year three are shared in this chapter. A narrator commentary follows each participant portrait. This commentary describes nuances in the relationship between the participant and the researcher and discusses the researcher's role in their journey.

It is important to highlight that the five African-American high school students had not just shifted into new educational environments, but also new living spheres. Their circles of influence became more self-selected than mandated by the structure of American schooling and familial living situations. In their post-secondary educational opportunities, many found themselves having to initiate, execute, and control, without much input, all their actions and behaviors. This personal agency is fundamental to the participants' ability to position themselves for the future that they envisioned.

Altering the Path and Hitting Road Blocks: Darren's Story

Two years ago, Darren aspired to become the first African-American male valedictorian in more than a decade at is his high school. He not only became valedictorian of his high school class, but he also gave a speech that has been seen by millions through social networking and digital platforms. His valedictorian speech has afforded him opportunities to speak all over the country for organizations like the Gates

Foundation, Jack and Jill Foundation Research Conference, and local YMCA events. Darren's speeches have focused on encouraging others to do what is necessary to achieve, in spite of the circumstances one faces. In his speeches, he detailed what it took for him to become valedictorian, while simultaneously dealing with his mom's cancer diagnosis, the violent death of his brother, being robbed at gunpoint, and turning down the opportunity to run drugs for a local gang. By sharing his life story, Darren felt like he brought hope, encouragement, direction, and motivation to his peers and many others. In year one of the study, Darren desired a future that would allow him to help those around him improve their lives. His speeches became his first step in accomplishing that goal. After reading and reflecting on his narrative from year one of the study, Darren stated

> I don't know, I guess I just feel like some of the things I mentioned, on that particular day…some of it has already come to pass...as far as making a difference in the world and speaking and helping in the community.

Darren already felt that he had accomplished some of the things that he felt would make him a success two years ago. In addition to giving motivational speeches, he started the Darren Benjamin Foundation, which sponsored back to school drives and other community events. Since our last interview, Darren had transformed from a rising senior in high school to the founder and CEO of a non-profit organization.

Darren continued to tell his life story for the benefit of others and himself; encouraging all to "be a warriors not worriers" as they dealt with life. Darren acknowledged that he was not always able to do this himself.

> Sometimes things can just get overwhelming and, you know, you try to keep the faith, and you try to believe everything work out in the end; but I guess, when you see things for what they are at the current time, you know, it's hard to stay encouraged sometimes for me, you know… Everything I experienced with my

> mother...I…you try so hard not to, but all you can do is worry, because you don't know what to expect.

The uncertainty of his mom's health, pressures of being successful, and the newness of being a college student caused Darren to fluctuate back and forth between his desired identity of a warrior and the unwelcomed identity of a worrier. Darren acknowledged that his unwelcomed warrior identity limited his ability to fully function as a college student:

> I spent so many nights just alone thinking and worrying and stressing or just trying to take it all in, whereas everyone else was just out networking and getting to know each other and just enjoying college.

While taking in all that life had to offer, Darren found himself in biology and geology classes during his first year of college. He commented that his geology was boring, but he enjoyed the lab. The geology teaching assistant was very passionate and made sure that Darren got the most out of the labs. Biology was more of a challenge. Darren felt he was prepared for biology, but that feeling ended up being somewhat of a hindrance. He blamed himself for not putting in the time studying and ultimately earned a C in the class. His biology professor was one of the most engaging professors he ever had in science. He actually enjoyed the class as much as his 9th grade biology class. For the warrior valedictorian, excelling in this class was an issue. "I fought myself. I let things and individuals to take away my focus and stress me out." Darren was not sure whether it was his devotion to his female love interest or his lack of focus that deserved most of the blame. He was certain, however, that he had lost his tunnel vision for academic success and fell prey to stress and poor time management.

Darren's ability to see himself as a success was challenged by his shift from a high school valedictorian to a C college student. He felt he had become undeserving of the praise and congratulations, but kept speaking in hope of igniting a passion for

education in himself and others. Darren acknowledged that he did not do what was necessary to succeed during his first year of college. To consider himself successful again, he had to "[pick himself] back up and then get back to doing what I been doing all my life…just start back applying myself and seeing the results." Academic achievement is a must for him to be successful at this point in his life. Education has been the key to having doors opened for him.

Our interview took place in July, and at that point, Darren still had not looked at his second semester grades out of fear of the results. Despite this trepidation, Darren believed he could change his trajectory and get back on track:

> I know I can bounce back. I been doing it all my life…just…just trying to figure out the steps I need to take and hoping everything falls in place so that I can bounce back.

He had experienced "unsuccessful" and could relate to his peers who were experiencing or had experienced the same thing. His first year of college was the first time he had been academically unsuccessful. "Going from on top of the world to the world being on top of him," Darren was still thankful and saw his experience as a gateway to reach more people.

Still uncertain about a future career, Darren believed that motivational speaking could be a perfect fit. It allowed him to "just go around and be uplifting and inspiring." He was not just praying to God to reveal his purpose; he embraced the knowledge that all of his experiences would be instrumental in his future. His self-professed challenge to become a warrior would not allow him to become caught up in making sure everyone else was successful at the expense of his own happiness and well-being.

Right now, Darren looked to Michael Vick, among others, as a role model. According to Darren, Michael Vick went from being "on top of the world to the world being on top of him." Vick managed to push the world off of himself and get back on top of it, much like Darren hoped to do. Darren charted a path to push the world off of him. While charting this path, Darren developed some definitive ideas about science:

> Um, um, I think science is a great subject. I just don't believe that it's for me, but I'm supportive of it and, you know, when we try to start a foundation…not just for folks going through and children in need...I guess be open up to all things concerning the environment and what not…just the whole going green initiative kind of taking over. I could just see my foundation supporting that…providing…far as some research, giving scholarships to individuals in the science field or whateva. I think that's how I see myself dealing with science in the near future.

When asked to envision himself as a research scientist, Darren declared the following:

> I would like to perform research on leukemia and diabetes, since it is an illness that plagues my family. Performing research on these two illnesses would allow me to understand them more and also help in making progress towards creating a cure for individuals who have been diagnosed with the illnesses.

Even when postulating about a possible future in science, Darren focused on his "main calling" of helping others before he focused on science. Science just happened to be a tool to achieve his desired successful future of inspiring, uplifting, and helping others.

Narrator's commentary. "Bing"…I glanced down at my phone and there was a Twitter update with me tagged. It simply read, "Going to have dinner with my college president." In less than twenty-four hours, a picture appeared in my Twitter feed of Darren and the president of his college. I was brought to tears of joy and excitement. In his final interview, Darren said, "I know I can bounce back. I been doing it all my life…just…just trying to figure out the steps I need to take and hoping everything falls in

place…" His audacity to hope and tenacity to achieve took him from an academic outcast to a becoming a campus leader that dined with the president of the college.

Based on Darren's achievements before heading off to college, we expected him to become a campus standout. As Darren stated in his valedictorian speech three years ago, "Life for [him] ain't been no crystal stair." Going from a high school standout to a college academic outcast to a college leader proved an unexpected roller coaster of emotions and resulted in a multitude of realignments in Darren's roles as a nonprofit founder, mentor, student, uncle, brother, and son.

Over the past three years, Darren was not able to connect to science, but he did connect to people in science, particularly me, who expected him to

> Stay positive, stay encouraged, and if I'm staying at…you know, my life is already planned out, so I really shouldn't have to worry, you know. Everything is already planned out in the future…in the future, you know, and I just have to go through whatever I'm going through just to get me to that point. I guess you wanted me to not worry and accept it and just know that deep down in my heart that is the case. Because I remember you telling…you sent me a text message saying that….

I desired that Darren to be a warrior that pressed toward his future regardless of the stumbling blocks or situations life presents.

Reshaping and Redefining the Vision: Debbie's Story

> I think now I've decided that I want to become president, so I'm going to try to become a lawyer. I'm going to try to become the first Black female president, if that has not been already taken, you know.

Since the first interview for the study, Debbie had expanded her original goal of becoming an attorney to being the first Black female president. She acknowledged that the president had a lot of responsibility, but she believed that "if somebody really wants to change the world that's the place to be, in the presidential spot." Becoming president

would afford Debbie the ability to affect gas prices, institute caring policies, and, most importantly, bring relief to communities that continued to experience injustices and a lack of necessary resources.

Debbie chose to leave her local high school and go to Ecuador for the majority of her senior year of high school. As a result of her experience, she was almost fluent in Spanish and had a completely different view of Americans. Through her new lens, she believed Americans were ungrateful, as evidenced by their wastefulness of food, lack of table manners, and lack of respect for teachers. Students in Ecuador "know when to play, when not to play, and when to get the class serious and in order."

In exasperation, Debbie declared that, much like biology in the US, she was unable to achieve peak performance in biology in Ecuador. Chemistry was a different story for her. She "went back to Atlanta and showed everybody what [she] learned." Physics was even more difficult than biology. However, in all her classes, Debbie persisted. She explained how she continued striving in these challenging classes by saying, "I try it. Every paper they gave me, they told me I didn't have to do, but I tried. I did it, and I got my grades up...So, all A's...I was like, wow." By sticking with her life motto, "if you don't do well, you keep trying," Debbie managed to duplicate the academic excellence she had in the United States. Seeing things in science she had never seen before, and being required to use measurement instruments she had not used before never discouraged Debbie from pressing towards achieving high academic honors.

Students in Ecuador had different educational experiences than those in the United States. In Ecuador, students took very hands-on courses in chemistry, biology, and physics for four years. Debbie believed this could lead to the appearance that they were

smarter in science than American students, but she thought they just had more exposure to the subject. Ecuadorian students were learning more from strict teachers that would laugh with students but require high behavioral and academic standards. It was not the students' love of the teachers or science that drove them to do well, but their familial requirements of respect and honor.

Ecuador shaped Debbie's definition of science. For her, science became a universal language. She would tell her friends back in the United States the following:

> I saw people do this in science in Ecuador, and they do this so differently. Like it's different, but it's still the same; and it made me realize that everybody in the world is the same, because we use the same techniques, basically. It was really exciting.

The material content and knowledge provided by science did not generate Debbie's excitement; it was her ability to use science to demonstrate principles to others and realizing that, unlike language, everyone uses the same foundational scientific techniques.

Coming back to the United States in March of the following year, Debbie felt a little lost. Her advanced placement classes had covered so much material. The only advanced placement class in which she felt she was not playing catch up was chemistry. A new chemistry knowledge base was not the only thing that Debbie brought back with her; she also had reshaped her vision of success, and began appreciating the minor more than the major. To her

> Americans see…Well, the average American sees success as having money, a nice car, a nice house, nice clothes, like material things. But in Ecuador, success is like doing well in school, getting a job and…I know my mother told me she made like $100 in a month. It was really shocking, like $100 in a month she made. So success is definitely not the beautiful houses and things; it's accomplishing the small things…

Debbie realized that she wanted

> to definitely embrace just accomplishing what you dreamed of, like you dream…like whatever I dream to be, all my dreams are going to add up to one big dream, and each small dream that I accomplish, that's my success. When I get to that big, huge dream, that is the ultimate success.

Major success for Debbie was becoming a lawyer, making partner, and getting elected president. The minor and major accomplishments that defined Debbie's ideas about success were grounded in her spirituality. She desired to live the principles and guidelines declared in the Bible.

> It's just the simple fact that I believe you should treat somebody the way you want to be treated, and you should be a Good Samaritan and reach out and lend a hand.

Even though Debbie entered college with a plethora of scholarships and strong beliefs about her future purpose, she felt the need to work in order to buy food and other necessities. Unfortunately, working did not allow her to really get the freshman year experience. Debbie was not able to network, missed campus social events, got B's when she could of gotten A's, declined an opportunity to meet First Lady Michelle Obama, and could not participate in study groups or study sessions. Despite her job and full course load, Debbie found time to talk to high school students about going to college. Talking to the high school students brought Debbie much pride and excitement, because she had "somebody there to tell me that, and that's why I'm successful."

Debbie had not been able to take a college science course, but planned on taking chemistry. She explained, "*[*I] definitely want to get an A, but after that…in addition to the A, I want to have really a better understanding of science." She cautiously prepared for taking college science classes, despite her minor successes in the subject matter, "because I don't think I'm not good at science; I think it just don't like me. It just doesn't

like me." Debbie embraced science because "science is the fixed object in our lives. It will always be there whether we ignore it, combat it, or work to understand it."

If she had to pursue a research science career, Debbie responded with the following:

> [I would] like to research how a child's upbringing affects their lifestyle and behavior because some feel unruly children should not be responsible for their actions. They feel it is the fault of the parents and/or guardians. I would like to research how a supernatural belief can cause a person to perform well in different areas because many believe that faith is the component that changes things, not the supernatural itself.

Debbie did not focus on science as a source of knowledge, but as a better way to understand her upbringing and religious faith.

It was not surprising that Debbie would describe Tyler Perry, an American actor, director, playwright, entrepreneur, screenwriter, producer, author, and songwriter, as her role model for achieving. She explained why she looked up to the successful entertainer:

> [Like,] the plays and all the movies and everything have something to do with God, and I promise to always put God first in whatever I do. He seems determined, and he has to be determined; he's where he is now. And he had nothing, and he has so much now. I'm not going to say I have nothing, because I have a lot; but there are also things that I wish I had that I don't have, and I'm going to work to get them. I'm going to work just like he worked to be where he is.

Much like Tyler Perry, for Debbie, success has experienced stopping points along a journey leading to an ultimate goal.

> Success is saying when I get 30, I want to have this; and then you go there, and you have it. You're successful…I love success. It makes me feel really happy. I can't wait until I get to another point in my life where I can feel successful.

Life experiences have led Debbie to reshape and redefine her definitions and visions for success and science. She no longer considered success simply a lifestyle, but a journey that never ends. Science shifted from required courses to a language that transcended the boundaries of countries.

Narrator commentary. Text messages received on June 25th at 5:48pm:

Debbie: I just realized that success is not I destination….It's a journey.

Me: Hallelu….foreva changing

Debbie: Always under construction.

Me. How did u get this revelation?

Debbie: Someone on Facebook asked y the road to success always changes n it made me wonder about my own n I realized as I grew my desires changed, the world altered, and therefore the things I need to do to help changed, because change is inevitable my road to success is never complete.

Debbie was constantly reinventing herself and adjusting her journey toward success according to how she could best help others. She lived for helping others. It is what keeps her pressing when she is tired and weary. For the first interview, I arrived at Debbie's aunt's house with expectations of having the interview at the house. Walking up to the door, I noticed three small heads stacked on top of each other peering through the glass window at me. Then I heard a small thump and saw the blinds from the window on the right shake. Almost out of nowhere, Debbie opened the door with purse and cellphone in hand. She closed the door with such force and speed that I was startled. Immediately, she told me that she and her sister were watching six children, ranging in age from two to ten, in the house. If we were going to get through any interview, it was not going to happen at the house. Debbie had decided to spend the summer between Atlanta, Georgia, and New York helping family members when she could have easily found something else to do. She was living what she proclaimed: "I'm going to make a change. I'm going to help somebody."

From the outside looking in, Debbie's home life and family relationships could be perceived as toxic and chaotic at best. Somehow, Debbie saw love, support, and

necessity. While she acknowledged that she will never spend her summer helping family again, it brings her joy to talk about how older and younger siblings and cousins wanted to model her journey toward success. When discussing individuals that she considered successful Debbie said

> I know a lot of people say their mother or their grandmother, but I see that my mother and my grandmother aren't where they want to be in life yet. Darren, he's doing exceptionally well. Like…I don't know. He's been awarded so many rewards. I think he's personable and friendly to people and not just doing something for himself. I think he's definitely the first person that comes to my mind.

The Darren she mentioned is the same Darren in this study. Even though Darren felt the world was on top of him, Debbie used him as her barometer for measuring success, not just because he has gotten a lot of awards, but also because he did not let his perceived success define him. He understood that the journey was not about him, but about those that he touched along the way. Debbie shared her perceptions of my own expectations for her:

> I know you expect me to use science in my life somehow, and I know you expect me to do well, and you expect me to always keep trying…like if I come up against something that I have trouble with, to take it like I take science or certain parts of science…like the moles. If I come against it, I keep fighting it until I understand it. Not even just science. Like, if I come up against a trial or something I don't understand to keep trying and seeking help 'til I get it.

She was correct in saying that I wanted her to keep trying and seeking. I did not want her to let any course, situation, or obstacle derail her from her journey toward success. I found it a privilege and necessary task to remind her of that when I could through motivational texts, an occasional phone call, or a brief visit when I was in the same town as her college.

Changing Me to Change My Perspectives and Priorities: Renee's Story

During my first interview with Renee, she shared that she really did not care for the field of science. Not only did she not science connect with science, but she felt it was unnecessary for her to understand the world. Two years later, Renee believed that "science is simply a subject in which the people within that field try to find out more about our world and the way it works." In her view, science had become a subject that connected to the world. Renee gained this new definition by using information from her college physics course to understand news reports about the nuclear catastrophe in Japan. Renee acknowledged that two years ago she hated science, did not want to take any science courses, and did not see any value in science. She would get A's and move on. After this experience, Renee explained, "I don't hate science. I just don't prefer it."

Education had the strongest influence on Renee's definition of science. For her, science was simply a lot of reading and thinking about how the world works. While she liked learning about how the world worked through science, scientific principles challenge her faith "too much sometimes." Renee recounted an incident in her college physics class where a student challenged the teacher about a particular science definition. While sympathizing with the student's cause, Renee just wanted to get on with it. She knew that regardless of what the student said, she was going to be tested on the science definition. The lack of her ability to see her faith in science proved another one of the reasons Renee did not particularly care for science.

While Renee's appreciation for science deepened, her vision for her future remained the same. She really wanted to be married and have a family one-day. Moreover, a successful Renee fifteen years later would

> …be settled. I want to have a family. I want to have a nice house. And I want to have a steady income, a good financial situation. I want my mother to have a good financial situation, even if it's totally dependent on me.

All of this would occur after she completed law school while working to support herself. Working was not just important to Renee; it was the way she would support herself and her family. In fact, she had worked since she reached the age requirement. When school is not in session, Renee clocked in nine-hour days on her job.

Success for Renee was

> …being exactly where you want to be in the position that you want to be. 'Cause success could be different for anybody. But if I'm…if I'm happy…if I'm making the income that I want…if I have the family that I want…if I'm truly and genuinely like happy with my situation, with my life…if I'm at the level that I feel like I can be at…the top level that I feel like I can achieve, then I'm successful. But if I'm still growing, then I'm just…I'm still making it. I have been successful at things, but I may not be successful at life.

Renee believed she had been successful in just sticking with school and understanding that she had to change to become better. I asked Renee about the most successful thing she has been able to do:

> [I would] probably say I've been successful at change and at understanding that to do what I want to do I got to other things, and I may have to do things that I don't like or I may have to do things that just don't seem to be right time to get when I want to be."

Renee did not strive for success. She thought it was "not important being successful. It's important for me to be satisfied with myself." For Renee, success was about self-satisfaction.

Self-satisfaction is one of the reasons Renee chose to pursue a career in entertainment law instead of criminal law. She could not stomach the idea of having to defend someone that may have actually committed the crime. She again mentioned self-satisfaction as a reason for her college science course selection. She took physics because

of good experiences in high school, and she was only taking biology because she wanted to learn about how the body works.

When asked if she had mentors or individuals that served as models for her, Renee responded

> I don't really have any mentors. Like with my teachers and stuff, I know that they're there for me, and they see where I come from and they see how people are expecting me to be who I am. And a lot of people assume that because I live in the neighborhood that I live in that I'm not smart and that I didn't make straight A's…But I'll always look up to my mama before I looked up to anyone else.

