

THE TRAJECTORIES OF MATHEMATICIANS OF AFRICAN HERITAGE

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ABSTRACT

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This research investigated the career trajectories of mathematics professors of African heritage. The principal objective was to determine the factors that promoted self-efficacy, which made them complete a PhD in mathematics or an EdD in mathematics education regardless of the obstacles they encountered. I investigated 10 professors, males and females, of African heritage at the City University of the Northeast by using open-ended biographical questionnaires and individual interviews. Several themes emerged from the data collected. The major themes that impacted the career trajectories of African American male and female mathematics professors were (a) family influence; (b) teacher influence; (c) peer influence; (d) problem solving approach; (e) perceptions of mathematics; (f) prior experience; (g) and individual perseverance (determination) and commitment (obligation). The findings of this research suggested that there are opportunities for young men and women of African heritage to develop into successful mathematicians (the term successful mathematicians is used to denote those men and

women of African heritage who have completed their terminal degree, in mathematics or mathematics related subjects) provided that parents, teachers, and peers act their part.

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DEDICATION

I would like to dedicate this dissertation to my mother, Ruby Joris, and grandmother, Ursula Joris, who passed away August 28, 2014 and April 16, 1976, respectively. I thank both for their belief in me and making me believe in myself. Although, they did not survive to see me complete my educational journey, I know that they believed that I would complete it. They have always encouraged me during my educational journey, and it was that encouragement that saw me through, or this task would have been difficult. When the road became uncomfortable it was their voices and the sincerity that encouraged me to continue, regardless of the hindrances. Thanks for your encouragement. I would also like to thank, Dr. Robert Sauté for editing, revising, and making suggestions; your assistance has helped me to complete this dissertation. I thank Dr. Abdul Hakeem Jimoh and Dr. Stacey Baptiste for their insistence that I devote my attention to completing my dissertation. You kept hope alive throughout this journey by constantly reminding me that the end justifies the means. I thank you for helping me fulfill my dream. Finally, I thank Cathyann St. Bernard for her assistance with this dissertation with her proficiency in grammar and mechanics. Thank you for your dedication and time, you assisted me greatly.

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T. A. T.

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Chapter 1

INTRODUCTION

Statement of the Problem

A problem in American education is the “achievement gap,” one sign of which is that African and Latino heritage students underperform relative to White and Asian students. Research about the gap in student achievement between low-income “minority” students and middle-income White students has been ongoing since the 1966 United States Department of Education-commissioned, *Equality of Educational Opportunity* (more widely known as the Coleman Report). No consensus about the causes of the academic gap exists, but researchers agree there is a serious problem (Singham, 2003; Medina, 2004; Walker, 2007; Gutierrez, 2008; and Martin, 2009). There are multiple perspectives regarding the gap with cultural and systemic causes vying for the attention of researchers. Several factors contribute to the achievement gap: low expectations for minority student achievement, group tracking into less demanding curriculums, culturally unfriendly environments, a disproportionate number of uncertified and inexperienced teachers serving African heritage and Latino students, and limited parental education among minorities (Rovai, Gallien, and Stiff-Williams, 2007). Teachers have low expectations of students while student levels of effort and motivation are also at a low point (Burns, 2016). There is a lack of adequate materials, equipment, and resources, including technology-based resources are lacking (Burns, 2016). For example, school

supplies, materials, and resources are lacking and an elementary cause of frustration and burnout among South Texas special education teachers (Kaufhold, Alvarez, and Arnold, 2006). Racial and ethnic differences in families' social and cultural capital, increasing economic inequality, varying academic standards in schools, and demographic changes in the structure of the family, such as an increase in the number of single mother households and absent fathers, further exacerbate the problem (Massey, Charles, Lundy, and Fischer, 2003; and Miksic, 2014).

Poor academic performance also results from lack of preparation, especially among African heritage and Latino males and females, who generally do not register for preparatory college courses and honor classes (Riegle-Crumb 2016). While some students of color lack a foundational background in mathematics and fail to enter the track for advanced placement in mathematics and science—a strong indicator that few of these students will pursue science, technology, engineering, or mathematics (STEM) disciplines in college—many of those sufficiently prepared are inappropriately tracked into less rigorous classes (Riegle-Crumb, 2016). Further, who takes advanced courses such as trigonometry and calculus strongly predicts who will attend college (Riegle-Crumb, 2016). The underrepresentation and underachievement are manifested in the small number of students of African heritage who graduate with mathematics and science degrees (Hill, 2007 and Walker, 2012).