Renee's response to a question about mentors vividly details the multiplicity of her self-prescribed and inherited identities. These identities conflicted and contradicted each other. Teachers, other students, and people who did not reside in her neighborhood often assigned negative stigmas to her, her friends and others from her neighborhood. Despite the negativity assigned to her neighborhood peer group, Renee valued and maintained strong friendships and bonds with the people who lived around her. She did have school, or better viewed friends. At school, Renee was considered the "smart girl." At home, she was the "around a way" girl. Maintaining these two identities may have been the reason that Renee declared that she did not have any mentors besides her mom. Despite the lack of academic credentials and a long list of awards, Renee's mom was her first and only mentor.

Renee had learned a lot since her high school graduation. Being in college taught her that she still had a lot of growing up to do:

> I'm just growing up and realizing a lot of stuff. And realizing that I'm not fully grown, although I thought – I probably thought that once I got in college every thing was going to be all different and I kind of wish I could go back to those days where I wasn't grown, per say. Eighteen, I guess, and I just grew a lot and realized that I don't have forever to be here and I got to do what I got to do while I'm here. I got to do what is the best thing for me to do. I can't fight it.

Renee had journeyed into adulthood. The promises of adulthood were an optical illusion for her. Instead of the fairytale Renee desired, she had to deal with emotional tensions; critically reflect on her attitudes, thoughts, and beliefs; and deal with the inevitability each day is not promised to anyone. Renee's perspectives and priorities about life and science shifted over the two years since our first interview to reveal a more connected and reflective individual.

Narrator commentary. Every morning, Renee recites the words to the serenity prayer to guide her throughout the day:

God grant me the serenity
To accept the things I cannot change;
Courage to change the things I can;
And the wisdom to know the difference

She explained why this became her ritual:

> I pray the exact same thing every morning. I pray my serenity prayer and I tell Him to just continue to guide me and have me follow His will and do what He wants me to do while I'm here on earth.

It was a prayer that released her from worry and stress and served as her anchor because she had a tendency to worry. She worried about meeting her basic needs, taking care of her mom, making the right choices, and being a better girlfriend. After reciting the serenity prayer, Renee felt free to go about her day in control of herself instead of emotionally paralyzed.

Renee's biggest fear was ending up like her mother. In everything she did, she purposely created a counter-story to her mother's life. In Renee's eyes, her mother made a lot of mistakes with early pregnancies, drugs, truancy, and male companions. As a

result, she spent a lot of time in her adult years seeking God for forgiveness and admonishing her children to not choose the same path of life she did. Renee stated

> I know she made a lot of mistakes in her younger years. And she talks to me a lot now about that because she's trying to repent and have Him forgive her for her sins, because a lot is going on in the world, and we just realized that we don't have a lot of time left here. And she always tell me you have to be right with God. Get your soul in order. You got to do right and stuff like that. And being that it's taken her so long to realize that, I just don't want to be that. I want to be to be right now and live my life right now. I don't want to try to play catch up later on in life, so I just let that guide me.

When she described the situation with her mom, there was visible pain in Renee's eyes, despite the smile on her face. Perhaps the dichotomy resulted from the fact that her mom was both her biggest fear and her only role model. Renee admired her mom's persistence and determination to keep the faith. Renee even valued her mom's "intuition," especially when it came to men.

> Renee had not quite determined my expectations of her:
>
> I don't know. I would just think that you just like me to grow as a person and hopefully I would be involved in science. If not…but maybe that my attitude towards science would have changed from when I first went to PREP to now, which it did. I don't hate it. I don't love it either, but I like that I did learn some stuff that I could see…that I saw on the news…that I understood what was going on. But I would think that, as a person, you would just want me to grow and be the best that I could be and hopefully not hate science.

She was exactly right. I just wanted her to be her best self, grow as much as possible, and appreciate science. She had already grown more that I would have ever imagined.

Knowing the End but Not the Beginning: Jessica's Story

Since 2009, Jessica had grown from a shy girl to a self-professed outgoing and confident young lady. Her growth came from her experiences in PREP, her family support system, her faith, and her newfound independence. Jessica maintained that *"when one door closes another opens."* No matter what type of rejection or disappointment

Jessica experienced, she did not become disheartened. She just waited patiently and looked for another door to open.

Two years ago, Jessica partially closed the door on science, and readily embraced a career in international studies. At the time of our last interview, she had thrown the door wide open to consider a career in science:

> "Yea, I mean, I'm actually a lot more open to it, I guess, having to study a lot of science classes in college now…mostly because, I guess, my parents finally did get to me and kind of made me realize it's going to be important…."

I wondered if this change was the result of her feelings about the rejection of not getting into her top two college choices, or of being denied admission into her current college's international studies program that caused her to open the door to a possible science career. I also speculated that her decision also may have been in response to the current job market. Was it really just her parents' influence? She quelled my questions by addressing her change in focus:

> ….my dad describes it, I was looking for a warm and fuzzy feeling in my job, and that's not necessarily the most important thing. While I do need to pursue something that I like and that I enjoy…Our family has a close family friend who got a law degree, and she hates being a lawyer above anything else. Because of the economy, she got laid off; and so she just…she fell back on being a lawyer, and she was making enough money to live very comfortably. So that's…that doesn't sound like a bad lifestyle at all. I can still pursue what I want, but it doesn't hurt to pursue something in school that is going to help me if I ever, you know…

It seemed like Jessica had reached the decision to open the door for a myriad of reasons, some of which involved her simply being attentive to her role as a national and global citizen. She could not deny the current economic climate, lack of jobs, or the advice adults in her life gave her about what it took to be competitive. Jessica was even willing to give up career happiness to have a lifestyle that she would enjoy. The lifestyle she

would long for twenty-five years from now would allow her to be her own boss, have a flexible work schedule, make six figures, and travel at will with her family. Her desired lifestyle took priority over self-satisfaction in a future career; at least it appeared that way on the surface. I asked her what she would do if we lived in a perfect world:

> What would I do? I would probably work in foreign relations dealing with China. I would deal with intelligence, so I'd know everything that was going on. Like all those things that people…yeah, I guess that. I don't know what specific field, but that's what I would do…. I feel like I definitely want to work with relations with China, but not so much…I guess my original standpoint was like in the government; now it's just sort of like every company probably has some sort of dealings with China. I can work in any field….

Even though Jessica declared that she had let go of pursuing a job that her dad said would give her a "warm fuzzy" feeling; beneath the surface, it was evident that Jessica had yet to give up on having the "warm fuzzy" job. While her career path may not have been international relations, she was still looking for a career that allowed her to travel internationally and speak Chinese. Maybe this would mean a career in science, because despite having a "horrible science department" in high school, she was open to careers in ophthalmology or computer science.

Despite her optimism and excitement about opening the door for a science career as plan B, Jessica understood the need to pursue a career that she would enjoy:

> I should be able to push myself to do something so that I have something to fall back on in the future, but I'm worried that it's my interests. If I don't have a passion for it, then I'm not going to do as well as others who do.

She knew that without a passion for what she did, she would never be the best in her chosen field, even if she made it through all the required course work and certifications.

Since the first interview, Jessica had developed a belief that science was more than her eighth-grade science fair project, and she was meticulously developing a plan

that would allow her to integrate science into her future. Jessica adamantly declared, “I’m still debating my future, I don’t want to waste my time by taking like one of those science classes that you can get an easy A…” She wanted to engage science in a way that would be beneficial and not just a mere academic exercise.

Jessica explained that her father did not just consistently remind her of the security of jobs in the science field; he made it clear that in a global market, “kids know what they want to do when they’re 12, and they get ahead of the game…[He explained that] I’m in a race.” For Jessica, this meant that “other people who have a passion for something already are ahead of me, but I don’t know…I don’t think I’m that behind. I just need to find out what I want to do.” Science, for Jessica and her dad, was more about strategic positioning for a brighter future. Jessica saw science as a field that she would not mind pursuing, but it did not represent her passion. Jessica would settle for a career in science, if she could subtly bring her passions into it.

Why science? Jessica explained that back in her parents’ younger years, “in order to be successful what you needed to have was the labor and the money, but now what you need to be successful is innovation and engineering and ideas.” Her parents wished someone had informed them about careers in science; so they did everything they could to keep her informed. With their help, she came to “believe that science really is the future because you can be the innovator.” Jessica expressed the belief that “science is our understanding of how things work, whether they are technical, chemical, or biological.” For her, the most pressing issue to research in science was alternative fuel sources, “since right now we are paying $4 a gallon to fill up our gas tanks.”

Jessica had a multitude of mentors and family friends to look to as role models. However, since the fourth grade, her older brother, by nine years, had been her primary role model. He went to an Ivy League college and lived the lifestyle for which Jessica longed. Unlike her brother, an economist, who was singularly focused on math, Jessica explained that she had several interests:

> [M]y thing is I'm kind of a jack of all trades. I feel like I'm good at a lot of things, but I wish I was just good at one thing. So I'd just be like, "Hey, I really like this, and I'm going to do that." I find that I have a little interest in everything, so I need to find out what I have the most interest in.

As Jessica decided what to do next, she remained confident. Partly because she had her high school diploma; which, she explained, physically "reminds me that I accomplished something." She discussed some of her other areas of accomplishment:

> I feel like I got into a good college. I feel like I got a good scholarship. I feel like I can graduate with a good GPA. I feel like I'm on my way; I just need to choose a specific task. It's like I have this as my path worked out, but I need to connect them. And I know it's not too late to do that…

The only thing Jessica had yet to do was find a career, "you're really willing to take a lot of grief in order to do it. You're willing to take it."

Narrator's commentary. As soon as our interview ended, Jessica was off to find two or three books to buy. As Jessica walked off, I could not help but smile. In an olive green, cotton, one-piece shorts jump set, Jessica was poised, confident, and self-assured as she made her way to the book section of the store. She did not even glance the way of two male suitors that where trying to get her attention. Jessica exuded a certain freeness and openness, which was completely different from the shy and unconfident persona that Jessica presented when she arrived at the dorm for SIP.

At SIP, Jessica spent the first week or so only associating with only her suite mates. It was not until another SIP participant told her that they were being snobby that she stepped outside her comfort zone to engage more people. Now she found pride in her role as the outgoing friend. Jessica was really pleased with the young woman she had become, despite being "lost," when it came to deciding upon a career path. At one point in the interview, we had the following exchange:

Jessica: I'm so lost now.

Me: You're not lost.

Jessica: I'm a little lost.

While Jessica may have felt behind because of her inability to decide on a career or major, I believed she was right where she needed to be. Despite not getting in to her top two colleges, not getting into her school's international program, and disappointing her parents, Jessica managed to become more secure in her identity. For Jessica, life experiences had proven that knowledge of self was more important than becoming the person that everyone else thinks you should be.

Jessica came from a supportive, two-parent home. Her parents, neighbors, and family friends provided a safety net, support system, and sounding board. During the interview, Jessica discussed how SIP, particularly me, influenced her views of science:

> **Jessica**: And so I realized that, you know, I shouldn't let my experience in high school completely define what science is for me. So SIP definitely helped me in that respect. I think you even called me out once.
>
> **Me**: I think so.
>
> **Jessica**: That made me really happy.
>
> **Me**: You were good.

Jessica: Thank you.

Simply telling the class to see Jessica if they had problems with the course material, changed how she viewed science, and made her feel good. She went on to further explain how that experience made her feel:

> I actually felt intelligent. Another thing was I just…I don't know. I guess another thing is I kind of pushed myself more because a lot of people expected me to be smart sometimes. And so I was like, okay, well, I have to know this and I have to know that…So in your class, I felt like I could actually like chemistry.

It was not until my class that Jessica felt she could like chemistry. Jessica went on to reveal that she thought I had high expectations of her and believed that she would make a great scientist. I felt honored that I helped reassure her about her ability in science, and enabled her to envision herself in a successful career in science.

Breaking Through the Red Tape: Tonya's Story

> Hmm, I think I'm…I think I'm still the same. I still have the same friends and still…I feel like we still act the same. I don't know. But I feel like I'm still the same person…probably just more wiser and more organized.

When reflecting on the two years since our last interview, Tonya did not believe much about her life had changed. She still had the same friends. To her knowledge, her behavior and that of her close-knit circle of friends had not changed. She still felt the same, just a little more organized. She stated, "I'm still shy."

Two things actually had changed: she no longer desired a career in broadcasting, and education was no longer her minor. Education was still a possibility, but she had chosen to major in psychology. It was by happenstance that she ended up in psychology.

> I really didn't know about the whole undecided thing, because they didn't really tell me like, "Okay, you can do undecided," and, you know, they would…they would then educate me about, I guess, the application process. So I just put psychology in, ended up taking a class, and I liked it; so I'm gonna keep it and see

> how it goes. I did like a little research on careers, so I might…I might do counseling or, um, forensic psychology.

Not understanding the major declaration process and enjoying one course completely shifted the path that Tonya was taking. Was the shift permanent? Even Tonya was not sure of that, as evident in her response to what a successful her would look like 25 years from now, "25 years from now I will have a family and a job in the field of psychology…(not sure yet)…" The shift happened to put her in a science-related career field, which she was not happily anticipating; partly, because she felt that her high school science curriculum did not prepare her for what she was going to see in college. In fact, she had been avoiding it intentionally.

> Ms. Courtney, I hate science. [Laughing] Like, I tried to take everything else first, and then I was gonna…I was like, "I'll just [take] science, you know, in the summer." But I ended up doing poli – political science, but I'm taking boil…yeah, biology this coming semester.

It was not clear whether it was her lack of familiarity with the subject, anxiety, or true dislike of the subject matter that led her to say "I hate science." As valedictorian of her high school, she did well in her science courses. She claimed she did well because she had to pass the high school graduation test. Tonya explained how she prepared for the test:

> I passed it on the first try, but I had to study on my own for science…I had to study for my own…like on my own, and that's how I really passed. I think if I didn't study on my own, I probably would've had to take it again or something. But I ended up studying on my own, got the little GGT books to, uh, practice the little problems and stuff, but, yeah…

Tonya learned science, but only because if she did not excel, she would not have graduated at the top of her class. Her definition of science rose out of these experiences.

As she stated, “Science I guess is just how everything works and just the discovery of how everything works, basically.”

The delivery of science content had the most influence on Tonya’s palatability of science. She explained, “I feel like the subject is interesting, but I guess who’s like delivering the information, I guess that has an effect on me.” Tonya acknowledged that pursuing a career in psychology, or forensic psychology, would force her to take a lot of science courses. She declared that she would have to get past her disdain of science, because, as she stated, “There is no other choice.” I asked her about her interest in forensic psychology, and she explained her choice:

> Well, I kind of like law and the court system and how it works. And I kind of want to work with that and maybe be able to interpret, um, criminal behavior or the court system stuff.

Tonya explanation for choosing forensic science was just like her definition of science. She wanted to know how something worked.

When Tonya reflected on what she considered necessary for success in our initial interview, she shook her head and laughed. She could not believe the emphasis she had placed on money. After having read more books and being exposed to a diverse group of individuals, Tonya had altered her perception of success:

> When you’re successful, I feel that you are happy. It doesn’t matter if you are poor or rich. You’re comfortable in your own skin. You’re, um, and you’re just happy. I feel like happiness is...plays a really big, um, part in it.

Oprah Winfrey modeled success for Tonya. Oprah was not a role model for Tonya because she was the richest and most recognized person in the world, but because she gave back. She cared for her community. Helping the community was a necessary task for Tonya. Tonya’s tangible role model was her older sister:

> [S]he works hard at…well, she does work hard at what she does. And I don't mind saying that she, um, she doesn't just settle; she…she might, you know, find something that she likes, but she's all…always trying to find something different to do.

Working hard was not just something her sister did, it was what her parents lived. They did everything they could to provide better opportunities for Tonya and her sister.

Tonya was going to pursue a career in science not because she wanted to do so, but because she had to do so. Tonya was searching for a career and not a hobby. She sought a career that would enable her to endure the course work, because she knows that happiness is her final destination.

Narrator's commentary. Tonya really believed that she was shy and quiet, despite being the drum major for her high school band and valedictorian of her school. It was an identity that she was unwilling to shed. It defined her; even though I could look at the way she carried herself and see that she was much more open and inviting. Maybe being known as shy and quiet was her security blanket, much like Linus in the *Charlie Brown* cartoon.

After our initial interview, I walked Tonya to her car, where her mother was waiting. It completely shocked, amazed, and honored me that her mother had thought enough of me to drive Tonya to the interview and sit outside eating dinner for the hour that we were together. If I had known her mother was outside in the car at the beginning of the interview, I would have rescheduled it or invited her mother to join us.

When I got to the car, her mother immediately jumped out of the car and gave me a hug. We both caused Tonya to blush when we declared that we were proud of her. She had grown into a beautiful young lady, and the best was yet to come. Then her mom, much to my surprise, said "thank you for helping her see herself and her life for what it is

and can be." I had no clue that I had done any of that. Tonya and I rarely spoke. When we did, it was a quick text message here and there, or a brief conversation through instant messaging on Facebook.

Tonya believed that I wanted her to "stay in school, work hard, and try my best. Do what I should do and do what I have to do." She even acknowledged that she needed me to think she was good in science, "[I]t'll probably, um, make it a whole lot better with my concerns on the subject because I would need the extra boost from someone else". She is right, I will always be there to give her that extra boost.

Chapter 5: Two Glimpses into Participants Evolving Relationship with Science as They Chart Pathways to Success

What is Science?

To understand how African-American students utilize their science experiences to make future choices, I first examined how participants defined science. This approach allowed me to understand what participants meant when they talked about science and allowed me to rule out the possibility of defining science for them. Additionally, an examination of participants' interviews and demographic surveys provided a profile for what students labeled as the "doing of science," in response to the following questions: Where does science occur? Who does science? Have you had exposure to "real" science? What science experiences have more of an influence on defining science? Answers to these types of questions provided a context for explaining the definitions most likely to attract and sustain the long-term interest of African-American youth in science.

Participant interviews in year one began with students describing as many science experiences as possible (from middle school through high school). This portion of the interview required students to recall experiences and place a set of experiences within the context of science. Their responses represented the definitions of science they had adopted. Participants had a chance to review their definitions two years later and decide if their definitions where the same or needed to be modified. The participant-produced definitions of science provided a context for understanding the perceptions of science that they drew upon to formulate post-secondary goals and career objectives. Utilizing two different time points facilitated an investigation of the stability of these definitions, post-secondary goals, and career objectives over time.

What is Success?

Participants' definitions for success arose out of various lived experiences. All participants described, in detail, their plans and goals for the future. Initially, every participant shared at least one possible career path that they desired for the future. For example, they detailed possible undergraduate college majors and then described how the college major would lead to a career. Many participants even acknowledged ways that science would help them to achieve future goals.

Participants defined success as being who they are, what they envisioned themselves to be, and who they have learned to be. Getting into their desired career fields and performing certain tasks would be the epitome of a successful life for them. Their definitions shaped the next steps that each student chose. In year one, each of the participants considered success to be remote and distant, not something they could achieve in the here and now. In year three, success had become something they had achieved in the past and hoped to attain in the future.

This chapter presents composites of science that were developed from participant portraits in year one and year three. Composites of science are snapshots of science experiences within the context of participants' retelling of their lives. I develop these composites by first describing how students defined science in the context of their lived experiences. I follow these accounts with descriptions of participants' visions of success for their future. After defining what science is and describing success for the participants, I provide a discussion of possible interactions between the two areas. I examine composites for year one and year three separately in the chapter, and conclude with a

discussion of similarities, differences, and changes between year one and year three of the study.

Year One Composites of Science: What is Science?

Participants expressed surprisingly different definitions of science. These definitions at times reflected more about the relationship the participants had to the environments where they perceived that science was occurring. All participants could recall numerous experiences with science. In the following section, I discuss four definitions of science that emerged from the data collected during the initial interviews with participants (See Table 1).

Science is everything. It is particularly salient that the vast majority of participants described science as being in everything and necessary for life. Their phrasing sounded much like introductory passages from a textbook or a script from a teacher trying to encourage apprehensive students to engage the material.

> **Marcus:** Science, science, science… I would say science is what keeps the world goin', I guess. The world is science. I mean, that's my opinion. Everything is based off science and math.
>
> **Keisha:** Science is…without science, how [would] we know what's going on around us and the status quo or back way back when? I don't know what we'd do without science. Science is like, in everything.
> **Tonya:** It is the study of how everything works together and is made of and all that stuff. I don't know. I mean it's just science.

All participants held a belief that science was essential to the existence of the world and our understanding of it. While articulating that "science is everything," participants like Marcus and Tonya displayed an unwillingness to fully commit to a "science is everything definition," as seen in phrases like "I guess" and "I don't know." Somewhere in their lived experiences, they came to accept that science was everything,

but failed to connect it to something practical, tangible, and believable to them. Even though Debbie declared that you have to incorporate science into whatever career you choose, when questioned further, she was unable to produce concrete ways she would use science in her future career. Not being able to connect the theoretical definition of "science is everything" to a practical example limited Debbie's understanding of the usefulness of science.

Science as a means to an end. I posed a key question to these African-American students who directly or indirectly placed themselves in the science pipeline: Why continue to seek out and participate in science experiences? The answers to this question ranged from the desire to get a particular grade to getting scholarships or achieving financial stability. Science represented a means to an end for many of the participants. It was a way for them to get to next steps in their lives.

For Mark science was a means to receive scholarships for college. He explained that he participated in a sports medicine science camp at a local college because of the promise of scholarship funds. Mark declared, I believe that's gonna be helpful and I get scholarships for that so that's good. As a junior in high school, Mark already understood that his ability to obtain a post-secondary education was contingent on his ability to receive financial assistance. Mark's concern reflected a national trend, which indicates that 67% of first year college students are concerned about their ability to finance their education (HERI, 2010). His participation in the sports medicine science camp was motivated not by the doing of science but by the role that the doing of science could play in helping him obtain a post-secondary education.

> **Darren:** And it was basically a science program where you…for, I believe, 3 or 4 weeks or so, you would do…perform research and scientific studies and reside on

> campus for about 4 weeks...You present your research or whatever you was doing…You'll present it to the judges or the panel and the stipend was worth…I mean, it's $2,800.00... And that's science-related, by…like I said, I saw the money…business…I coulda started something with that.

In the statement above, Darren recalled being selected to attend a summer science program. Even though the program required him to participate in and successfully complete a research project, it was the stipend the program offered that drove Darren's willingness to attend. He saw the money as a means to start a business. The money was attached to doing science. The theme of science serving as a means for financial stability for Darren appeared again when I asked if he had completely ruled out science as a possible career choice. He replied, I mean, it's becoming very competitive out here in the world, and I realize that. So, you know, I might have to fall back on science. In this statement, Darren acknowledged that if financial stability does not come from his initial career, then he would pursue a career in science as an alternative.

Mary defined science as a way to help her become a pediatrician. She explained her motivation:

> Well, I chose this when I was little. I've known that I wanted to be a pediatrician since I was a little girl. It's just been my drive. And science…health science really has been my favorite science of all.

Her desire to be a pediatrician has lead to the pursuit of science. Her pursuit intensified after taking a health science courses and having a baby. Science was her tool for opening the "Raven Wellness Center for Pediatric Child Care."

All of the participants in the study were part of the cohort of individuals that attended a preparatory research program where one of the articulated goals was to provide students with nontraditional science experiences that could cultivate long-term interest in science and science-related fields. In addition to providing nontraditional

science experiences, the program provided academic preparation for Advanced Placement and entry-level college science courses. All participants stated that one of their primary reasons for attending the program was to gain the college experience.

> **Debbie:** Obviously, I expect to expand my knowledge and get a college feel, but I also expect to like get to know other people from different schools and to connect and make friends from other schools.
>
> **Renee:** I expected it to be the college feel and to meet new people especially. And to - I don't know - have a new experience, really…something different… something that'll kinda prepare me for college. Give me a little insight about it. And maybe have a - like something happen that maybe would influence what I want to do when I get older.
>
> **Marcus:** I think it's a learning experience to get a college feel, I guess. And so, that's pretty much why I'm here
>
> **Michael:** My expectations are to like get a good education, a feel for a college life…college campus...meet new friends and basically just to have fun throughout the summer.

Some participants expanded their answers to include the desire to learn more about the college sponsoring the science intervention program, gain information to make better decisions about the future, and meet individuals with similar goals and interests. None of the participants cited the exposure to new science experiences as a primary reason for attending the science intervention program. The science required for participation was just a way for them to gain access to the experience of discovering and negotiating college requirements.

Is it wrong to use science as a way to achieve personal objectives that may or may not be in the field of science? No, but it calls attention to the fact that many students who are in the science pipeline at the secondary level are not there because of a “love” or strong desire for science degrees or careers, but for something different and, perhaps,

greater. The greater is to fulfill dreams, goals, hopes, and aspirations that they have developed for themselves.

Science as a course. Science first became a part of the traditional public school curriculum at the end of the 19th century. By the beginning of the 20th century, science education had become essential to the public and to educators, out of a fear that certain individuals would destroy mankind in their lust for new discoveries (Del Giorno, 1969). This desire to develop an understanding of scientific advancements and discoveries has dictated what students are exposed to during schooling. It also has become what some students define as science.

> **Renee:** I feel sometimes like, "I'm not gonna need this outside of this classroom. What am I gonna do with science when I get outside this classroom? More than likely, nothing…
>
> **Darren:** I mean I trust and I know it become quite challenging and difficult but if you put in the time and hard work and remain patient and keep a positive mind state, you're conquer that challenging obstacle called science...
>
> **Tonya:** I just read the book, and I'm only reading things. I've never really do anything…
>
> **Keisha:** I want to say that it's easy, but it's like over the years, like, math has gotten, like, draining and hard or whatever, but science still seems to be the same to me.

These phrases are representative of statements in which students defined science as a class instead of something they do. For Renee, being unable to see how science in her class is relevant to her life defined the usefulness of science for her future. Darren called science an obstacle to overcome, but he actually was referring to science courses. Tonya leaned toward believing that science was stuff that you could read in a book. Keisha enjoyed science and attributed her enjoyment to the fact that science consistently came relatively easy to her in school. Like Darren, she actually was referring to her

science classes not becoming more difficult. Based on the results from the study, the majority of the students linked science to the curriculum they experienced within their science classrooms and not the science they do. This perception became the science they know.

Science as doing. When chronicling their science experiences. all participants acknowledged having done one or more science projects. Only one student, Jessica, viewed science projects as the doing of science. She explained, "[W]ell, the first time I ever got into anything really scientific was in the eighth grade. And that's because that was the first time that my school ever made me do a science fair project." Her science experiences did not start with being in a course, but with the actual act of performing an experiment. Jessica confined her science interest to a particular question, "Why does that work over there? But I kind of just want to look it up instead of performing experiment after experiment." For Jessica, becoming completely engrossed in science meant not taking classes, but performing science through a set of experiments.

Michael, Keisha, and Mark all described science as something one does after situating science as a course. According to Michael, "we made circuits and we just did different experiments and stuff. That was my most memorable experience about science." Keisha situated her science experience as doing in her statement:

> …oh, and my grandma who like, I used to always plant in her garden with her. It just got me into plants. I just love plants. I just think it's amazing how they feed themselves, photosynthesis and all that. So, I guess that is a motivator in science.

Similarly, Mark explained*:*

> I like doing like stuff like technology, like physics, like physical science cause like *we* used to do stuff like we build a car. It was like a little toy car. It was cool, and what else we did? We did this little, we did model and then it was like this, he pulled out the marble and like do all these tricks and stuff.

Jessica is the only student who immediately recognized that science was not just something she learned and acknowledged it as something that she actually does. Michael, Keisha, and Mark are representative of most of the participants in the study. They recognized that science was something one does, but only after their characterization of it as something that one learns. More high school students, especially African Americans, may need to see science as something they primarily do, not something they simply learn. The participants show that excitement and joy comes from doing science not through regurgitating facts, theories, and formulas. Excitement and joy are more likely to create long-term interest and engagement in science.

Table 1 represents how each participant defined science. Only Keisha defined science as all four categories. Jessica limited her definition of science to only doing, and Renee limited her definition of science exclusively to a course. All other participants had definitions of science that spanned at least two categories.

Table 1. Participants Definitions of Science: Year One

Participant	Science is Everything	Science is a Means to an End	Science is a Course	Science is Doing
Darren	X	X	X	
Debbie	X	X		
Jessica				**X**
Keisha	X	X	X	X
Marcus	X		X	
Mark		X	X	X
Mary		X	X	
Michael			X	X
Renee			**X**	
Tonya	X		X	

Definitions of Success

Participants articulated similar definitions of success. The definitions of success contained more communal than individual outcomes. All participants linked their desired future outcome with a particular area that they were passionate about. In the following section, I discuss the definitions of success that emerged from the data collected during the initial interviews with participants.

Success as completion of a course. The first way that the participants articulated their perceptions of success was not in their descriptions of their goals for the future, but rather in their discussions of previous encounters with school courses, particularly science. Participants repeatedly recalled having done whatever it took to achieve academic success in courses, regardless of the teacher or their interest in the material. Mark, Keisha, Tonya, Michael, Darren and Debbie described their success in terms of their academic accomplishments:

> **Mark:** I say in middle school I never liked science, but I passed.
>
> **Keisha:** I just come home. I get, you know, get what you need to get done. Because ain't nobody got time for - I come too far to look back now, you know.
>
> **Tonya:** Like, I do as best as I can and pass, and I pass and do well.
>
> **Michael:** Oh, basically just focus, listen to the teacher and do my homework basically. Cause like if I listen, like stuff will come to me so that's all I do, just pay attention.
>
> **Darren:** So because like I go – my intention when I go to class, just do what I have to do, work hard, take what I can from it.
>
> **Debbie:** I just did what I had to do to pass, did what I had to do to more than pass, 'cause I never really accepted a B. I always had to get an A.

The examples above demonstrate that, for participants in the study, success was demonstrated in their commitment to doing whatever it took to receive high academic

evaluations. The strong commitment of these students to education meant that regardless of the requirements or materials that were put in front of them, they would find a way to demonstrate academic achievement. They achieved and were recognized for their achievement because they understood that success was tied to their work ethic and their strong desire to complete the course.

Success as personal fulfillment. Success is not just about displaying hard work and persistence; it is tied to whether one can enjoy the work in which they are engaged. If one cannot find meaning in or a "passion" for what they are doing, then they may not feel as successful as they could if they truly loved what they were doing. When you do what you love, you find yourself learning about or performing that activity even when the extra work is not required. The students expressed an understanding of the importance of enjoying their work:

> **Mark:** And that's the thing that I believe that everybody should do 'cause it could make you happy.
>
> **Jessica:** So, as much as I like looking at things, I think that if I started experimenting to figure out things myself, I kinda just, I don't know, lose hope sometimes.
>
> **Renee:** I have to have a passion for it. Like a real strong passion…like a strong drive for it for me to do it in my free time.

Mark felt that everyone should participate in something that brings them happiness. Jessica acknowledged that, as she loses her drive and motivation to complete experiments, she loses hope. Renee acknowledged that for her to do something in her free time, she has to have a strong "passion" for it. For each of these three participants, to reach the end or choose to continually engage in something, they have to have some sense of personal fulfillment.

Success as helping others. Philanthropy was a key theme throughout all the futures that participants envisioned for themselves. By accomplishing their expressed goals, they each would be able to help someone else. They hoped to accomplish helping someone from their community by working with them directly, creating something the community could use, or providing funding for areas of critical need. Often, the participants' desire to help others arose from a personal experience that they had or something they witnessed within their families. According to Darren:

> I just see myself giving back to the community…and helping out the world. 'Cause, I mean, I believe that's what I was put on this earth to do…just giving back and helping those who are less fortunate than I am, because I had to be appreciative for the things I do have. I may not have everything I want, need, or like to have; but I understand that people do have…I mean, they are living in conditions and circumstances, which I knew I wouldn't know how to handle….

Darren strongly believed that it is his "calling" to give back to the community and world. He attributed his "calling" to having an appreciation for what he had and a realization that there was always someone else living in conditions worse than his. Debbie declared the same type of passion for changing her community. This idea came across very strongly after she conveyed a story where she and her sister were abandoned on a school bus. Debbie described details around her abandonment:

> Like, [the driver] just walked away with no repercussions, and that made me angry, because your job is to take students home. Your job is not…and then especially because you just left us on the bus and didn't care. It's like I gotta do…I wanna be…I wanna make a change in the world. I wanna be a part of a change, and I want to see a change. So, I'm gonna contribute to that.

Unlike Darren and Debbie, Mark described, in detail, exactly how he wanted to help individuals in his community:

> I wanna make my own health insurance company, too, 'cause I believe that the ones that we have now in America are not good…far as, like, how many people, like, get denied…how much the medicine cost. And, like, simple thing as like

> you probably cutting your finger, how much it gotta cost to like sew it back in probably cost like $20,000.00 and for another country it could be free. I don't like that. And it's like the doctors get paid more to like deny more people. So I feel like the company I wanna make is like doctors get paid more to treat more people. I think that would be good, but I don't know if I could do that, but I'm gonna try and see how far I'll go.

Renee actually attributed her career choice of being a lawyer to wanting to help individuals who may have been wronged by the justice system.

> …because of the reason that I want to be a lawyer is because past experience with my brothers and unfair things that happened to them dealing with law…with stuff not being fair or whatever. That made me want to be a lawyer.

Keisha, on the other hand, attributed her career choice to experiences she had as an inner-city youth.

> …like just open up a teen clinic because I really…I don't know. I just…I just think that's my cup of tea…Like, this experience, like being a teenager and seeing so much…Because I go to an inner-city school, and so, all the issues that are related with teens is just around you every day, like pregnancy, dropouts, even STDs. Everything is just around you every day, and some of the stuff you experience for yourself, and it's just like a life changing thing. And it leaves an impact on you, and once you make…it just led me to want to do something about, not just be about…you know, just do something about it.

Darren, Debbie, Mark, Renee and Keisha are representative of participants in this study who had the strong desire to right social injustices and ailments in their communities. Social justice and change is necessary, not optional, in the futures participants envisioned for themselves. For Darren, his life's purpose involved helping others. For the rest of the participants, the desire to help others would manifest itself in how they positioned themselves within their chosen career fields. For these students, success required that they help others.

Table 2 provides participant responses to how important different work outcomes were for them in their future careers. All participants expressed their desire to choose

work that was fun. Nine of the ten participants agreed that wanted a career that allowed them to have time for family, that allowed them to think, and that was satisfying. These preferred outcomes reaffirm that success is represented as personal fulfillment for the participants. Also, almost all of the students expressed a desire to engage in work that allowed them to help their community and/or society, and provided opportunities for them to help solve problems and create solutions. They articulated success as the ability to help others.

Table 2. Importance of Outcomes in Future Career: Year One

Participant	Tell us how important each of the items below is to you in your future work. How important is it to you to do.....									
	Work that makes me think	**Work that allows me to make lots of money**	**Work that allows me to use math, computer, engineering or science skills**	**Work that allows me to tell other people what to do**	**Work that allows me to help solve problems and create solutions**	**Work that is fun to do**	**Work that allows me to have time with family**	**Work that allows me to help my community and/or society**	**Work that makes people think highly of me**	**Work that is satisfying to me**
Darren Benjamin	Very Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important
Debbie Grahm	Very Important	Very Important	Very Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important
Jessica Gale	Very Important	Very Important	Somewhat Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important
Keisha Green	Very Important	Somewhat Important	Somewhat Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Somewhat Important	Very Important
Marcus Hillman	Very Important	Very Important	Very Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Somewhat Important
Mark Andrew	Very Important	Somewhat Important	Not Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important
Mary Roberts	Very Important	Very Important	Somewhat Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important
Michael Stevens	Somewhat Important	Very Important	Somewhat Important	Somewhat Important	Somewhat Important	Very Important	Somewhat Important	Somewhat Important	Very Important	Very Important
Renee Echols	Very Important	Somewhat Important	Not Important	Not Important	Somewhat Important	Very Important	Very Important	Very Important	Not Important	Very Important
Tonya Edwards	Very Important	Very Important	Somewhat Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important	Very Important

The Science of Success

The participants' definitions of science and success were as complex as the individuals themselves. Even when participants described their visions for the future, they expressed a certain degree of uncertainty. The only thing they seemed confident about was their innate or "passionate" interest. One thing is certain; all of the participants understood that they needed to demonstrate high levels of competency in science to achieve the success that they desired. All participants were unwilling to completely rule out the need for science in their future.

Mark, Marcus, Mary, and Keisha decided that they could consider a career in the science pipeline. Mark liked to "invent stuff," and science represented one pathway that would allow him to do that.

> …Like to invent stuff. I don't know what I wanna invent. Technology is like so advanced, but something useful I believe everybody could use. Maybe a flying car or something...I don't know.

Marcus conceded that science would be a part of his future as a by-product of his pursuit of his interest in math:

> I'll probably end up doin' somethin' with math, more than likely. Engineering and stuff…with that comes science, so I guess, yeah, science will be a part of my future.

Mary acknowledged that to accomplish her career goal, she was going to have to know science and ace as many science classes in college as she could. Keisha had known since she was a little girl that she wanted to be a pediatrician. Because of this career goal, Keisha would need to continue in the science pipeline.

> …if I want to open a clinic or, like, be a psychologist, you need to know about biology and how the cells work and everything…how stuff moves in the nervous system and whatnot. So, yeah, science is going to take a big part. You're gonna

> need to know…You gonna need to ace them science classes. So, I'm gonna be up in them in college.

Darren, Jessica, Mary, Tonya, and Debbie all expressed strong desires to leave the pipeline to scientific careers. These participants also were unable to describe any way in which science connected to their "passion." However, Debbie did describe a situation where a teacher used dance to teach chemistry. This demonstration led her to sign up for AP chemistry, but it did not connect to her enough for her to consider a career in science. Darren, Mary, and Debbie had all experienced social injustices or ills that aided in propelling them into careers unrelated to science. The alternative careers would enable them to make immediate change in the world. Jessica was the only participant who clearly articulated being part of a global community. Tonya was the only student who clearly expressed a desire to be financially stable.

At the time of the interview, Michael had not decided to stay or leave the science pipeline, but was pursuing his dream of becoming a professional basketball player. Everything else only came into play if he was unable to bring this dream to fruition.

The ten "successful" African-American students in this section of the study were highly focused on demonstrating above-average academic achievement in high school and on helping others, particularly those in their families and communities. The realization that science was something that they do well seemed to be of no great concern when discussing a career or undergraduate major. Importantly, for most participants, school science experiences were foundational in how they defined science. Even after being exposed to science enrichment and intervention programs, school science served as the main influence on how participants perceived science.

Four of the ten participants in the study expressed, sometimes reluctantly, a desire to continue on a trajectory that would lead to a scientific career. Participants conveyed that the most important factors in selecting a career were the degree of personal fulfillment that it would bring and the resources it could afford them to help others in their community. The definitions of science developed by participants in the study informed their current career and undergraduate major choices as they sought future experiences that would afford them the success they desired.

Year Three Composites of Science: What is Science?

While some participants shared definitions of science that were similar to those they shared in year one, others provided definitions that were very different. These definitions appeared to represent relationships and actions inhibited and aided by science. Participants rarely showed as much enthusiasm when recounting their science experiences as they did when re-telling stories about their growth and future directions. In the following section, I discuss the definitions of science that emerged from the data collected during the year three interviews with participants.

Science is a course. For all the participants in this study, the public school system mandated that they take a science course as a part of their primary and secondary school curriculum. Students also had to demonstrate a level of "scientific competence" in science on a graduation test. Without establishing this competence on the standardized high school graduation test, participants would not have been able to receive a high school diploma, regardless of whether they received high academic marks from their teachers. These required interactions with science through schooling could be the main reason that most of the participants saw science as a course.