Hines (1997), Hrabowski, Maton, and Greif (1998), and Moore (2006) have observed an underrepresentation of African Americans at both the undergraduate and graduate levels. Hill (2007) reported that 8.4% of all baccalaureate degrees in science and engineering were awarded to students of African heritage—African Americans make up about 11% of the US population (US Census Bureau, 2010); on the other hand, 65.1% of bachelor's degree in science and engineering went to White students. The remaining 24.5% (exclusive of 2% with unclear ethnicity) went to Asian Americans and foreigners. For master's degrees awarded in science and mathematics, 6.3% were students of African heritage. The percentage of White students who received master's degrees was 45.9%. The data also show that only 0.5% of African heritage students chose mathematics as a major in college (Lutzer, 2002, p.1). The underrepresentation of students of African heritage in the field of mathematics according to Singham (2003), Martin (2009), Gutierrez (2008), and Savas (2016) is further manifested in the small number of candidates who received PhDs in mathematics and science. According to the National Science Foundation's survey of earned doctorates, of the 1,872 PhDs earned in Mathematics and Statistics in 2016, Blacks or African Americans earned 36 (1.9%)

National Science Foundation, National Center for Science and Engineering Statistics (2013) provided data which showed that 1, 589 US citizen and permanent resident received PhDs in mathematics. This was a remarkable improvement over the years. There was a 53% increase in the number of doctorates received by Americans and permanent residents compared to the year 2003. The data did not distinguish the number of recipients who were of African heritage male or female. Joseph, Hailu, and Boston (2017), reported that in 2012 Black women made up 1.1% of those awarded the terminal

degree in mathematics compared to White women, made up 19% of mathematics degree recipients. White men received 55.4% of doctoral degrees in mathematics. The most recent Survey of Earned Doctorates from the National Science Foundation, 2015, reported that 13% of all STEM doctorates were conferred on US citizens and permanent residents in 2014. The data suggest that there is progress in this direction for students of African heritage.

“Society is quick to blame Black culture and socioeconomic standing for their students’ consistent underperformance in schools” (Perry, Steele, & Hillard, 2003, p. 3). Underperformance and underrepresentation do not reflect the historical philosophy of African Americans in education. Black families historically placed great emphasis on education and literacy. Theresa Perry captured the sentiment well: “freedom for literacy and literacy for freedom, racial uplift, citizenship, and leadership” (Perry, Steele, & Hillard, 2003, p. 3). Furthermore, high academic achievement correlates with financial stability and quality of life (Bailey et al, 2003; Williams & Williams, 2010). If men and women of African descent are to pursue PhDs in mathematics or EdDs in mathematics education proportionate to their share of the population, our educational system will have to encourage them to pursue post-secondary education where they can direct their attention to STEM subjects (Harper & Woods, 2016).

What factors contribute to African heritage students’ development and learning of mathematics? How do we implement strategies that people of African heritage can adopt? In this study, I examine the careers of successful Black mathematicians. I hope to glean insights into the challenges they have faced and the causes of their success.

Self-Efficacy as a Tool to Remedy Academic Deficiency

Self-efficacy is likely to have played a role in the success of African heritage professors. It can play a role in how one approaches goals, tasks, and challenges (Bandura, 1997). It is the belief that individuals have the power to produce an effect by completing a given task related to a particular competency (Bandura, 1977). Self-efficacy according to Pajares (2002, p. 391) is “people’s judgment of their capabilities to organize and execute courses of action required to attain designated types of performances.” It is concerned with well-being, motivation, and accomplishment. People believe that their actions can produce the outcome they desire, even when they face difficulties. Empirical evidence confirms Bandura’s argument that self-efficacy beliefs affect every aspect of human life – it affects whether people think productively, positively, or negatively and how well they motivate themselves and persevere to achieve their goals (Pajares, 2002; Prieto, 2009; Walker, 2014; McLeod, 2015; Shorette & Palmer, 2015; Goings, 2016; Harper & Woods, 2016; Brooms & Davis, 2017).