After resigning herself to the fact that science would not be part of her future trajectory, Debbie declared, "I think science is definitely something that I've tried…" Renee expressed a similar sentiment, by saying that you have to "go take science" as a reason for not having engaged in more science experiences. Debbie and Renee tried to "take science," but Tonya deliberately avoided "taking science" in college.

> **Tonya:** I just, Ms. Courtney, I hate science. [Laughing] Like, I tried to take everything else first and then I was gonna…I was like, "I'll just [take] science, you know, in the summer." But I ended up doing poli…political science, but I'm taking biol…yeah, biology this coming semester.

In declaring her disdain for and avoidance of science, it is clear the Tonya had defined science as a course she *must* take. Unlike Debbie, Renee, and Tonya; Darren had a more complex way of seeing science as a course. Darren explained that "science is boring, but I think science is a great subject." In this statement, he characterized science as a "boring" course, but considered the material to be worthy of his interest.

Despite participating in a science intervention program and taking more practice-based science courses and labs in college, all participants, except one, still saw science as a course with valuable content. Unfortunately, the material had not proven valuable enough for any of these accomplished scholars to take a science course that was not required for their undergraduate majors. All of them avoided taking these courses until it was absolutely necessary. In fact, many would be okay with not taking any science courses at all; however, much like in primary and secondary school, they had no choice. Post-secondary science courses were required for them to obtain degrees in their desired fields.

Science is a universal language. The children and youth in grades K-16 at the time of this study are all a part of Generations Y and Z. Not only do these youth fight to

have their differences respected and counted; they strongly value peer-to-peer interaction. With the rise in internet accessibility through public spaces, cell phones use, emailing, texting, and IMing have become a natural part of life. Networks, relationships, and friendships are built, destroyed, and sustained through social networking on Facebook, Twitter, MySpace, and Google+. These youth are not confined to the community in which they reside, but have the ability to reach the world.

From this global perspective, Debbie, Renee, and Jessica viewed science as a necessary tool. They saw science as a universal language that allowed them to understand concepts and communicate with individuals all over the world.

> **Debbie:** I'm going to say science…whether you like it or you don't, you need it. So, you should try to understand it, because it's something that…like I said, it's a universal language that everybody understands in some way. We need science….We use techniques from people around the world, so it has to be a universal language. We understand it.
>
> **Renee:** But I feel like, for a lot of people, it's just a way to explain the things that go on in the world.
>
> **Jessica:** Well, I feel like science…I could get into a great deal…That would have a great deal to do with me being successful. But either way, no matter what path you choose, science is kind of always around you, you know, using more machinery and computers to do a lot of things in the future. Sometimes, you don't get jobs unless you're computer savvy…unless you know Word and Excel and Power Point. So, everybody has to know some science, some computer science, some form of science in order to be successful in a lot of things that we have to do.

Debbie's definition of a science as a universal language came from her time studying abroad. Jessica's definition originated from her desire to do something international and from watching numerous science education documentaries at the urging of her father. Renee's definition represented her finally being able to use a scientific concept to

understand an international nuclear crisis. For each of these young ladies, science represented the ability to understand and live in a global society.

Science is a teacher. Debbie and Tonya discussed the important role that their science teachers played in their perceptions of and performance in science classes.

> **Debbie:** I had her for three years in high school, and each year she pushed me harder and further and further. I said, "I don't understand biology," and she looked at me like, "Debbie, come here, sit down, let me show you this, let me show you that, look how it relates to chemistry, look at how it relates to what you're doing today," and she would help me out with it.

> **Tonya:** Um, it's probably the classes. I feel like the subject is interesting, but I guess who's like delivering the information, I guess that has an effect on me. But I should…I should find a…I don't know.

For Debbie, seeing science as her teacher helped created a positive view of science for her. When Debbie reflected back on her science experiences in high school, the first thing she talked about was her positive experiences with her chemistry teacher. In fact, her teacher was so great in high school chemistry that she entertained the idea of taking chemistry at the college level. Debbie saw her teacher as science, but not a scientist. For Tonya, on the other hand, seeing science as a teacher negatively affected her view of science. While she acknowledged that information in science could be interesting, she felt that the person delivering the information had the most effect on how she perceived science. Debbie and Tonya were unable to see science without seeing a teacher. Darren echoed their sentiments slightly when he discussed the fact that he only liked and explored geology because he had a passionate teaching assistant. Debbie, Darren, and Tonya could not see the nature of science because their science teachers blocked, shaded, and brightened the view.

Science is doing. Debbie, Renee, and Jessica see science as something that you do. Jessica's statement below is particularly interesting because she a purpose for the doing of science.

> **Jessica:** I think science is probably mostly used to help others, like with medicine, technology. You know, technology is used for a lot more than just entertainment purposes…with environmental issues. So I think that most people who go into the science field do it with intentions of helping others.

Jessica believed that the main reason for doing science was to help others. Debbie described how she would utilize science to improve the lives of those around her:

> **Debbie:** Like if somebody in your family has cancer, somebody in your family has HIV, and they're still suffering with it because there's been no cure. So I feel like, especially because I'm the type of person that like to help people and make people feel like they're being done right, I'm going to try my hardest to find a cure, to get into it to see if there's anything else I can do as a person or anything else I can help do with other people. So that's literally science right there that I would take part in.

While Jessica believed that the main reason for doing science is to help others, Debbie saw helping others as the only way she would engage in something scientific. Renee did not specifically define science as doing, but she discussed the activities in which a scientist would engage.

> **Renee:** I don't know the technical…but I just think…when I think about scientists, I just think about the people who are actually like doing work within it… not the ones who are teaching it, but are going to like observe and stuff, taking notes, finding out some things.

According to Renee, scientists observed, took notes, and conducted research. Teachers could not be scientists, because they were not doing the work of science.

Table 3 represents how each participant defined science. Only Debbie defined science as all four categories. All other participants had definitions of science that spanned at least two categories.

Table 3. Participants Definitions of Science: Year 3

Participant	Science is a Universal Language	Science is a Teacher	Science is a Course	Science is Doing
Darren Benjamin		X	X	
Debbie Graham	X	X	X	X
Jessica Gale	X			**X**
Renee Echols	X		X	X
Tonya Edwards		X	X	

To further explore definitions of science, participants were given the Scientific Attitude Inventory II (SAI II) and sections of the Relevance of Science Education (ROSE) instrument. The results are shown in Table 4 and Figure 5.1. The outcomes from ROSE, detailed in Table 4, show the three different areas into which the outcomes can be grouped: (a) disagreement (in blue), (b) indifferent (in green), and (c) agreement (in red). First, the areas of disagreement confirm the qualitative results. None of the participants expressed a desire to go into science as a career, and none wanted to have the option of taking extra science classes in school. Science was not their favorite subject, and only one individual felt it helped her understand ways to improve their health. Secondly, in the area of indifference, the participants did not feel strongly about either the appeal of science for future opportunities and or the difficulty of science courses. Much like in their interviews, the participants express an appreciation of science, but not a strong pull toward or away from it. Lastly, in the agreement area, most students agreed that science should be taught in school, that school science has increased their curiosity, and that they have a greater appreciation of science as a result of science classes in school. ROSE results corroborate that the participants in the study had an appreciation for the nature of science, but that their science experiences, particularly with science courses, did not foster in them a palatable taste for future science courses or careers.

The SAI II results show the complexity of participants' attitudes toward science. Only two of the items--the search for scientific knowledge would be boring and scientific ideas may change over time--demonstrated a consensus across all participants. The subjects strongly agreed that scientific ideas changed and somewhat disagreed that the search for scientific knowledge would be boring. While in varying strengths of disagreement and uncertainty, no participants agreed with the statement that most people understood science. Also, all participants showed some agreement or uncertainty about the belief that scientists study too much and have to report what they observe. When responding to whether working in science would be fun and whether scientists seek further understanding, the students demonstrated a wide variety of responses. Based on the results from SAI II, it is evident that participants appreciated the nature of science; understood that there were challenges to grasping scientific material; and believed that, over time, science principles, discoveries, and theories shifted and changed.

Much like in their narratives, the participants in the study reported an understanding and appreciation for the nature or essence of science, but lacked a practical ability to connect this meaning to the future they envisioned for themselves. Figure 5.2 shows select questions from SAI II that were also addressed in the qualitative interviews. None of the participants strongly agreed with wanting to be a scientist or finding personal fulfillment in doing scientific work. In their narratives, participants expressed a strong desire to pursue careers that allowed them to help others and possibly change the world. The results from SAI II show that participants did not see science as a tool to help their communities. None of the participants felt that a science career would afford them time with their family. When asked about the inventions of science, such as drugs and

electronics, only one participant strongly agreed that the inventions were valuable, beneficial, and helped people live better lives. For this population of students, an appreciation and understanding of science is separate from a practical application of science in their lives.

Table 4. ROSE Responses to Questions about Science Classes: Year Three

	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
I would like to become a scientist	0	0	2	3
I would like to get a job in technology	0	1	1	3
I like school science better than most other subjects	0	0	3	2
I would like to have as much science as possible at school	0	0	3	2
School science has taught me how to take better care of my health	1	0	4	0
I think that the science I learn at school will improve my career chances	0	2	2	1
School science has opened my eyes to new and exciting jobs	0	1	3	1
School science is interesting	0	3	1	1
School science has shown me the importance of science for our way of living	1	2	1	1
School science is a difficult subject	0	3	2	0
School science is rather easy for me to learn	0	2	3	0
The things that I learn in science at school will be helpful in my everyday life	0	3	2	0
School science has increased my appreciation of nature	1	3	0	1
School science has made me more critical and skeptical	1	3	0	1
School science has increased my curiosity about things we cannot yet explain	1	3	1	0
I think everybody should learn science at school	4	0	1	0

Figure 5.1. Results from SAI II: Year Three

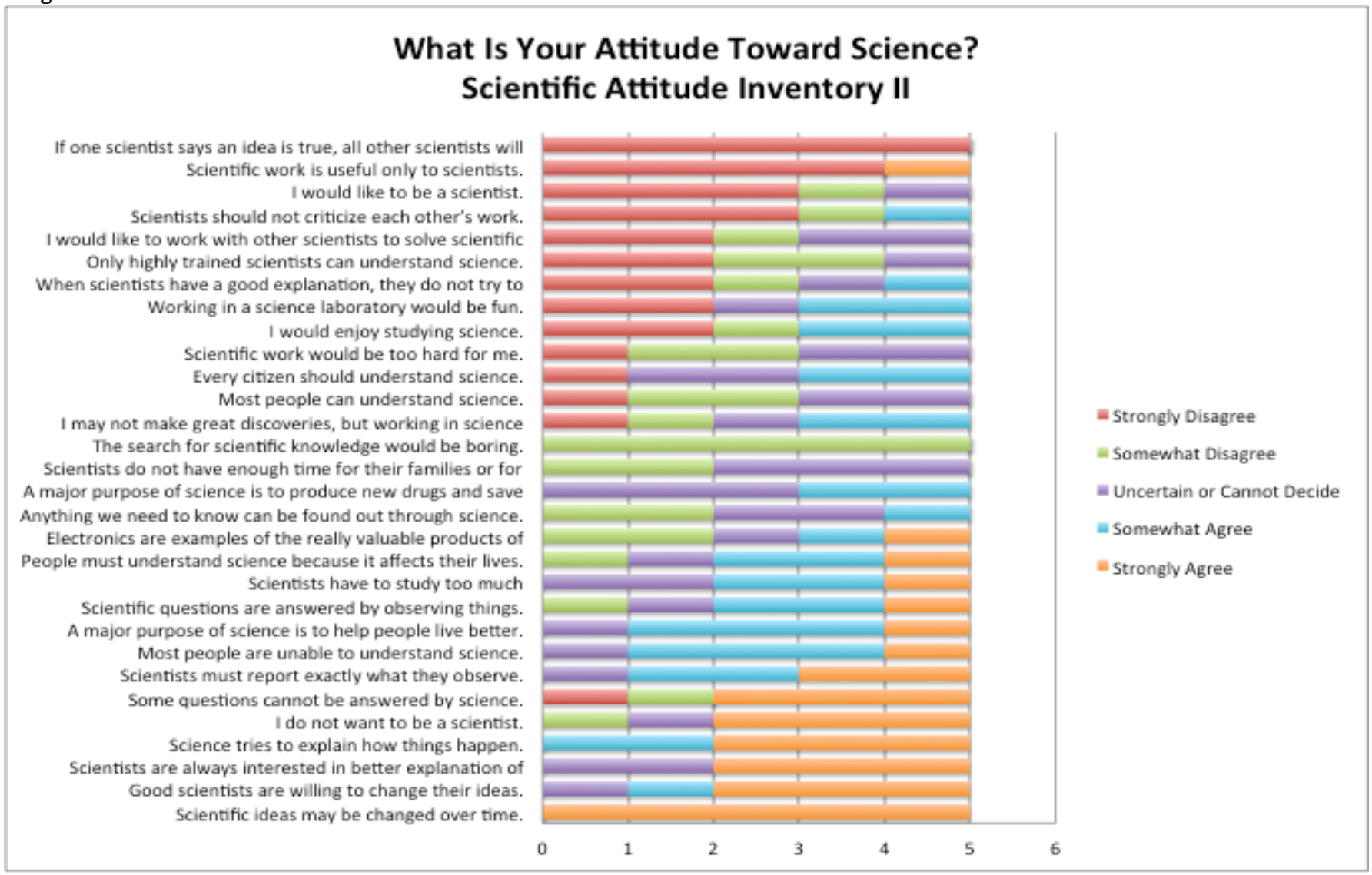
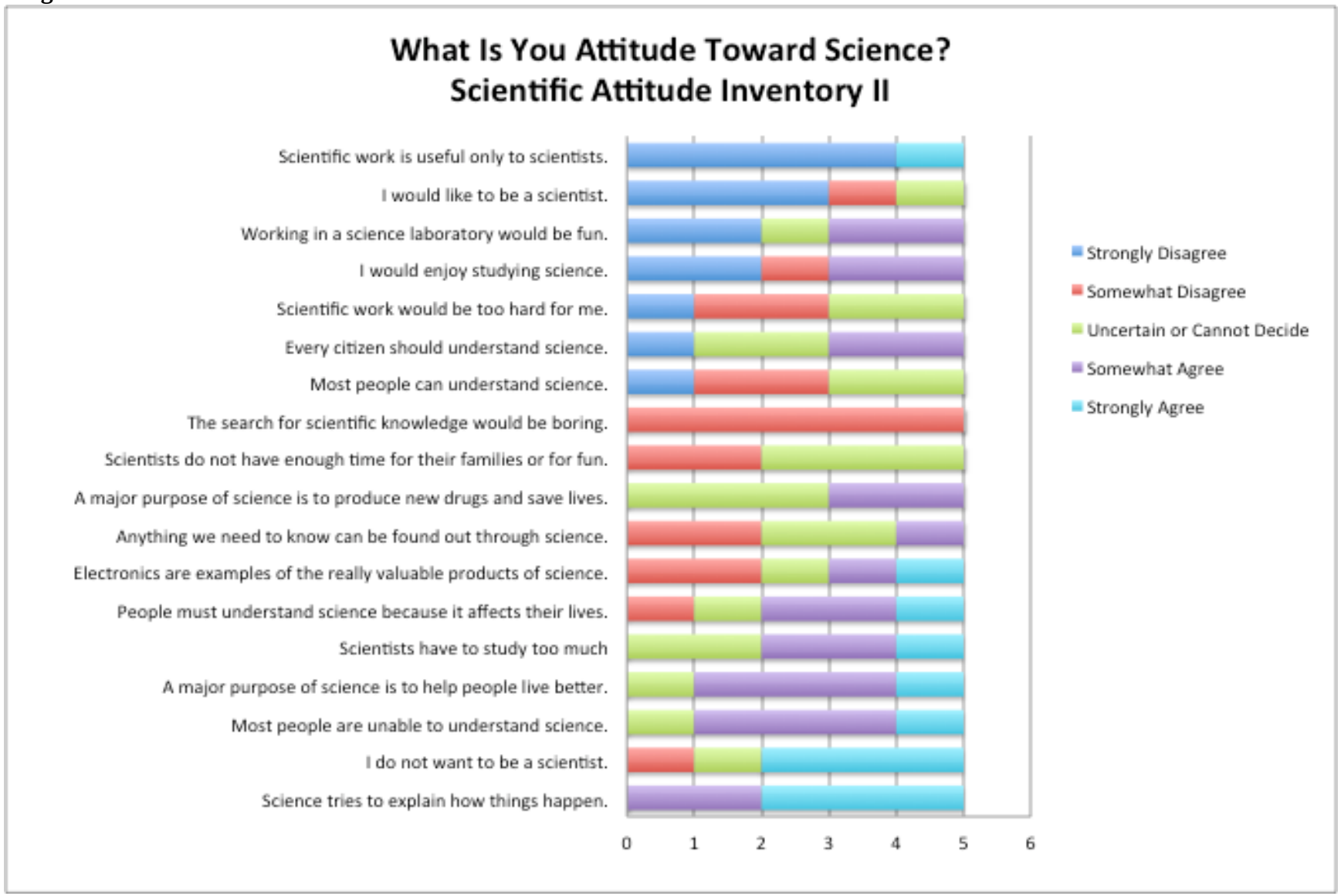


Figure 5.2. Selected Results from SAI II: Year Three



Definitions of Success

Participants articulated multiple definitions of success that contained both communal and individual outcomes. All participants linked their desired future outcome with multiple definitions of success. In the following sections, I discuss the definitions of success that emerged from the data collected during the initial interviews with participants.

Success as scholastic achievement. The participants first described success as scholastic achievement. To these students, scholastic achievement meant getting desirable grades (A's with some B's) in a course or receiving honors based on classroom performance. Darren and Tonya were valedictorians of their high school class and Debbie was salutatorian. While not one of the top two of their graduating classes, Renee and Jessica were in the top ten. All participants recounted receiving honors and awards for class performance, SAT scores, scholarly essays, peer tutoring, and leadership. At the time of the first interview, scholastic attainment was the epitome of achievement for the students, it marked a measure by which family, community, and other outside individuals considered them successful. Darren discussed the positive repercussions of his academic success:

> Just for all the opportunities that I've received and places I've been able to go and people I've been able to meet. It's all…it's all connected to my academic achievement.

When asked why others considered her successful, Renee replied that this perception was due to the fact that people saw her "just sticking with school and stuff like that." Jessica measured her ability to be successful in college by whether or not she could "graduate with a good GPA." Participants defined high scholastic achievement as success

because of the doors it had and could open for them to achieve their educational and vocational goals. Both the participants, and the gatekeepers to their futures, recognized that high scholastic achievement was a form of success.

Success as college admission and scholarships. Getting good grades, receiving academic honors, and being the top of their graduating class were not the only ways that participants defined success. All of them expressed that they felt successful because they obtained college admission and received scholarship funding. Debbie articulated this sentiment best:

> I went to college, and for my first year, didn't have to pay a dime…nothing…I got so many scholarships. And people look at me and say, "Wow, you're really…you don't have to pay anything and you're doing so well." So it made me, like, a role model and made me feel successful.

Jessica responded similarly to a question about whether she felt successful:

> Well, yeah, I do…I do. I feel like I got into a good college. I feel like I got a good scholarship.

All participants in this study attended college for free, and they all got at least two scholarships to help cover their tuition costs. Participant responses indicated that Darren was the standout in the number of scholarships he received. Debbie, Jessica, and Tonya each described Darren as someone they considered successful, based upon the amount of money he received in scholarships.

> **Debbie:** Darren, he's doing exceptional well. Like…I don't know. He's been awarded so many rewards.