Self-efficacy addresses several sub-functions, but here we examine only three. These include cognitive, affective, and motivation processes. With strong self-efficacy capabilities, goals are set high, and there is a strong commitment to fulfill these aspirations (Bandura, 1991). In effective processes, those with a high sense of efficacy visualize success scenarios that propel their performance. Those who doubt their efficacy visualize their failure scenarios and how things can go wrong (Beltz & Hackett, 1986; Lent & Hackett, 1987). In affective processes, the beliefs of individuals in their

capabilities influence how much stress and depression they experience in threatening or difficult situations, as well as their level of motivation (Bandura, in press).

In contrast to this study's emphasis on self-efficacy, most research projects, according to Pikula (2000), direct attention to factors that foster poor performance; for students of African heritage these include status, biased curricula, and family background. This study rejects the false assumption that people of African heritage are inferior intellectually. Instead, I highlight success among African heritage mathematicians to focus on the factors that encourage and enable their success (Walker, 2006, 2012, 2017; Noble, 2009; Davis, 2014; Brooms, 2017; Jett, 2019).

Purpose of the Study

This study investigated the professional trajectories of African American, African-Caribbean, and African émigré professors of mathematics and mathematics education at a public university system. It examined motivations, education (including opportunities and barriers), teaching preferences, and professional aspirations.

The study asks the following questions:

- 1) What factors contribute to the success of mathematicians of African heritage?
- 2) What beliefs do mathematicians of African heritage have about their self-efficacy?

3) How do mathematicians' experiences with mathematics inform their suggestions for improving the mathematics performance and participation of students of African descent in the present day?

Procedure

To answer the research questions, I interview a sample of public university system professors that included:

- 1 African American professors born in the United States and educated in US schools.
- 2 African-Caribbean professors born and reared in a Caribbean environment, who have received part of their education in a Caribbean environment.
- 3 African émigré professors born and reared in Africa, who have received part of their education, most likely their undergraduate degree, in Africa.

This study employed purposeful sampling. According to Patton (2001), it is a non-random method of sampling where the researcher selects information rich cases, i.e., cases from which one can learn about issues important to the research. I informed each respondent, whom I contacted by phone, the purpose of the study and the confidentiality of the data. I used a mathematics autobiography and semi-structured interviews to gather data. The ten participants submitted responses to specific questions (see Appendix B) a week in advance of their individual interviews. The mathematics autobiography provided insights into how the professors view their intellectual ability and their teaching

competence at the collegiate level. In the interviews, I asked the professors why they decided to major in mathematics, what hardships and successes they encountered, and what factors pushed them to complete a PhD in mathematics or a doctorate in a mathematics related field. I asked each professor to identify and write about periods in his or her life where mathematics played a significant role.

I interviewed each respondent about their ability and self-efficacy to make choices and achieve goals. A second set of questions asked about perseverance, the effort put into tasks, and expectations. A third set of questions detailed who influenced each respondent's mathematical interests. Final questions focused on excitement, fear, anxiety, and the impact they had on the respondent's performance and perception of mathematical ability. I examined test-taking experiences and what light they shed on how students cope with similar situations. I asked respondents to describe their physical state on the day they took a test (comfort, anxiety, autonomic responses, and fear). These questions provided information on affective responses and strategies to balance their mathematics lives and day-to-day concerns.

To answer each of the three research questions, face-to-face interviews were conducted, recorded, transcribed, and reviewed by a third party to resolve possible misinterpretations. The interviews were conducted at a public facility or at a location amenable to participants. I recorded and analyzed the data, but the interviewees' names, place of work, and other confidential information were not revealed.