Going to college with scholarships made both the participants and their parents feel successful. Only one of the participants had parents that attended college. Earning college admission and several scholarships brought the subjects' parents much joy and excitement; especially since many of the parents acknowledged that they could never

afford to send their students to college and had no idea what to do to access the necessary funding.

Success as happiness. Renee, Jessica, and Tonya all expressed that they would not consider themselves successful in the future if they were not satisfied with their position and well-being. To these young ladies, being happy meant that they would have lives and careers that brought them joy and fulfillment. Renee declared that she would consider herself successful "if I'm happy…. if I'm truly and genuinely, like, happy with my situation…with my life." Jessica described how her ideal job setting would make her happy, "But I feel like if in any job I'm able to kind of like help out with my knowledge of another language and still have time to travel, I'd be happy with it."

Tonya drew her own correlations between happiness and success and explained, "When you're successful, I feel that you are happy. It doesn't matter if you are poor or rich. You're comfortable in your own skin. You're, um, and you're just happy." She admitted that before college, she equated success with money:

> [I] had to have money. Like that was probably my biggest goal: Gotta have money. Um, and then I guess all that happiness and stuff probably came afterwards. Now I probably…I feel like happiness is more important now, and then the money. Like, you have to be satisfied with what you're doing. Then, I feel like the money and all that can come later.

Tonya, Jessica, and Renee had grown to believe that there is no success without happiness.

Success as financial stability. During the year three interviews, only three participants directly equated success with their financial situation. When articulating the desire for financial stability, only one student expressed a desire for her own material comfort. The other students sought financial stability as a means to assist family members

or help individuals in their community. Darren, for example, wanted to be a motivational speaker that traveled the world handing out scholarships and funding activities in the community. He also wanted to provide his mother with access to the best healthcare and to make sure that she had a "roof over her head and change in her pocket." Renee expressed this same desire to assist her family:

> I want to be settled. I want to have a family. I want to have a nice house. And I want to have a steady income, a good financial situation. I want my mother to have a good financial situation, even if it's totally dependent on me.

Unlike Renee and Darren, Jessica wanted to be financially stability so that she could provide for herself. In fact, she emphatically declared that a successful her at thirty would have a job making six figures. She explained the necessity of making six figures:

> I feel like if I – if I'm not making enough money at the job I'm at, I'm not really going to enjoy it. I have to be making enough to – making enough money to be able to support myself and be able to travel.

Renee, Darren and Jessica each felt they would be successful when they achieved a certain level of financial stability. However, the level of stability and the reasons for the stability were unique for each individual.

Success as helping others. A key theme throughout all of the participants' interviews was that they could measure their success by whether or not they were helping others. These "others" could include family members, peers, younger youth, members of their community, or anybody in the world. Darren stated that he "really just want[ed] to go around and uplifting and inspiring" and that "all my life I just always told myself I just want[ed] to change the world." Debbie also explained her desire to change the world. She stated, "I really want to change the world. I see things that are still happening that should have been changed." Debbie cited Darren's willingness to help others as one reason she

considered him successful. Darren read college and scholarship essays for her and others. He also shared with Debbie and others several scholarship applications and key deadlines.

Jessica did not want to change the world, but she did state, “If you have free time and someone else is lacking something that you have, I feel like you should help them.” She even signed herself up to tutor and mentor at a local high school.

Tonya shared her vision of her future helping people. She stated, “I’ll be somewhere in counseling. I think I’m leaning more towards counseling ‘cause I like people and helping people.” She also shared her thoughts about her sister’s success, and stated, “She’s pretty successful. Um, I like the fact that she gives back. Uh, and she says that she cares for her, um, she cares for the community.”

Renee did not believe that she could have a successful future without being able to help her mom and siblings. Helping others was a key component in whether or not these participants saw themselves as successful in the future. It was not enough for them to exist in the world; they had to be caretakers and change the world for the better.

Success as achieving personal goals and objectives. Success, for the individuals in this study, was not something defined by some outside individual or group. They saw success as the achievement of personal goals. It is the attainment of what an individual personally desires. Darren attempted to describe this attainment, but stated, “[It’s] kind of hard to explain until you get there because I feel like it's always going to be a desire to achieve more and do more.” Debbie described this drive for success in more detail:

> Success to me is doing something you always wanted to do. Success is not having a lot of money or having a big house, a nice car, a lot of friends. Success is saying, ”When I get 30, I want to have this;” and then you go there, and you have it. You’re successful.

Renee had somewhat similar comments about success:

> I define success as being exactly where you want to be in the position that you want to be….If I'm at the level that I feel like I can be at – the top level that I feel like I can achieve, then I'm successful.

Additionally, Renee declared that she considered her cheerleading coach successful because "she seems like she's where she want[s] to be." For Darren, Debbie, and Renee; success was about achieving the goals and objectives that they set for themselves, not those set out by others.

Success as leading. While none of the participants specifically said that they desired to be leaders in their future, all of them described a future that would be impossible if they were not leading. Darren wanted to be a motivational speaker. Debbie wanted to be the first Black female President of the United States. Renee dreamed of owning an entertainment law practice.

While Jessica and Tonya were a little less sure about how they envisioned their future careers, they did have traits for the jobs they were considering. Jessica wanted to be "the boss of herself", and Tonya desired a position of leadership within a team environment. Each envisioned future required the students to inspire, direct, be self-critical, and respect others. Without doing those things, these individuals would never achieve the success they desired, a success based on being a leader.

Success as work ethic. Success as a work ethic is dealing with a particular trait. The participants in this study described a trait that entailed continually being engaged in a particular activity to achieve a desired end. When discussing why he did not have a successful first year of college, Darren explained

> I just feel the work…the work ethic and I…I see them do whatever they had to in order to turn their selves or just become whatever they're trying to become in life and just don't receive any recognition for it. And I feel like I…I did the same thing, but it started getting to the point where I just felt like I stopped being a case for while.

Darren felt he was unsuccessful because he lost his work ethic. He did not continue engaging in activities that would have led to him or outsiders considering his freshman year a success. Renee described this as "just doing what she had to do."

Tonya admired her sister because "she's a hard worker." By hard worker, Tonya meant that her sister consistently engaged in whatever was necessary to get the job done. She did not stop; she kept going. Tonya's sister exhibited much of the same work ethic as Tyler Perry, who Debbie considered successful. In fact, Debbie stated, "there are also things that I wish I had that I don't have and I'm going to work to get them. I'm going to work just like he worked to be where he is. These responses indicate that, for several participants, work ethic defined success. Without work ethic, the students would find themselves in Darren's position, where they are defined as unsuccessful by themselves and others. According to Debbie, "if you don't do well, you keep trying." Successfully work ethic means consistently engagement and persistence toward your desired end.

Success as a journey. For the participants, success was not a destination but a journey. Success evolved as they experienced different points in their lives. Also, participants believed that success was always attainable and that being unsuccessful was not permanent. Darren surmised all of these points when he stated

> …I feel like I'm still maturing and I'm still…and I'm still learning about life, but I feel like that was this time in my life where…where I been unsuccessful, and I feel like I have grown from it and I've learned from it.

Debbie described success as a journey by discussing her dreams:

> I want to definitely embrace just accomplishing what you dreamed of, like you dream…like whatever I dream to be, all my dreams are going to add up to one big dream, and each small dream that I accomplish, that's my success. When I get to that big, huge dream, that is the ultimate success.

She proudly exclaimed, "I can't wait until I get to another point in my life where I can feel successful!" Renee, also, saw success as a journey. She separated being successful into categories. She stated, "I have been successful at things, but I may not be successful at life."

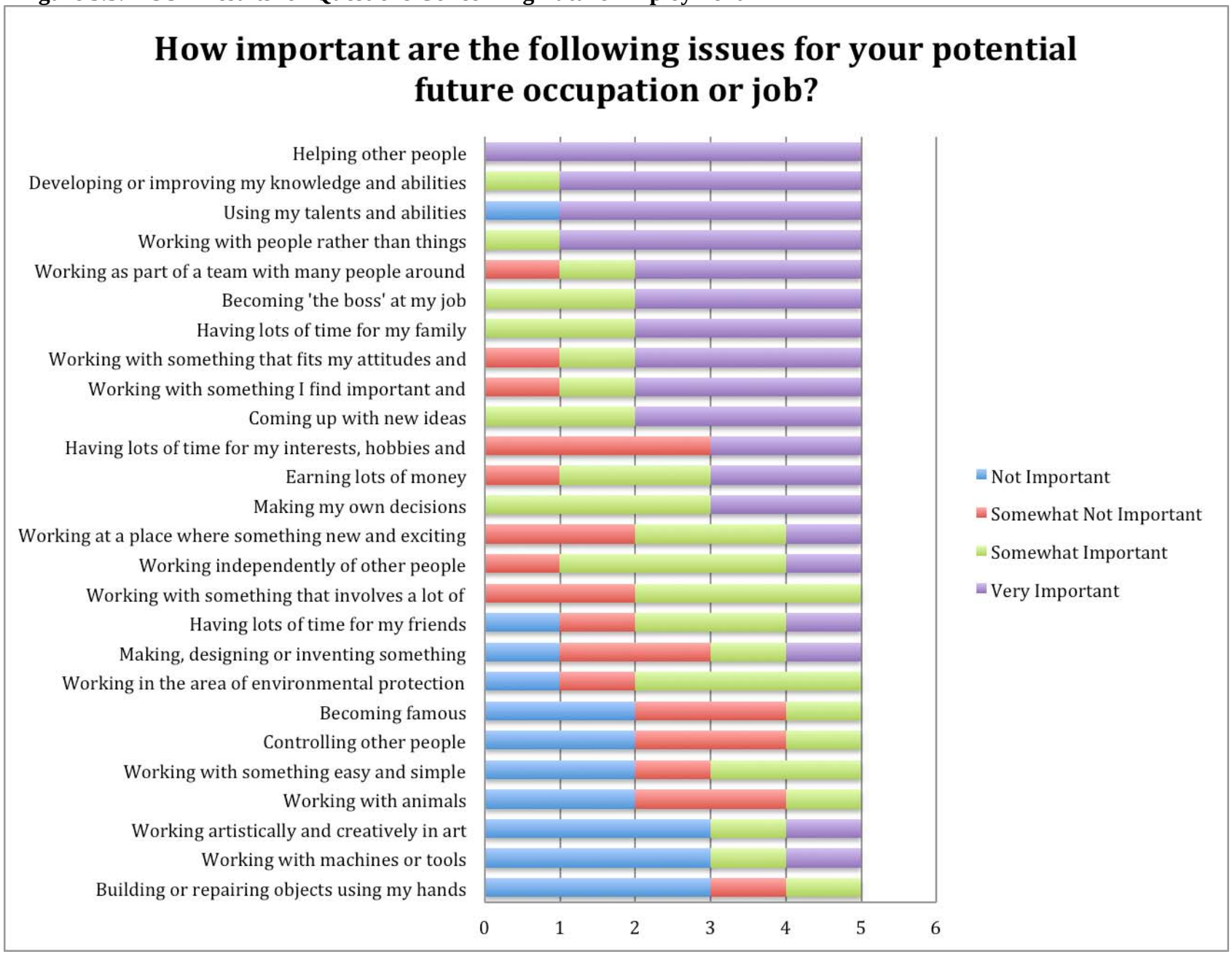
As a journey, success can be achieved not just on various days and times in one's life, but also in various areas of one life. The participants in the study acknowledged that they were growing and learning. As they grew, they experienced various points along their journey where they considered themselves successful, and, as in the case of Darren, unsuccessful.

Success as innovation. Jessica was the only participant that described success as innovation. In describing the tools necessary to be successful, both in her parents' day and in her own, Jessica stated, "I think back then, in order to be successful, what you needed to have was the labor and the money; but now what you need to be successful is innovation and engineering and ideas." After watching numerous science-related documentaries, having conversations with her family, and moving to a more diverse community, Jessica decided that success was innovation. It was having ideas and ingenuity.

Figure 5.3 shows how important different work outcomes were to the participants in their future careers, based on questions from the ROSE study. Just like in their narratives, all participants described helping others as very important in their future careers. Also important to participants was choosing a career where they worked with

people rather than things, coming up with new ideas, having time for family, becoming the boss, and developing or improving my knowledge. The students desire to "[become] the boss" is very similar to seeing success as leading. Desiring to coming up with new ideas is identical to desiring success by innovation. Results from the ROSE study support an initial finding that participants desire careers and futures that will allow them to help others, lead, provide meaningful outcomes, and spend time with their families.

Figure 5.3. ROSE Results for Questions Concerning Future Employment



The science of success. In year three of the study, five of the initial ten participants chose to continue in the study. The five participants that chose to continue in the study had gone from rising high school seniors to rising college sophomores. As a result, they could provide more insight into the future they wanted and the role that science would play in that future. Only two students, Debbie and Renee, were confident with their educational trajectory. Darren knew he wanted to be a motivational speaker, but could not decide on an undergraduate major. Tonya and Jessica were the most uncertain, but also the most open to a career in science. Because Tonya did not understand the major selection process, she had chosen a major in psychology for the time being. In response to parental support, and a desire for job stability, Jessica was considering a career in science. Jessica commented, that "science really is the future, because you can be the innovator." While embracing her innovator self, Jessica was still trying to decide on a major and career.

One of the things Jessica, struggled with was her ability to sustain her interest as she continued through the science pipeline. Much like the other participants, Jessica believed that she should have a strong passion or work ethic in order to be successful in the career she decided to pursue. Jessica stated, "If you really like it, then you're really willing to take a lot of grief in order to do it. You're willing to take it."

Darren believed that you have to work hard to achieve success, despite life situations or circumstances. Debbie, Renee, and Tonya admired individuals that had enough passion for what they did to persist and achieve various rewards, despite educational or financial limitations. It is the passion for successful work ethic that kept the research participants from firmly committing to science or science-related careers.

For the two that did make that commitment, Jessica and Tonya, the lack of passion could present a problem. Jessica believed it could hinder her from being one of the "best" in her field. Tonya was concerned that the lack of passion, coupled with a poor science background, could keep her from becoming a psychologist. She was still going to give it her all by seeking assistance when needed and not quitting when she did not immediately experience the success to which she was accustomed.

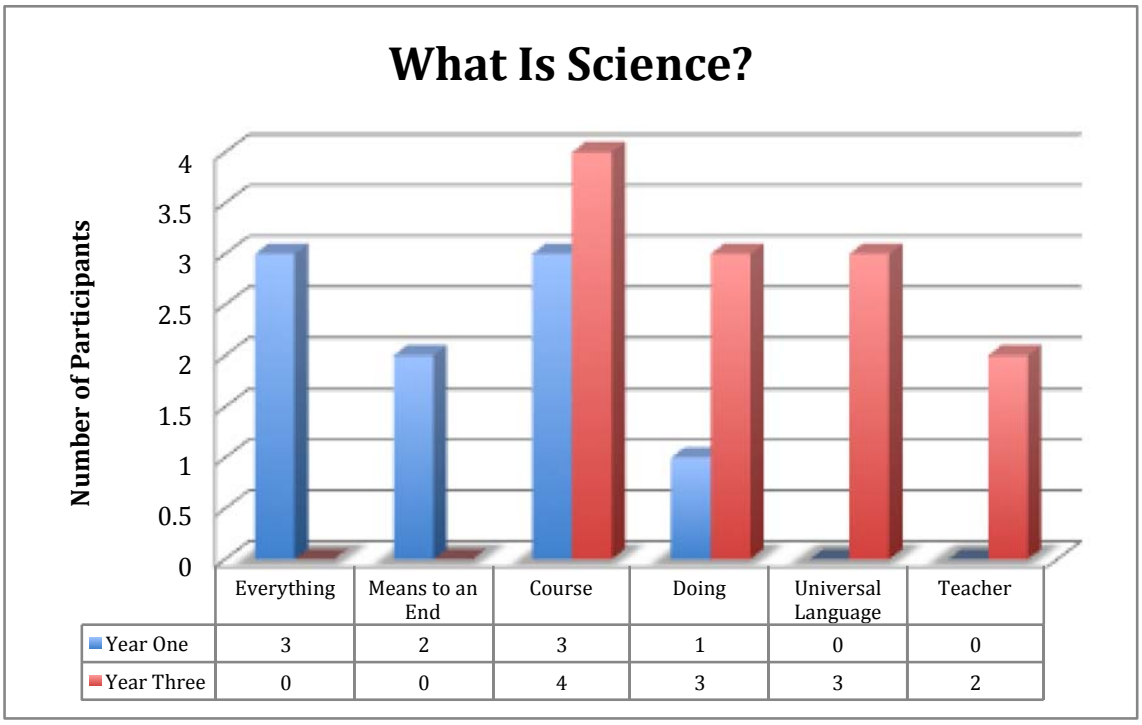
Success had become a journey for the participants. Along this journey, they each strove to maintain their scholastic achievement and work ethic after having obtained what society considered success for African-American adolescents: no arrest, no children, lack of drug addiction, college admission, and full college tuition scholarships. The students worked to achieve their personal milestones, while lending a hand to their families and communities. Through leadership and innovation, they would reach their desired levels of financial stability and make changes to right social injustices. Jessica was the only participant that saw a career in science as way to reach her successful self. Science represented success for Jessica not because she had a strong passion or drive for the field, but because she had a strong passion and drive for the affluent lifestyle she envisioned for herself. Science was a means to an end. For each participant, success was a necessity, not simply for the end, but for the length of the journey. Science was simple tool to continue on the journey.

Comparison: Summer 2009 vs. Summer 2011

By employing a qualitative research paradigm and Narrative Inquiry approach, participants' rich oral descriptions about their lives and experiences were emphasized in the participant portraits and composites of science. Participant portraits were included as

data for analysis. Thematic analysis was employed to illuminate the content, within and across stories, related to definitions of science and success. The themes found in participants' science experiences led to further interrogation about how science related to the future success that participants' desire. Findings, articulated in this section, frame understandings about the ways that these students defined science, and how science definitions can be a part of the success envisioned in students' future lives as they grow and change.

Figure 5.4. Definitions of Science for Year One and Year Three



	Everything	Means to an End	Course	Doing	Universal Language	Teacher
Year One	3	2	3	1	0	0
Year Three	0	0	4	3	3	2

Figure 5.4 displays participants' definitions of science in year one and year three of the study. Only two definitions, *science is a course* and *science is doing*, were evident in both years. The number of participants who saw science as a course increased by one in year three. As a result of life and college experiences, two additional participants viewed science is something you do. Having graduated from high school, participants no

longer viewed science as a means to an end or as everything; they saw it as a universal language and a teacher. Between year one and year three, the participants' definitions of science changed in some ways and remained constant in others. The changes and consistencies resulted from the students' ability to maintain their identities and from exposure to a new learning community.