Chapter II

REVIEW OF LITERATURE

Overview

African American students possess the abilities of other students, yet there is an achievement gap at all levels of education, with some studies finding the gap starting as early as kindergarten Johnson & Kritsonis, 2007; Ansell, 2011; Olszewski-Kubilius, Steenbergen-Hu, et al. (2016) claim that research today suggests that minority achievement gaps persists among all socioeconomic groups. African Americans, Latinos, and Native Americans are underrepresented among the top 1%, 5%, and 10% of students at every level of the American education system from kindergarten through graduate and professional school (Olszewski-Kubilius & Clarenbach, 2012, p. 6). Recurring themes in the literature on the achievement gap highlight historical constraints, barriers to the study of mathematics, low retention and graduation rates, and the impact of self-efficacy on academic success.

Historical Constraints

Historically, the constraints of slavery limited opportunities for African Americans to engage in the pursuit of mathematics and mathematics education as academic careers. But, even in the era of slavery, Blacks distinguished themselves as mathematicians and mathematics educators. The first Black men recognized as mathematicians were Benjamin Banneker (1731-1806) and Thomas Fuller (1709-1789). Both men had little formal education. Banneker was born into slavery, in America, while Fuller was born in Africa and came to North America as a slave (Walker, 2009). These men possessed remarkable skills in mathematical calculations, an indication that although mathematics is a challenging discipline, it could be mastered with perseverance (Alexander, 2006).

The abolition of slavery paved the way for African Americans to pursue careers in mathematics and mathematics education. Elbert F. Cox was the first man of African heritage to earn his PhD in mathematics, in 1925, from Cornell University. That year, Cox was one of 28 candidates in the United States to obtain a PhD in mathematics. Like Banneker and Fuller, Cox's achievement was extraordinary despite the difficulties he experienced (Alexander, 2006). Subsequently, the achievements of Black women in mathematics were also recognized. In 1943, Euphemia Lofton Haynes became the first African American woman to receive a PhD in mathematics (Walker 2009). These early achievements are indicative of the drive that men and women of African heritage displayed to obtain advanced mathematics degrees.

David Blackwell was one of the greatest mathematical minds of the twentieth century. Born in Centralia, Illinois in 1919, Blackwell earned his PhD in 1941 at the age of 22, from the University of Illinois (Roussas et al., 2011). He was the seventh Black American to receive a PhD in mathematics. Dr. Blackwell, a president of the American Statistical Society and vice president of the American Mathematics Society, was the first African American elected a member of the National Academy of Science. Despite these accolades, he failed to win the most prestigious award in mathematics, the Fields Medal (Kessler et al. 1966; Grime 2007). According to Scott Williams, a professor of mathematics at Buffalo University and the author of the *Mathematicians of the African Diaspora* (Williams, 2008), Blackwell claims, “he was raised in a family which expected and supported working hard and a little faster than most folks” (Williams, 2008). Blackwell went on to say that he was fortunate to attend an integrated school rather than an all-black school. Racism, he said, did exist, but he was unaware of it: “I had no sense of being discriminated against” It was not until Blackwell was exposed to real analysis, based on Hardy’s *Pure Mathematics*, that he became aware of the elegance and analytical aspects of mathematics. Analysis is a course to inspire or attract a fledgling mathematician. Evolving from calculus and dealing with limits and related theories such as differentiation, integration, measures, infinite series, and analytic functions, the subject matter is in the context of real and complex numbers.

Dr. Blackwell secured a postdoctoral fellowship at the Institute for Advanced Study in 1941. This appointment created an uproar because a Black student had yet to attend Princeton (Musser & Trimpe, 2007). A faculty fellow was even more unlikely. Blackwell was aware that no White institution would hire him so he applied to 105 Black schools nationwide. In 1941 he joined the faculty at Howard University as an instructor. It was the

premier institution of Black higher education in the United States and provided training for a disproportionate number of Black professionals in all fields (Albers, 2008). Howard played an important role in training Black lawyers, many of whom led the legal struggle for integration during the 1940s through the 1960s (Sauté, 2014). Howard extended this practice in establishing a PhD program in mathematics to train Black mathematicians, but not until much later in the 1980s. In 1954 he was invited to present a paper on probability at the International Congress of Mathematics in Amsterdam. Soon after he was appointed professor of statistics at the University of California at Berkeley, where he held that position for many years until his retirement (Roussa et al. 2011). Higher education went through immense growth in the post-war period, which provided new opportunities for previously excluded groups. In addition, West Coast schools, the best of which were mostly public, tended to be less constrained in whom they would hire.