Figure 5.5. Definitions of Success for Year One and Year Three

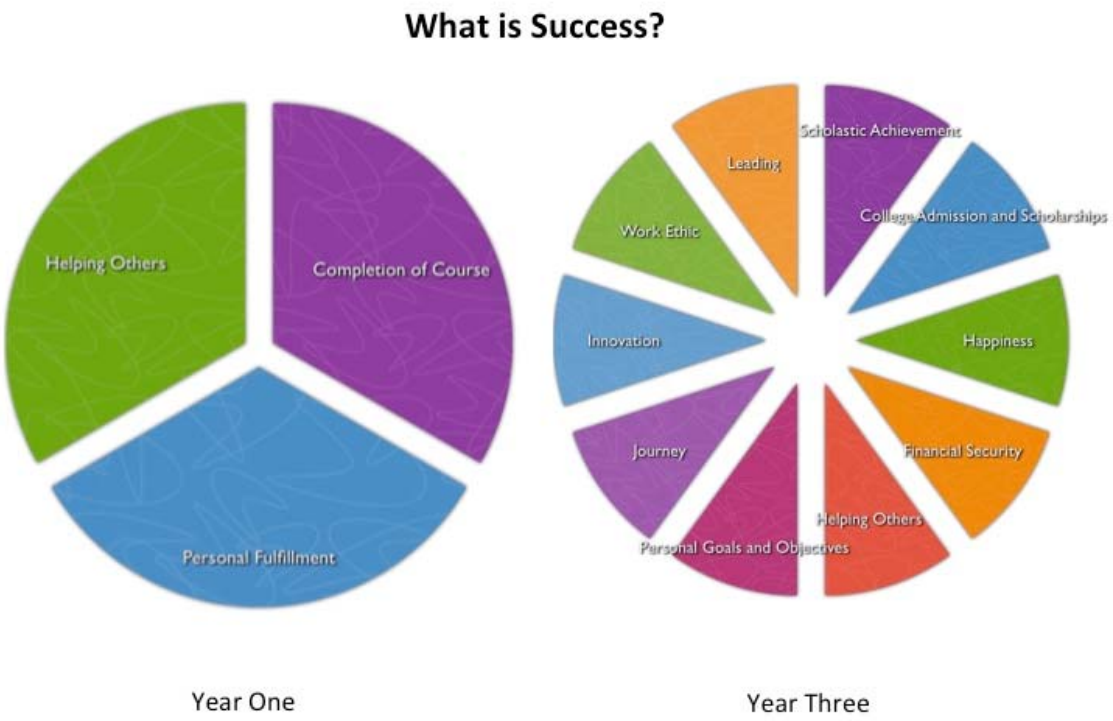


Figure 5.5 shows the various definitions of success that participants developed in year one and year three. The definitions are relative and not absolute. There is a noticeable increase in the ways that participants represented success in year three. The vagueness of personal fulfillment became more clearly defined as leading, happiness, financial security, and personal goals and objectives. Helping others remained an important component for success. Completion of a course shifted to mean an exhibition

of work ethic, scholastic achievement, and innovation. The complexity of success in year three, versus year one, caused participants to see success as a journey made up of various stops and pathways. Participants knew what they envisioned for themselves ten to fifteen years into the future, but they were unsure about which path would take them to their desired destination. This uncertainty about what path to take to get to success was prevalent, but only shifted two of the participants into considering careers in science or a science related field. Skepticism abounded for the participants that were considering science, as they wondered whether they could sustain the work ethic and scholastic achievement necessary for them to be the successful selves they envisioned.

Chapter 6: Science as a Tool

This study represents an exploration into the experiences that contribute to the formation of high school students' future life and career goals. Future life and career goals of students are important because the United States possesses a strong desire to produce its own scientific human capital. On January 25th, 2011, in the State of the Union address, President Barak Obama declared,, "this is our generation's Sputnik moment. Two years ago, I said that we needed to reach a level of research and development we haven't seen since the height of the Space Race." Without recruiting a large percentage of foreign-born scientists, the only way to achieve President Obama's goal is to produce more scientifically and technologically-trained individuals in younger generations. This study examines how younger generations view science in the context of the future they desire for themselves. President Obama, business leaders, and science educators can provide opportunities, funding, and incentives for pursuing futures in science; but if students do not see a future they desire in and through science, then the wave of innovation desired for this country will take place.

African-American students, in particular, have to struggle for educational opportunities and access in science, and in education as a whole. Lynn (2006) asserted that "the history of education for Africans is not a story of liberation and prosperity but one of struggle and disappointment" (p. 116). Most African-American students experience the same denial of access to educational resources that they do to societal resources because of their socioeconomic status and positioning. Social stratification within the United States arranges groups in "hierarchical orders of subordination and domination in which some groups so organized have unequal access to fundamental

resources of society" (Ogbu, 1994, p. 266). Schooling has managed to perpetuate the oppressive political, social, and economic conditions for African Americans by serving as institutions where White culture, values, and practices are not just taught but utilized as a means for evaluation. As Ogbu (1994, 1999) emphasized in his work, the power and structural forces in the United States shape the more micro school experiences of minority students. Similarly, Parsons (2008) argued that African Americans are continually denied access to science knowledge and careers because of their oppressed positioning. Racial factors play a significant role in they type of science education African-American students receive. To participate in the learning and doing of science, African-American students must struggle against societal oppression and the elitist legacy of science. "In today's world, economic access and full citizenship depend crucially on math and science literacy" (Tate, 2001, p. 1015). Regardless of the corrective measures policy makers and educators put in to place, it is crucial for African-American students to find ways to understand, achieve, and participate in science as a means to gain access and power.

Despite the inequities present in society and science education, the participants in this study successfully navigated K-12 schooling and its science curriculum. Participants were exposed to a variety of science experiences, informal and formal, that shaped the way they would allow science to be a part of their lives in the future. These findings show that definitions of science and success can differ based on environment, time, and exposure. Throughout the study, three relationships between the participants and science emerged: personal objectives and long-term interest, appreciation of the nature of science, and fluidity of science definitions.

Personal Objectives and Long-Term Interest

Villarejo et al. (2008) developed a career choice model that started at the college entry point and looked at input factors that influenced college major and career choices. They found that the input factors from pre-college experiences that had the most influence on college major were socioeconomic background, academic preparation, values, and interest. Values and interest were the only input factors that influenced the entire career selection process. Similarly, in this study, participants valued personal fulfillment and helping others in their selection of long-term career objectives in years one and three of the study. Students, at every stage in the science pipeline, were attracted to and repelled away from careers in science for very personal and specific reasons. Those who chose to pursue scientific careers formulated definitions and examples of science that enhanced what was most important to them in their future.

By examining participants' conceptions of success, this research revealed the possible ways science can become a part of the long-term goals and objectives of students. Darren, Debbie, and, Renee expressed strong desires for righting social injustices and ailments in their communities through their future careers. Calabrese, Barton, and Tan (2008) found that introducing science to students' in ways that allowed them to combat political, social, or economic forms of oppression increased interest in and motivation to learn science. Being able to change social ills that have affected them and their community was important to science students in Barton and Tan's study, as well as this one. The level of importance that students assign to righting social ills should be used as a tool to increase their desire to learn science and their long-term interest in doing science. Students must come to see science an expedient instrument of social justice and

a tool for achieving equality.

Being able to change their community and increase personal satisfaction was important to the future students envisioned for themselves. Unlike Baker and Leary (1995), this study found that both males *and* females sought opportunities to help others. Whether or not this phenomenon is unique to African-American males has yet to be established. This study demonstrates the need for future research to determine if African-American males are motivated by an attitude of caring, since all males in the study expressed a desire to help themselves, their families, and their community. Based on this research, students, whether male or female, who are able to see science as a vehicle for achieving the success through emotionally satisfying relationships, are more likely to persist through the science pipeline.

Exposing students to a more humanistic view of science could create more life-long learners of science. Teaching students how to be helpful in science courses, instead of teaching them how to demonstrate academic achievement in science, might be a better way to sustain interest. The only way this shift can occur is if success in K-12 science education is no longer measured by standardized tests. Carlone, Frank, and Webb (2011) believed that even if educational leaders reframed a lack of science achievement as a "school science problem" instead of a "student deficit" problem, what counts as success would remain the same. A science curriculum that is equitable and aligned with students' definitions of success is only possible if science policy makers and educators alter how they measure science success. The results highlight that few school science experiences eagerly invite students to learn about science or pursue careers in the field. By changing science measures, teaching will be forced to provide a different set of science experiences

to students that could appeal to their desires to make a difference in their communities. Instead of teaching facts and problem-solving techniques for standardized tests, teachers would present relevant facts and techniques to help student better understand problems and situations that they encounter in their community.

Course completion was an important dimension of success that arose from the study. This group of African-American students believed that completing a course, with high honors, was necessary for success. In science classes, these students did whatever it took to achieve, regardless of the helpfulness of their teachers. Their intrinsic motivation, or work ethic, propelled them to achieve in science, but it did not help them develop a greater interest in science. Being able to achieve in science was necessary to be a successful high school student. On the surface, their self-efficacy in science appeared to be extremely high, since they all persisted in the face of obstacles to achieving their goals (Bandura, 1997; Betz, 2004). Based on the study, I would hypothesize that for this group of African-American students, their science self-efficacy is high because their academic self-efficacy is high. They did well in science because they did well in school.

Appreciation of the Nature of Science

Through their experiences in year one of the study, participants viewed science as everything, a means to an end, a course, and doing. Only one participant in this study, Jessica, immediately associated science with something you do. She did not see it as facts in a book, an abstract concept, or a roadblock. Science educators see science as an appreciation of the nature of the world and a civic right. Science policy makers define science as a way of thinking or intellectual training. “Learning science is something that students do, not something that is done to them” (National Research Council, 1996, p. 4).

If one of the goals of science education is to increase the number of scientists, then students need to develop a better understanding of what it means to do science, instead of learning about what has been done in science. This research demonstrates the need to reconnect students to science, not to classes or to experiments, if they are to embrace the definitions of science articulated by science educators and policy makers. Greater appreciation does not automatically translate into the connections necessary for long-term engagement and participation in science.

Participants who connected their definitions of science to their visions of success remained open to the possibility of becoming career scientists. Even participants that did not express interest in pursuing science or science-related careers would not completely give up on the idea that science could become a field they explored as an interest or hobby.

All participants appreciated and valued science. Unfortunately, the value that participants believed science could add to their life is not enough to for them to commit to a career in science. As the findings support, and as Aschbacher, Li, and Roth (2010) substantiated, "more students might be interested in science careers involving the study of science if they were aware of them and if the learning process were more personally meaningful, acknowledging what they bring to science, and provide the chance to enact who they might want to be" (p. 580). Other careers become more valuable than science when students perceive that they provide more obvious and expedient ways to achieve their visions of future success and more meaningful lives.

Also, all the participants in the study had been a part of at least one science intervention program and some had engaged in others. In the interviews, participants

revealed that the science intervention program caused them to develop a deeper appreciation and understanding of science, but it did not radically change their beliefs, definitions, and thoughts about science. According to the participants, the greatest benefit of the science intervention program was that it provided them with a network of like-minded individuals that they could go to for academic and personal support. The program was life-changing, not for the science it presented, but for the community it created. An exploration into why science intervention experiences are not dominant when students define science will provide insight into ways science intervention programs can have more of an influence on how students view science. Some suggestions for science intervention program directors would be to explore ways in which science can support community building amongst participants, allow participants to integrate science into personal interest, and expose participants to non-traditional science career choices and pathways that involve their native interests.

Fluidity of Science Definitions

At the beginning of the study, participants were rising high school seniors; by the end of the study, they were burgeoning college sophomores. Over the course of the study, participants transitioned into new communities, new localities, new responsibilities, and new academic experiences. During this transition, they went from a somewhat homogenous group to distinctive individuals and experiences. As a result of these new experiences, they began to view science as a teacher and a universal language. They defined their science experiences by how engaging and caring they viewed their teacher to be. The language of science may sound different in various communities, but the principles are universally understood. Experiencing science in different communities

allowed participants to see continuity in the nature and usage of science, but it also highlighted the fact that these experiences were valued based upon who was leading the community.

More research is needed to fully understand how African-American high school students' definitions of science and success influence long-term career goals and educational attainments. Specifically, looking at how definitions of science and success may evolve or remain the same over time and space. All participants in this study were seniors in high school at the beginning of the study and rising college sophomores at the end of the study. They were still taking in information to shape their identities and their desired future selves. As the participants re-envisioned who and what they were becoming, the role of science shifted in their lives. Science became a tool to understand and communicate with individuals in their direct and indirect spheres of contact. As they continued on to post-secondary schooling, the participants recalled more about a teacher than their science experience. They saw the teacher first and science second and highlighted post-secondary instructors' enthusiasm and knowledge of the subject matter versus that of high school teachers.

Implications

The responses of the academically successful African-American students in this study provide evidence that educators must find ways to connect science to what students believe are important goals and objectives in their lives. Despite inequities in science and in society as a whole, the research participants found ways to achieve. Regrettably, achievement does not always lead to long-term interest or engagement. For these African-American students, their futures were more important than science. These

findings bring into question whether or not the science pipeline analogy should be modified to include a more holistic picture of the lived experiences of potential participants. Presently, the pipeline represents science. Based on results of this study, the pipeline should actually represent the students. Science becomes the material that enters into the lives of the students. Students permit science to aid them in achieving their goals. Students' goals and objectives are more important than science. Students are more interested in who they become than what they become.

Fostering interest and enthusiasm in science is of significant importance to developing future scientists. As a result, teachers and teacher educators must frame science curriculums in ways that connect to the daily lives of students. Maltese and Tai (2011) asserted that this reframing does not entail doing more labs. Instead, it requires that educators craft inquiry-based lessons that provide students an opportunity to explore science issues that are relevant to them (Bouilion & Gomez 2001; Rivet & Krajcik, 2004). More specifically, the presentation should provide a space for student voice, critical reflection, and collaboration between home and the community (Mallya et al., 2012).

This study shows that students that choose to pursue futures in science see science as a means to achieve a desired social outcome, either in their lives or in their community. School science aided them in making decisions and connections relevant to their personal lives (Brotman et al., 2010) The earlier students can draw connections between what they want or desire to change and science, the more likely they will be to pursue future endeavors in science.

No Child Left Behind focused attention on students' science proficiency in K-12 education. Race to the Top then provided funding for increasing the number and type of rigorous science courses available for high school students. Much like Maltese and Tai (2011), this study suggests that course completion and achievement may be misguided ways to increase the number of students who enter science or science-related career fields. Participants in this study were so driven by the desire to achieve academic success in high school that they would have risen to any academic standard or taken any course recommended. Course completion and achievement were not the main factors participants used to select future careers and interest. They mainly relied on personal satisfaction, the ability to help others, and the ability to be a leader.

In 2009, Basu et al. developed a framework for connecting agency and identity that they termed *critical science agency*. ''A framework of critical science agency requires us to understand that what students know is intertwined with who they are and want to be''(p. 370). Basu et al. explained that for the two participants in their study, Donya and Neil, critical science agency was identity development. Physics became more exciting for Donya when it connected to her developing identity of a budding lawyer. The subject became more affirming for Neil when he could hone his skills in robotics. For Donya, Neil, and the participants in the present study, identity development was the most important aspect of who they were when engaging in science experiences. By connecting to students' identity through a critical science agency approach, teachers and program directors cultivate sustained interest and engagement in the field of science.

The Choice, Control, and Change (C3) science curriculum provides a framework for designing formal and informal science experiences for students. The curriculum is

designed to allow students to (1) critically analyze the conditions of their food environments, (2) purposefully make healthier choices, and (3) expand the options available to themselves and others and share information with others (Mallaya et al., 2012, p. 263). Through this curriculum, students arrive at conclusions that best fit them and their community instead of prescribed solutions. As a result, they understand science in the context of everyday decisions they make about food and activity. The more they desire to understand food patterns and choices, the more science they learn. Science learning, interest, and enthusiasm is increased as a result of the desire for agency. While C3 is a good framework for science educators, it falls short of generating sustained interest in areas of science that students value the most for their present and future identities. One recommendation for achieving sustained and transformative experiences is to develop science curricular choices based students' innate interests and aspirations for the future.

Business leaders, policy makers, science educators, and community leaders that desire an increase in K-12 science test scores, the number of individuals pursuing careers in science, and the number of citizens that are able to examine critically science policy issues must push for more ways for students to see science as alive instead of dead. Science has to become more than a course in which they learn facts or, worse, a class they feel they are forced to endure and overcome. Alive science provides an immediate connection between science and students' social, economic, and familial concerns or issues. Because of the present lack of these connections, academically capable students are self selecting out of science, regardless of previous experiences or achievement. In fact, this group of students often views science as a means to provide better opportunities

for them than more living or interesting subject matter. Science provides a temporary wind for a success-bound ship, instead of being the ship. To become a ship, students' desire to sail science must become a vehicle through which they can see immediately success.

Limitations

Four limitations were germane to this dissertation study. First, although participants were selected for this work because counselors, principals, teachers, and the program believed they had achieved academic success, the actuality of this "success" is relative. While GPA's and class rankings suggested "success," there was no pre-determined measure by which to determine claimed student achievement. Second, the study utilizes participants' definitions of science and success. There are limitations inherent in the self-reporting of theses definitions by participants. However, by utilizing in-depth interviewing and demographic surveys, the researcher ensured continuity of responses. Further limitations of the study involve concerns about the generalizability and narrowness of the sample. The narrowness of the sample may have unduly influenced the findings of this study. Only five of the initial ten participants continued for the duration of the study for reasons known and unknown. Some of the known reasons for lack of continuation in the study are pre-college program participation, employment obligations, and relocation. It is important to acknowledge that more could be learned not just from a larger sample, but also from the inclusion of the five nonparticipants.

The generalizability of the study is limited. While participants in the study were from the same school district, they participated in different science experiences based on school-to-school differences and participation in informal science experiences. However,

I attempted to account for these differences by discussing those experiences that would be considered unique for this population of participants.

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Appendix A

Interview Guide: Interview 1

Interviewee: _____

Interview Type
Phone _____
In Person _____

Location: _____
Interview Date: _____
Interviewed By: _____

Where Stored/File Name
Voice Recording: _____

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1. Can you tell me as much as possible about the details of your experiences in science as a high school and middle school student? What were your sciences experiences as a student like for you?

2. How did you become involved in past and present science experiences?

3. Was there anything that struck you as interesting, unique, or important in during your science experiences? What science experience do you think has had the most influence on how you view science?

4. What after-school and/or out of school activities are you currently a participant? Why or why not is one of the activities science related?

5. Who do you want to be? How does science help you or hinder you from achieving this goal?

6. What do you hope to accomplish during your post-secondary (college) tenure? Are you participating in activities to prepare you for your future?

Appendix B

Informed Consent

Emory University School of Arts and Sciences
Consent to be a Research Subject

Title: A phenomenological analysis of high school students' participation in science

Principal Investigator: Courtney Tucker

Introduction/Purpose:

You are being asked to allow your child to be in a research study. This form is designed to tell you everything you need to think about before you decide to consent (agree) for your child to be in the study or not to be in the study. It is entirely your choice. If you decide to let your child to take part, you can change your mind later on and withdraw them from the research study. The decision to join or not join the research study will not cause your child to lose any benefits associated with being a participant in the Emory Preparatory Research Education Program (PREP). I anticipate 25-35 PREP participants to participate in the study.

Procedures

Your child is being asked to participate in focus groups and interviews while at PREP meetings and programs at Emory University. Your child is also being asked to complete electronic surveys, record audio journals, and produce a video documentary. Both the focus groups and the interviews will audio-taped for research purposes and analyzed. The interviews, focus groups, and surveys are being done to focus on the science experiences, practices, and perspectives of PREP participants. The study aims to describe a particular culture or social setting from the perspectives of the participants. First participants will be asked to complete an electronic survey. Then there will be two focus groups and four interviews. Interviews and focus groups will last from 30 to 90 minutes. Also, participants are asked to record their thoughts, feelings and beliefs about science weekly on a digital recorder that will be provided. As a part of the PREP summer program participants will produce a video documentary of their science experiences. We will provide your child with instructions for using the digital recorder and production of the video documentary after he/she is enrolled in the study.

Risks and Discomforts

There are no foreseeable risks to your child for participation in this study. In this study, your child will not have any more risks than he or she would in a normal day of life. This study will not have an effect on your child's participation in the PREP program. In all publications, your child's name will be changed to a pseudonym to protect his or her

confidentiality. No identifying images will be utilized when portions of video documentaries are shared in a public venue.

Benefits

This study is not designed to benefit your child directly. The study is designed to learn more about the youth science experiences and the influence of the PREP program on your child.

Compensation

You will not be offered payment for being in this study.