There existed a social framework for African Americans who were talented and excelled in mathematics despite the racial atmosphere that existed. The pursuit of advanced study presented challenges; teaching in Ivy League schools was virtually unheard of and becoming members of professional organizations was no easy matter for either African American men or women. Their exclusion mattered because these organizations were not only marks of distinction, but they also offered opportunities for increasing social networks and cultural capital.

J. Ernest Wilkins, Jr., a contemporary of David Blackwell, had quite different experiences. According to Williams (2006) at the age of 13 Wilkins entered the University of Chicago. He later received his PhD at 19 from New York University. Wilkins experienced racism from the American Mathematical Society (AMS), but it did not prevent him from

publishing over 100 papers (about 70 were of a mathematical nature) and 6 textbooks (Williams, 2003; Spangenburg, Moser, & Otfinoski, 2012). Wilkins was not only a mathematician; he was also a physicist and a mechanical engineer. At NYU, he obtained his degrees in engineering. Wilkins, admitted in 1965, was the second African American member of the National Academy of Engineers. One of his major achievements was his development of radiation shielding against gamma radiation, which was emitted during radioactive decay from the sun and other nuclear sources (Williams, 2003).

Albert Bharucha-Reid was a great mathematician, but a central criticism leveled against him was that he failed to get a PhD. He was not an exception. James Joseph, a Black mathematician, and Andrew Gleason, who was White, (a chairman of Harvard's Mathematics Department) made advances in mathematics without PhDs. With a double degree in mathematics and biology, Bharucha-Reid graduated at 19 from the University of Iowa. By 23 he had produced eight papers in mathematics but did not produce a PhD thesis at the University of Chicago. Bharucha-Reid believed that it was a complete waste of time to earn a PhD in mathematics. This did not prevent him from publishing textbooks and several papers. His work was not confined to mathematics. His publications included work in topology, biology, statistics, analysis and algebra (Garcia-Johnson, 1999) and (Fikes, 2018). Bharucha-Reid was a leading figure in the area of random polynomials. Born February 22, 1930 in Hampton, Virginia, Bharucha-Reid wrote his first paper in mathematical biology at 18. His interest in this area could be attributed to his uncle, the great African American biologist Charles Henry Turner (Williams, 2003). His family provided encouragement and cultural access to the world of higher education and science and contributed to his success (Williams, 2003).

Raw talent in mathematics must be awakened (Smith, 1965). The individual's gift is motivated by influences in the environment. Bharucha-Reid's family had an impact on his choice of specialization. Charles Turner handing over a slide rule to him influenced his nephew's performance in mathematics (Williams, 2008). Peers, relatives, school, and the church affect the career development of students. The role the community plays in the mathematics education of children cannot be overlooked because of the correlation with higher academic performance and school improvement (Belfield & Levin, 2007).

Walter Richard Talbot was the fourth African American to earn his PhD in mathematics. Professor Talbot taught at and chaired the mathematics departments at Lincoln University in Missouri and Morgan State University. He noted his, and Black scholars in general, isolation from a national community of mathematicians: "It was 35 years later [after he started teaching at the college level] before I had a chance to start existing in the national activities of the mathematics bodies" (Williams, 2008). In April 1969, Talbot participated in a Morgan State College conference for 26 mathematics professors who could influence curriculum development at Black institutions, both private and public. The Ford Foundation financed the event because of the potential to advance the education of the Black community. There was a long history of Black exclusion from academic and professional organizations. For example, in 1870, the American Medical Association voted to exclude the admission of Black delegates and the White delegates who were colleagues of the Blacks to the national meeting in Washington DC (Haynes, 2005). As a result, the Black professional class created parallel organizations such as the National Medical Association, the National Association of Colored Graduate Nurses in 1908, and the National Bar Association in 1925 to challenge White authority and supremacy and to establish organizations that would benefit the Black

community. In the 1960s, large foundations played an important role in minority access to higher education. It was probably the apex of the influence of historically Black colleges and universities (HBCUs). The conference provided the first opportunity for Black PhDs in mathematics to meet each other, and, in some cases, to discover each other's existence. Reflecting on the Morgan State conference, Talbot reminisced, "it was not long after that mathematicians from TBI's [traditional Black institutions or HBCUs] began to appear at meetings" (Williams, 1989, p. 167; Williams, 1999).