Confidentiality

Certain offices and people other than the researchers may look at your child's study records. Government agencies, Emory employees overseeing proper study conduct may look at your study records. These offices include the Emory Institutional Review Board, the Emory Office of Research Compliance, and the Office for Human Research Protections. Emory will keep any research records we produce private to the extent we are required to do so by law. A code and your child's initials rather than his or her name will be used on study records where possible. Your child's name and other facts that might point to him or her will not appear when presenting this study or publishing its results. In the final report, participants such as your child will be referred to by a pseudonym or referenced as "STIM participant in Atlanta".

Withdrawal from the Study

Your child's participation in this research is voluntary. He or she has the right not to be in this study. If your child decides to be in the study and changes his or her mind, they have the right to drop out at any time. Your child may skip questions or stop participating at any time. Even if you consent to your child's participation in the study, he/she may refuse to be in the study. Whatever your child decides, he or she will not lose any benefits in the PREP program to which they are otherwise entitled.

Questions

If you should have any questions about this study, you may contact me at cetucke@emory.edu or 678-984-1730. You may also call or email Dr. Magnia George in the Division of Educational Studies at magnia.george@emory.edu or 404-727-6468. If you have questions about your rights as a research subject or if you have questions, concerns or complaints about the research, you may contact the Emory Institutional Review Board at 404-712-0720 or 877-503-9797.

Consent

We will give you a copy of this consent form to keep. Do not sign this consent form unless you have had a chance to ask questions and get answers that make sense to you.

Nothing in this form can make you give up any legal rights. By signing this form you will not give up any legal rights. You are free to take home an unsigned copy of this form and talk it over with family or friends.

Please sign below if you agree to participate in this study.

_____

Name of PREP Participant

_____ _____

Signature of Legally Authorized Representative Date

_____

Authority of Legally Authorized Representative or Relationship to Subject

_____ _____

Assent of PREP Participant Date

_____ _____

Signature of Person Conducting Informed Consent Discussion Date

Appendix C

Interview Summary Form

Interviewee: _____

Interview Type
Phone _____
In Person _____

Location: _____
Interview Date: _____
Today's Date: _____
Written By: _____

Where Stored/File Name
Voice Recording: _____
Transcripts: _____

---

1. What were the main issues or themes that struck you during this interview?

2. Summarize the information you got (or failed to get) on each of the targeted questions?

Questions	Information

3. Anything else that struck you as salient, interesting, illumination, or important?

4. What new/remaining questions do you have for this interviewee?

Appendix D

WHAT IS YOUR ATTITUDE TOWARD SCIENCE?
(A Scientific Attitude Inventory) Moore and Foy (1997)
SAI II

There are some statements about science on the next pages. Some statements are about the nature of science. Some are about how scientists work. Some of these statements describe how you might feel about science. You may agree with some of the statements and you may disagree with others. That is exactly what you are asked to do. By doing this, you will show your attitudes toward science.

After you have carefully read a statement, decide whether or not you agree with it. If you agree, decide whether you agree mildly or strongly. If you disagree, decide whether you disagree mildly or strongly. You may decide that you are uncertain or cannot decide. Then, find the number of that statement on the answer sheet, and **CIRCLE** the:

A if you agree strongly

B if you agree mildly

C if you are uncertain or cannot decide

D if you disagree mildly

E if you disagree strongly

Please respond to each statement and circle only ONE letter for each statement.

1. Good scientists are willing to change their ideas.
A B C D E
2. I would enjoy studying science.
A B C D E
3. I may not make great discoveries, but working in science would be fun.
A B C D E
4. Scientific work is useful only to scientists.

A B C D E

5. Scientific ideas may be changed over time.

A B C D E

6. Scientists are always interested in better explanation of things.

A B C D E

7. Most people are unable to understand science.

A B C D E

8. Working in a science laboratory would be fun.

A B C D E

9. Some questions cannot be answered by science.

A B C D E

10. When scientists have a good explanation, they do not try to make it better.

A B C D E

11. Scientists should not criticize each other's work.

A B C D E

12. Most people can understand science.

A B C D E

13. Every citizen should understand science.

A B C D E

14. Scientific questions are answered by observing things.

A B C D E

15. Anything we need to know can be found out through science.

A B C D E

16. A major purpose of science is to produce new drugs and save lives.

A B C D E

17. If one scientist says an idea is true, all other scientists will believe it.

A B C D E

18. Scientists must report exactly what they observe.

A B C D E

19. Scientists have to study too much.

A B C D E

20. I would like to be a scientist.

A B C D E

21. The search for scientific knowledge would be boring.

A B C D E

22. Only highly trained scientists can understand science.

A B C D E

23. People must understand science because it affects their lives.

A B C D E

24. Electronics are examples of the really valuable products of science.

A B C D E

25. A major purpose of science is to help people live better.

A B C D E

26. I would like to work with other scientists to solve scientific problems.

A B C D E

27. Scientists do not have enough time for their families or for fun.

A B C D E

28. Science tries to explain how things happen.

A B C D E

29. Scientific work would be too hard for me.

A B C D E

30. I do not want to be a scientist.

A B C D E

Appendix E

The Relevance of Science Education Questionnaire

ROSE (Schreiner & Sjøberg,, 2004)

This questionnaire has been given to students in many different countries. That is why some questions may seem strange to you. If there is a question you do not understand, just leave it blank. If you are in doubt, you may ask the teacher, since this is not a test! For most questions, you simply put a tick in the appropriate box. The purpose of this questionnaire is to find out what students in different parts of the world think about science at school as well as in their everyday life. This information may help us to make schools better. Your answers are anonymous, so please, do not write your name on this questionnaire.

My future job: How important are the following issues for your potential future occupation or job?

Not Important- Very Important

1. Working with people rather than things .....
2. Helping other people .....
3. Working with animals .....
4. Working in the area of environmental protection .....
5. Working with something easy and simple .....
6. Building or repairing objects using my hands .....
7. Working with machines or tools .....
8. Working artistically and creatively in art .....
9. Using my talents and abilities .....
10. Making, designing or inventing something .....
11. Coming up with new ideas .....
12. Having lots of time for my friends .....
13. Making my own decisions .....
14. Working independently of other people .....

15. Working with something I find important and meaningful .....
16. Working with something that fits my attitudes and values .....
17. Having lots of time for my family .....
18. Working with something that involves a lot of travelling .....
19. Working at a place where something new and exciting happens frequently
20. Earning lots of money .....
21. Controlling other people .....
22. Becoming famous .....
23. Having lots of time for my interests, hobbies and activities .....
24. Becoming 'the boss' at my job .....
25. Developing or improving my knowledge and abilities .....
26. Working as part of a team with many people around me .....

My science classes: To what extent do you agree with the following statements about the science that you may have had at school?

Disagree---Agree

1. School science is a difficult subject .....
2. School science is interesting .....
3. School science is rather easy for me to learn .....
4. School science has opened my eyes to new and exciting jobs .....
5. I like school science better than most other subjects .....
6. I think everybody should learn science at school .....
7. The things that I learn in science at school will be helpful in my everyday life
8. I think that the science I learn at school will improve my career chances ..
9. School science has made me more critical and skeptical.....
10. School science has increased my curiosity about things we cannot yet explain
11. School science has increased my appreciation of nature.....
12. School science has shown me the importance of science for our way of living
13. School science has taught me how to take better care of my health
14. I would like to become a scientist .....
15. I would like to have as much science as possible at school .....
16. I would like to get a job in technology.....

My opinions about science and technology: To what extent do you agree with the following statements?

Disagree--Agree

1. Science and technology are important for society .....

2. Science and technology will find cures to diseases such as HIV/AIDS, cancer, etc.

3. Thanks to science and technology, there will be greater opportunities for future generations .....

4. Science and technology make our lives healthier, easier and more comfortable

5. New technologies will make work more interesting .....

6. The benefits of science are greater than the harmful effects it could have

7. Science and technology will help to eradicate poverty and famine in the world

8. Science and technology can solve nearly all problems .....

9. Science and technology are helping the poor .....

10. Science and technology are the cause of the environmental problems

11. A country needs science and technology to become developed

12. Science and technology benefit mainly the developed countries

13. Scientists follow the scientific method that always leads them to correct answers

14. We should always trust what scientists have to say .....

15. Scientists are neutral and objective .....

16. Scientific theories develop and change all the time .....

Myself as a scientist

Assume that you are grown up and work as a scientist. You are free to do research that you find important and interesting. Write some sentences about what you would like to do as a researcher and why.

I would like to:

Because:

Appendix F

Participant Portraits Year One

This section details the portraits that were constructed from interviews, information contained in entrance packets, and demographic surveys in year one of the study.

Darren

> 'Cause like this year I got most outstanding student in AP biology, which I didn't see how 'cause I'm like, I'm just doing – I mean I'm sure it was cause of my hard work. But I feel like other people may have deserved it and they were the individuals who had a passion for science and worked just as hard as I did. So that connection, I don't know, maybe it'll come at another time or maybe it's something I just have to wait and see.

Darren was a self-professed "hardworking" rising high school senior. He struggled with the fact that his hard work in science led to rewards and recognition, but no real passion or connection. He received an award for most outstanding student in AP biology, but felt that other individuals who possessed enthusiasm about the material should have received the reward. Even though he felt this way, he did not refuse or return the awards. Instead, he held out hope that maybe one day he would have the same passion and connection to biology that he would attribute to someone who, he believed, should receive those rewards. Besides, the rewards were ways for him to articulate his commitment to education.

Darren's interest in science was much like taking a drive down the highway. At times, the roads were smooth and the scenery interesting. At other points, the roads were bumpy; the scenery, dull.

> Well science, you know you have the opportunity to come up with new discoveries, experiment, which we have been doing in the past couple days here at prep. But on the bad side, on a bad note, I had to say you know some of the material can be boring. I mean I like for it to be challenging but sometimes it can

> become dreadful and sometimes it seem like it's too much. And you often wonder who came up with these ideas and concepts and put everything together. But other than that, no, I'm not really a big fan of science.

At times, he found himself bored; and other times, he found himself interested. The opportunity to come up with new discoveries and do experiments emboldened him, but eventually the material became dreadful and massive. His interest never maintained the consistency needed to make him a fan of the subject. Despite not being a fan, he found a way to excel in a way that put him academically above his peers who connected with science.

Most, if not all, of Darren's experiences in science occurred in the science classroom. At times, the courses became obstacles he had to conquer. In middle school, he participated in the science Olympiad. Darren approached his science class much like all his other classes; by taking what he could from them, working hard, and making sure he met all course requirements. Science was not the only subject for which he did not have a passion. He did not have a favorite subject.

Helping people and giving back to those in his community drove Darren. He thrived on inspiring and motivating his peers and those in the generations behind him. "I just see myself giving back to the community helping out the world. Cause I mean I believe that's what I was put on this earth to do. And you know maybe that just may be my callin'." His mission was to help those around him strive to be better and improve their lives. If this meant tutoring, speaking, moving, or sharing; Darren would do it. He had participated in numerous different walks to raise awareness and funds, and volunteered for the Special Olympics. Even though he may not have had everything he

wanted or desired, Darren was appreciative because he believed there is always someone in a worse situation.

After dealing with the untimely death of his brother and sickness of his mother, Darren found another passion besides helping others. To deal with the realities and difficulties of life, Darren started writing. At first, he wrote poetry, then he began to write lyrics over hip-hop and R&B beats. His writing led to an invitation to join a select group of high school students in metropolitan Atlanta called The Freedom Writers.

Darren's leadership skills and academic success were evident in the school activities in which he engaged. He was junior class president and was a part of all of the academic honor societies at his school. While science experiences may have been a component of his extracurricular activities and daily tasks, Darren believed they were of no real importance, because he could not recall them. He did remember being selected for a science-based program at a local college. It was going to pay him $2,800.00; and if he had not committed to another summer program, he would have chosen to participate. He saw something in the program besides science. "…that's science related but like I said, I saw the money, business, I could of started something with that."

Darren, a hopeful valedictorian, planned on becoming an entrepreneur. "I plan on being an entrepreneur and going into business or maybe I can have some scholarships for students who wanna pursue careers in a field of science but me and science, like I said, I succeed and do very well in science but that connection, it just isn't there, for some odd reason." If possible, he said he would sponsor science activities or even own a business for science equipment. One thing is for sure; he would not major in science or a science-related field in college. Instead, he planned to pursue a degree in business administration.

As he settled on a major and career, Darren was tentative about completely ruling out the possibility of a career in science.

> I mean it's becoming very competitive out here in the world and I realize that. So you know, I might have to fall back on science. I may need science one day but you know. I wanna try something else first. I won't give up on it but you know, I keep it there on the side. I keep it there on the side.

Debbie

Debbie, a compassionate and vibrant, high school senior made no apologies for who she was or where she felt she was going. Debbie proudly declared to all children, youth, and adults that she came into contact with that they should "remember Debbie Graham, 'cause I will be making a change in this world."

Debbie moved from New York to Atlanta for high school. Debbie earned all A's in her elementary and middle school science classes in New York. She only had to participate in science fairs when in elementary school. In middle school, she only had lectures and did traditional science projects. Once in high school in Georgia, Debbie began to struggle with science. Science was never her strongest subject, but one teacher made it easy by making sure Debbie knew all the teaching objectives. Later, she had a chemistry teacher who utilized her passion, dance, to show chemical bonding and reactions. After this, Debbie had a revelation:

> Science and social studies, I have never liked them. I just did what I had to do to pass, did what I had to do to more than pass, 'cause I never really accepted a B. I always had to get an A, so I coped with it, but I never really enjoyed it until chemistry with the unique dancing…. Chemistry is just really my favorite part of science, and I plan on taking AP Chemistry next year.

Debbie's chemistry teacher was able to connect chemistry into Debbie's passion. "I've been dancing since I was three, so I've been dancing for 14 years, and that is just my passion. That is one of my biggest passions." This made Debbie want to continue

learning about chemistry. Biology did not appeal to Debbie in the same way. She possessed an extreme dislike for the subject and commented that biology was so complex that it was confusing. During this course, she felt "the information just didn't go in my head the right way." Regardless of her self-professed weakness in biology, Debbie still found science interesting and mind-boggling at times. Her academic competency in science manifested itself in her pass plus on the high school graduation test.

Debbie's knowledge of science was not limited to her school environment. Her mom is as nurse. "Well, some of the knowledge I have about science is from my mother, because she's a nurse. So I don't understand, though, why I don't have it like I should." Debbie was perplexed by the fact that she did not enjoy science when her mother was in a science-related field. She asserted that she would find a way to incorporate science into everything she did because science is important.

> I know science is important. Like it's important - one of the most important things on this earth to learn about how things came about, to learn about where you're go, to learn about the basic foundation of things. Science and math are the two foundations of everything, I believe. You use them every day whether you know it or not. So I feel incorporate them into what you do, and maybe you could do it better.

Debbie was known as a leader and scholar at her high school. She served as captain of both the football and basketball dance teams. She also tutored students in math and served on the leadership team for a group of district-wide high school students. Being on the leadership team allowed her to host various district events and chauffer VIP members around the district. Debbie was also a scholar for an Ivy League preparatory program.

> It's for low-income students that wanna get into Ivy League schools, but don't have a chance because of their income. So it was founded to provide a full

> financial aid package so you can go to schools like Stanford and Princeton and everything like that.

The best way Debbie believed she could make a change was by becoming a lawyer. It was something that she had always wanted to do. She spent her time watching criminal justice shows and attending a high school of law and social justice. Law was her passion because when she saw all the issues that Americans and citizens of the world faced, she wanted to help them and make things easier. It angered her to see injustice in the world around her.

> So law has just become a major passion, especially because of my own experiences. It's like people get away with things that they shouldn't… It's like I will do everything for free to make sure that nothing…nobody is deprived of their rights.

Besides wanting to become a lawyer, Debbie was sure of one thing, "I want to make a change in the world. I want to be a part of a change in the world, and I want to see a change. So, I am going to contribute to changing the world".

Renee

As a rising senior, Renee anticipated that she could continue to balance being a full-time student, varsity cheerleader captain, and part-time employee at McDonald's. These three demanding, yet rewarding, roles afforded Renee little time to pursue any other activities or interests in her life. Eliminating her job at McDonalds to pursue interests at her high school was not an option. Renee's income was essential to maintaining her household. Renee had little time to plot next steps or pursue activities that could increase her cultural capital outside of normal school hours.

In middle school, Renee had the same science teacher for the gifted program in both her sixth and seventh grade science classes. She remembered little about these experiences, but knew that they were better than her experiences in eighth grade.

> Then when the science teacher came, it was like he didn't teach like - it seemed like he knew the information but he didn't know how to put it out there. So I didn't get it the way I probably should have. Like I got it enough to past the test but it was from me studying on my own. It wasn't from me actually learning in the classroom.

In high school, her physics teacher taught her exactly what she needed to know, but biology and chemistry was problematic. Biology presented information that she felt was useless, and her chemistry teacher moved too fast because a he was not hired until three months after the school year started. Chemistry had rules that would always have exceptions, and biology discussed facts that were not needed in the real world or her field of interest. “Like osmosis and all that. I really didn't care. It didn't seem to connect to me, 'cause I didn't feel like I needed it in the real world…So…or the field I was going into.” Despite inconveniences in the classroom and the realization that science was not her favorite subject, Renee understood the work. “Like, I get it. I get an A out of it, but it never…I don't know. It just never was attractive to me.”

Renee was extremely interested in law and history. “I like learning about stuff that has happened. That appeals to me. Like learning about stuff that's happening every day and why it happened. And what people went through in the past and stuff like that.” Earlier in her high school career; Renee considered being a forensic scientist, so that she could find out how and why homicide victims were murdered. The desire to be a criminal lawyer overshadowed her initial interest forensic science, because she had to “settle her mind.” In settling her mind, she realized that she had more passion for law than forensic

science. Maybe the right experience through a school club or activity could have changed her mind, but at the time of our interview, she had chosen going to pursue a career in law. For Renee to pursue any activity or interest, she believed she had to be motivated by it or she would lose focus.

> I have to have a passion for it. Like a real strong passion…like a strong drive for it for me to do it in my free time. 'Cause I have to do it in school, I get what I need done; and I do it because it's required. But if it's not required and I don't have that passion for it, I don't really think about it that much outside of school. It's not the thing that pops up in my mind.

Science did not appeal to Renee. She credited this partly to disengaged teachers and partly to not seeing the usefulness of science. Law afforded her the opportunity to right injustices experienced by her brothers, some of whom received jail sentences as a result of false charges. It provided her with an obvious way to prevent other families from having similar experiences. She admitted to the slight possibility that, if the right opportunity happened along, she might reconsider a career as a forensic scientist.

Jessica

Jessica was a rising high school senior who was searching for something new and challenging. Since starting high school, she had been a part of the International Baccalaureate program. This program afforded her the opportunity to take classes that were not offered everywhere in her district, like Theory of Knowledge. Jessica's high school preparation had created lenses through which she saw her future and career in terms of a global society.

Jessica recalled, "[The] first time I ever got into anything really scientific was in the eighth grade, and that's because that was the first time that my school ever made me do a science fair project." Jessica elected to use Petri dishes and agar to compare how

many bacteria were present on brass, gold-plated, and silver-plated doorknobs. After this experience, Jessica really got into science and wanted to go to observatories in her area to explore what astronomy had to offer. As she continued to do science through her science fair projects, Jessica always used Petri dishes and agar. For one project, she looked at the effects of different disinfectants on bacteria growth; and for another, she used different water samples. If her mother had not suggested she use a Petri dishes and agar, Jessica would never have explored her interest in growing different things. “I still have like a whole bunch of…I don't have any dishes, but I have a whole bunch of Agar mixture at my house…in my closet, for whenever I decide to grow more bacteria.” Jessica explained, “[The] most I've been into science is basically my experiments that I've done with my science fair from eighth grade to my junior year.”

Jessica confined her interest in science to wanting to know why something works.

> Well, because my interest in science is strictly like, “ Why does that work over there?" but I kind of just want to look it up instead of performing experiment after experiment. I think my attention span is kind of…it's not that…I don't…it's…I couldn't be a scientist because I couldn't sit there and deal with all those formulas. And sometimes I'll be doing even a math problem, like my math class. And in the middle of it I'll realize that I changed some number along the way. And I know if that happens in a science experiment, I just…I get like despondent and I stop. So as much as I like looking at things, I think that if I started experimenting to figure out things myself, I kinda just, I don't know, lose hope sometimes.

In pursing the answer to why something works, Jessica preferred to just look the answer up. Being a scientist required a level of attention and concentration that she felt was unattainable for her. She could only do experiments for so long before she lost hope in there being an outcome. Once she lost hope, she became despondent and stopped pursuing the answer.

Jessica believed that all her science classes since the seventh grade were horrible. She acknowledged that her teachers were great scientists, but not great teachers. Some showed enthusiasm and some just wanted to earn a paycheck. Her science teachers lost student work, showed favoritism, did not provided explanations, and lacked the ability to manage students in the classroom. Based on observing and interacting with her teachers, Jessica came to believe that "scientists, because they…because they're so into this whole science thing, and it's such a different aspect of life, they're out there…They're eccentric."

Jessica took pride in being president of the Chinese club at her school. Serving in this capacity allowed her to organize an international night for students and families at her school. She also served as secretary and treasurer of the eleventh grade while playing on her schools tennis and softball team.

One of Jessica's favorite pastimes was watching cable television's History Channel and *Modern Marvels* with her dad. Both her mom and dad enjoyed figuring out where things came from and how they worked. Her parents' interest indirectly passed on to Jessica, who admitted that "as much as I like science and looking at scientific things, I don't really want to get into that as a field in my career." Instead of a career in science, Jessica wanted to further her interest in the Chinese language and pursue a career in international relations or Chinese foreign affairs. Her interests had not yet translated into her determining an undergraduate major. Jessica's dad was optimistic that one day, she would be an environmental lawyer or engineer. "My father really actually does want me to get into science. He thinks that everything is in science, and I should really get into it. And he looks up stuff every day; especially, like, incomes, and says, 'Here.'"

Although Jessica kept the door open to the possibility of a career in science, she was more interested in pursuing her passion in foreign affairs. She explained, “I'm considering it but I'm still gonna incorporate that if I do get into science with my, I guess, my longing to deal with foreign nations.” Much like her parents, Jessica resigned herself to the possibility “that in my spare time I'll definitely still try and figure out how things work…Science is fascinating.”

Tonya

Tonya Edwards was a rising senior who was ranked number one in her high school class. She prided herself in diligently seeking to complete assignments on time and with excellence. Regardless of the course, Tonya had a singular motivation with all her courses, “I mean that's my motivation, just passing it, 'cause I really wanna pass it so I can move on. Don't have to take anything over…”

When trying to describe her science experiences Tonya stated that she “struggles because the school's I've been to concentrated on math and English, and they really wasn't that strong in science.” It was not until attending her current residential summer program that she actually worked in a science lab. Even though she did a couple science fairs in middle school, all her other experiences consisted of simply listening to and regurgitating lectures. Tonya professed that she did not like science, but it could be due to the fact that she had never really done any science. “I just haven't been really exposed to it. I just read the book, and I'm only reading things. I've never really got to do anything else.” Her school did not have any extracurricular science-related offerings.

The fact that Tonya’s science teachers did not take science seriously played a large part in her disinterest in science.

> I mean I don't wanna say they didn't take it seriously, but like the school's I've gone to is like math and English, math and English, math and English. That's it, and science and social studies come after, but everything is involved around math and English.

To her, science was the study of how everything worked together, what it was made of, and "a bunch of other stuff dealing with properties of something." Math, not science, was her passion. Tonya did more projects in math and English than in science.

> Like I mean I'll take science, and I mean it's okay. It's just okay. Like I do as best as I can and pass, and I pass and do well, but like just me loving it, like loving going to the class and loving hearing the teacher talk about the lesson, I'm not all into it.

Even though Tonya's dad wanted her to have a career in science, Tonya wanted a career in television or broadcasting. Tonya saw herself minoring in education partly because she wanted to teach and partly because her parents believed she should have something to fall back on. Her parents provided her with a lot of emotional and financial support, but wanted her to be financially stable as an adult. As Tonya thought about her future and passion she declared, "I mean, science is really not my passion. I mean, it's okay. Science is okay. I like math. I rather do math."

Marcus

Marcus Hillman started his education at a historic private Afrikan-centered school in Washington, D.C. that prided itself on not placing students in learning groups based on their age, but their ability. As a result, Marcus took the majority of the classes he was required to take in his high school magnet program in Atlanta, Georgia. Even though he was enrolled in honors classes, Marcus acknowledged that the coursework did not challenge him nearly as much as his courses did at his Afrikan-centered school. In fact,

the only courses that did not resemble what he experienced in middle school were science and math.

Math was not just a subject that Marcus liked--he loved it! He became excited about anything that had to do with math. His greatest educational disappointment this past school year was that the counselor made a mistake with his schedule, which did not allow him to take calculus in the eleventh grade. It was not until he encountered an unconventional, unique, knowledgeable, and motivating science teacher in high school that he even considered the idea that he could like science.

> I think my teacher, he used to always tell us his life stories and all the things science took him and stuff. So, that made me take science more seriously 'cause at first I was like math, math, math, but now I realize I need other things, too. Even though math is everything, math is in everything, so with science there's math, like scientific notation and all that. Math is everywhere, so I realized if I like math, I might as well like science, too, 'cause it's gonna be there.

This science teacher helped Marcus navigate the intricacies of chemistry and biology, "but when chemistry came, he got a promotion so then we had a new teacher and it kinda threw stuff off." Marcus acknowledged that the number of labs and stories decreased with the new teacher. He still learned something, just not as willingly. It was this instructor who made chemistry accessible to Marcus, and showed him how it complemented the math he already enjoyed.

Even though Marcus admitted that he did not like science until his experiences in high school, he always achieved A's and B's in his courses. The only assignment he had every really liked in science was making commercial advertising beakers.

> Like, we just wanted to make somethin' bubble up or something, so we were advertising for beakers, I think, like, "Our beakers are all-purpose" and stuff like that. It was fun. So, like, we had mixed all the chemicals and stuff. I think that was probably the funnest thing I ever did with science.

At the time of our interview, Marcus based his definition of science on all of his previous experiences. He explained that “science is what keeps the world goin', I guess. The world is science…Everything is based off science and math.” He liked science. He liked mixing chemicals and compounds. He felt you could learn something new every day in science. Marcus appreciated the seemingly limitless things you could do with science, “[There’s] so many different types of science. Science…There's a whole lot.”

In line with his “love” of math, Marcus served as an alternate on the high school math competition team. In addition, he participated in basketball, which he considered to be his second “love.” When not doing math or playing basketball for his high school, Marcus participated in activities with the swim and golf teams. Golf was only temporary. He did not like all the idle time.

Coming from a family that has a legacy of attending college, Marcus expressed confusion about where he would like to attend college. Most of his family attended a historically black college in Washington, D.C. The problem with attending school there was that he would not get to play basketball for a more prestigious institution. Like most high school eleventh graders, Marcus was still trying to figure out what his future will look like. One thing was certain; Marcus had decided that the most important thing for him to do in his future was to be himself. “Me. I wanna be me. I don't wanna be a teacher, I know that.” In staying true to himself, he realized that he did not possess the skills to be a teacher.

> I can do stuff easy. Stuff comes to me easy, but I can't explain it to other people, like stuff just comes to my mind like a little aha moment, if you wanna say, but I can't teach people. What clicks for me doesn't click for other people sometimes.

His grandmother suggested that he become a lawyer because of his argumentative nature. Marcus confessed that he would probably be a basketball player, statistician, or accountant, and would select a major in math. As he pondered his future, he declared

> I mean, yeah, math could take me anywhere: engineering and things like that. So, I think all in the end I'll probably end up doin' somethin' with math, more than likely. Engineering and stuff: with that comes science, so I guess, yeah, science will be a part of my future.

While he liked science and does well in science, Marcus only saw science as a part of his future if it was coupled with his first "love," math.

Mary

Mary Roberts constantly acknowledged that God had blessed her with wonderful parents. They supported her in anything she decided she wanted to do. In the summer before her tenth grade year in high school, Mary gave birth to a little boy. She credited parental support for her ability to continue to be active in extra-curricular activities and even attended a six-week residential program on a college campus. Being a teenage mother did not limit Mary's ability to be a successful high school student. In fact, even after talking with her and having her in a class; you would not know she was a mother unless you noticed the baby pictures prominently displayed across her notebook or in her cell phone.

As a rising junior at a health science and research-focused high school, Mary took pride in the fact that she had completed a science project every year since elementary school. The number of science courses she took would qualify her for graduation in a number of other school districts. In her classes, she had built cars, performed dissections, and learned to wrap sprains and ankles. Her health class in ninth grade was her most

interesting science experience. In that class, she performed health services on her classmates.

> So we was practicing on each other and like wrapping up the legs…a broken leg…or putting on a neck brace and doing a lot of things like that…Learning new things about health and how to help people in the emergency…what to do in an emergency and how to help someone like that. That was the best thing…one of the most interesting experiences.

When not in class, Mary participated in cheerleading, track, honor society clubs, a science club, and served as an ambassador for her school. During the past two summers, she participated in two different programs at college campuses.

Having a baby had the most influence on how Mary viewed science and the career path she wanted to pursue. When her son was born, she decided, "That's what I want to do--help them." Mary wanted to help babies make their way into the world.

> I want to be a pediatrician and own my own like, clinic - not a hospital, but not a small clinic…like, a medium-sized place with all kinds of practitioners in there. Like, all the different kinds of doctors for kids…the pediatric care service, called the Raven's Wellness Center for Pediatric Child Care.

Her baby solidified her decision but being a pediatrician has always been her dream.

> Well, I chose this when I was little. I've known that I wanted to be a pediatrician since I was a little girl. It's just been my drive. And science…health science really has been my favorite science of all.

Michael

> I'm play basketball and if I get that that's not working out I'm gonna stay, probably go to grad school and then hopefully I'll have a major, I'll have a real major by the time I get to college.

As a junior, Michael Stevens was a star player on his high school basketball team, which made it to the semi-finals of state competition. The only thing he was certain about in his plans for the future was that he would continue pursuing opportunities to play basketball. He hoped that one day, he might even play professional basketball. The reality

of the chances of making it to the professional level led Michael to consider the possibility of furthering his education to graduate school. Michael was not sure which career path he would pursue, but he had faith that he would figure it out eventually. The most important consideration for Michael's career was "how it makes me feel. What can…how does it like what makes me be able to make enough money and also be with my, be supportive of my family at the same time."

Michael was among what some literature suggests is a small portion of African-American males who profess to enjoy science. Michael comment, "I really like science since I was young." In high school, he had been in numerous honors classes, and he credited his teachers at his high school for health sciences and research for sustaining his enjoyment of science. He could not recall a science class in which he did not want to participate. His classes had lots of labs, experiments, and dissections. Michael had not taken part in one science experience that he did not enjoy or take away some benefit.

Michael participated in a lot of different science programs at local college and university campuses. He particularly enjoyed an engineering project where he picked different sports and discussed the science involved in performing them. This program showed him how science related to his everyday interests and demonstrated the fun to be had in science. In another program, he built circuits and performed experiments in a college laboratory. Besides participating in these programs, Michael participated in his school's science club and was a valuable member of the basketball, football, baseball, debate, and chess teams. It was important to Michael to cultivate his interest in sports, science, and critical thinking.

Even though Michael liked and had an appreciation for science, he would not settle on having a major or career in science.

> 'Cause I have a lot of other stuff I'd like to do.' Like, I also like to talk about sports and play sports, and I also love math too; so it's like pretty hard to decide on what I wanna be.

The possibility of coupling two of the things he liked to do disturbed Michael. He acknowledged the possibility of the idea, but tensed at the thought of how hard it would be.

If he had to settle on a career, Michael responded that he would become a sports broadcaster. To make a firm decision about his future, Michael wanted more experiences in the different areas that he was considering. As he sorted through the possibilities, Michael's mother encouraged him to go into engineering. "I guess cause she's like it's a great thing. She knows I'm good with science and math and she also knows that like it pays a lot, like it's a good, it has a good salary too so it could really help me out." Also, she believed he would have more time to be with family.

Unfortunately, Michael was unable to find a role model in science.

> It's just like 'cause most of the scientists that I know, like, they were…let me guess, like say like they were bigger on academics than I am. But I think that's just cause of me. Like, I have to step up my academic… I don't think there's nothing wrong with them. Like me, I just have to pick up in academic levels.

He believed that scientists were much more singularly focused on academics than he was. Michael commented that for him to be a scientist, he would have to overcome being laid back and complete assignments and tasks on time. Presently, he was in classes with all the top students. Michael performed better than the top students on tests, but he failed to show the same caliber of work in other areas of the coursework.

> ‘Cause, like, seeing all of my friends and stuff get inducted to the beta club, and I take all of these AP classes with them…I mean, I know I'm as smart as them. I beat them on tests. So, it's like it's just like there's something way down there that's, like, ”You know you can do better. They in the beta club. You know you can get in there and National Honor Society…You can too.”

To him, basketball was still more exciting and necessary than science achievement or a science career.

> I just like always loved basketball. Like science, that's something I picked up when I was younger. Like, I'd say middle school but like basketball, I loved that since like 4 or 5. I've always loved basketball, and that's always gonna be a passion of mine

Keisha

> My mom and my family, they have really high standards for me, which sometimes always doesn't work out. Like, you can't come home with no C's. They'll look at you crazy if you have a B. And it's just like, oh, if you have an A it's not like no big hurrah, because they already expect that from you.

Keisha Green came from a family that treasured and placed significant value in academic success. Coming home with a C was not an option for Keisha. A B received looks of suspicion. Getting an A meant peace. There was no big celebration, but no restrictions were placed on you. Keisha did whatever was necessary to get her schoolwork done. Having been on the honor roll since elementary school, Keisha felt she had come too far to turn back. “So, just lift as you climb, really. Who said that? Barack Obama? ‘Lift as you climb.’ That's what you can do.”

When Keisha thought about her science experiences through the years, she stated, “I want to say that it's easy, but it's like over the years, like, math has gotten, like, draining and hard or whatever, but science still seems to be the same to me.” Keisha could not recall a point in her life when she had not liked science. At a young age, her

grandmother exposed her to horticulture. Since then, Keisha had always been fond of anything dealing with plants.

While attending middle school in Indiana, Keisha did lots of science projects. Keisha enjoyed the projects that would happen three to four times a year. It was through these projects that Keisha felt she could see how science could be fun and beneficial. For high school, Keisha moved to Georgia where experiments and projects were not as central.

Keisha considered her health science and research high school something to be proud of and a blessing. She did not feel this way because of the numerous science and math courses she had to take, but because of the partnerships and programs the school provided. Through the school, she had attended programs at various college campuses in Georgia and abroad. Keisha participated in a science club where she debated different issues and a college program that allowed her to do different robotic-based activities on Saturdays. Keisha participated in these activities to enhance and satisfy her interest in science. Keisha enjoyed participating in her science activities as much as she enjoyed participating in swim and debate. Keisha believed that if you paid attention, were engaged, and never stopped asking questions, then science became cool.

Keisha defined science as the means through which we know what is going on around us. She did not know what we would do with out science. Science was in everything. It was in math. It was in reading, because you had to know how the brain works to understand how you read words and speak. For Keisha, science was linked to life.

As Keisha entered her junior year in high school, she had numerous different potential careers and objectives. Keisha's first potential goal was to get her Ph.D. in psychology. As a psychologist, she planned to conduct research on the human brain and help others overcome mental problems. Her second goal was to open a teen clinic. This goal originated from seeing so many of the people at her high school and in her community deal with issues such as teen pregnancy, teen dropouts, and sexually transmitted diseases (STDs). Her experiences had left an impact on her and made her want to do something make a positive change in her community. In Keisha's words, you had to "just do something about it." Whether she opened a clinic or became a psychologist, Keisha acknowledged the need to know how cells work. Science was a tool for uncovering these truths. When considering the role of science in her future, Keisha stated, "[So], yeah, science is going to take a big part. You're gonna need to know. You gonna need to ace them science classes. So, I'm gonna be up in them in college."

Mark

> Science…I think science is helpful so far for me, but I don't know what I really want. I don't know what is gonna help or benefit me, but I'm finna take this little…I might go to this camp…this little three day camp, and we gonna do sports med….I believe that's goin' be helpful and I get scholarships for that so that's good.

As a junior at a school for health science and research, Mark Andrew was still trying to figure out where he wanted to go, what he wanted to be, and which experiences would be most beneficial. As he attempted to answer these questions, he chose to expose himself to different experiences that possessed the potential for some future benefit. The sports medicine camp that he mentioned above offered him the opportunity for training and exposure that could aid him in finding ways to pay for college tuition.

Even though Mark was exposing himself to science programs at this point in his life, he admitted that in middle school, he did not really care for science. “Middle school, I didn't really care for it. But now I'll go. I mean it was boring. It was just boring.” One year, he had no teacher; the next year he had a teacher who did not do any activities; and then in his last year of middle school, he did not have a science teacher again. At his health science and research high school, he had taken a large number of science classes where the teachers valued hands-on-activities over the traditional lecture format.

> And I like doing, like…I just like learning about more stuff about the body and doing hands-on activities…Like, I just like doing more hands-on activities and learning new things. I like the chemistry ‘cause you can mix up, like, chemicals together and just blow up stuff. That was pretty cool…Yeah.

Being able to mix substances together in his chemistry class appealed to Mark’s desire to learn new things on his own. Mark’s most memorable experiences in science came from building robots and cars in physics and physical science. He admitted that he chose not to participate in too many science experiences outside of school, because he really had not cared for any of the ones that were offered.

> ‘Cause, I mean, I be in class I just wanna go sleep. I be bored, but when it comes down to experiments, I believe, like, most people start to have fun and stuff. But, I mean, science…it can be boring, and it can be hard; but if you work hard at it, and you learn more about it, it could be fun. Gotta have a good time with it.

Mark admitted that he often just wanted to go to sleep in his science classes. He found the classes boring, but when the class started doing experiments, it became fun. For Mark, “science is like either discover new things or you help people out. And that's a thing that I believe that everybody should do, ‘cause it could make you happy. Think science can make you happy.” He believed that everybody should do something that made them happy. Science could make you happy because it allowed you to study and try

different things. Mark acknowledged that even though someone may hate one type of science, there are so many more. He felt there were many different things that you could do with science. The variety and ability to create in science appealed to Mark's curiosity and kept him seeking to find a place in science, despite how he felt about what happened in science classes.

Instead of participating in science activities after school, Mark was on the swim team, a part of academic clubs, and a member of an African-American male mentoring group. He took pride in his participation in the African-American male mentoring group, because it allowed him to help other young males find alternative pathways to drugs, gangs, and exploitation. It helped him to feel like he was making his community better.

This desire to help improve his community was at the heart of the various options Mark envisioned for his future. Mark first stated that he wanted to be a sports medic. Second, he said that he would like to own his own health insurance company.

> I wanna make my own health insurance company too cause I believe that the ones that we have now in America are not good, far as like how may people like get denied, how much the medicine cost. And like simple thing as like you probably cutting your finger, how much it gotta cost to like sew it back in probably cost like $20,000.00 and for another country it could be free. I don't like that. And it's like the doctors get paid more to like deny more people. So I feel like the company I wanna make is like doctors get paid more to treat more people. I think that would be good but I don't know if I could do that but I'm gonna try and see how far I'll go.

Lastly, Mark could see himself in science or engineering because he wants to create something.

> …Like to invent stuff. I don't know what I wanna invent. Technology is like so advanced, but something useful I believe everybody could use…maybe a flying car or something…I don't know.