An Historical Look at Black Women in the Field of Mathematics

Earlier I referenced the academic achievement of Euphemia Lofton Haynes, the first Black woman to earn a PhD in mathematics. According to Walker (in press), many other Black women followed in her path, including Marjorie Browne, (1914-1979), Evelyn Boyd Granville (1924-) and Vivienne Malone-Mayes (1932-1995). These women and others made significant contributions to education, industry, and their communities, but their work has been undervalued and their activities unacknowledged by historians (Walker, in press).

Haynes was born in Washington, DC in 1890. Her father was a dentist and her mother an active member in the Catholic Church. After graduating from high-school she went on to earn a BA in mathematics and a master's in education in 1920. That same year she founded the mathematics department at Miner Teachers College, now the University of the District of Columbia (Riddle, 2016). Haynes continued her personal education and training and earned a PhD in mathematics in 1943 (Kelly, Shinnars, & Zoroufy, 2017). She was an active member of the Catholic Church, just as her mother had been, and she

implemented policies aimed to promote the rights and interests of women in her community. She was also prominent in supporting the integration of schools in DC in the 1960s and 1970s. Haynes was a fierce opponent of tracking, but a strong supporter of students seeking post-secondary education. She left a legacy of excellence in education, a devotion to women's causes, and uplifted the Catholic Church (Walker, in press). She also continued to serve the DC Public School System after retirement, this time on the city's board of education serving part of the time as its first female president and was considered integral to the integration efforts of DC public schools. Haynes established the mathematics department at Miner Teachers College and served as the chair of the division on mathematics and business education at DC Teachers College (Mazzenga, 2016).

Another woman of African heritage in the field of mathematics was Marjorie Lee Browne, an outstanding mathematician and educator and the third woman of color to receive a PhD in her field. [The Biography.com (2014). "Marjorie Lee Browne Biography." Born in Tennessee in 1914, Browne was a gifted mathematician who set up an electronic digital computer at North Carolina College at Durham, now North Carolina Central University, one of the first of its kind at a minority college (Kenschaft, 1981). Early in her life Browne's step-mother, a school teacher, and her father a postal clerk encouraged their daughter to take her studies seriously (Williams, 2008). Browne taught both at the undergraduate and graduate levels and later published her lecture notes for other teachers to adopt. Her contributions and keen interest in mathematics earned her a grant from Ford Foundation which allowed her to attend Cambridge University in 1950 where she studied topology (Fletcher, 1994; Walker, in press). Browne received awards

of excellence in mathematics education. She was a member of numerous organizations including the Women's Research Society; and the Mathematics Association of America. In addition, Browne was one of the first Black women to serve as a member of the advisory council to the National Science Foundation. Unfortunately, she died at the age of 65, shortly after retirement (Kenschaft, 1980).

Black women have made positive contributions in the field of mathematics, education, computer, technology, and other activities. Why were their accomplishments obscured? Katherine Johnson was another individual who made contributions to the field; from an early age she excelled in mathematics and other subjects. At the age of 18 she completed her bachelor's degrees in mathematics and French but was stymied by family commitments. She became a school teacher, the most common profession available to talented Black graduates (Walker, in press). Eventually she gained a position with the federal government at Langley Air Force Base. Johnson's assignment with the National Advisory Committee for Aeronautics program helped to advance the American space program. Johnson was a human computer (Hodges, 2008) who played a key role in the space program's success. Despite her contributions she and others were relegated to the colored section because of prevalent segregation (Hodges, 2008). Her work and life were featured in the Hollywood blockbuster biopic *Hidden Figures*, along with African American mathematicians Dorothy Vaughan and Mary Jackson. The talent, proficiency, intelligence, and excellence were in plain sight yet hidden from the public (Walker, in press), neither acknowledged nor written about until after the fact. The performances of these Black female scientists were overlooked and undervalued, but there is no doubt that they have influenced others to follow in their footsteps.

Black women, who were talented, educated, and professional in mathematics have been described as in a “double-bind.” These women’s experiences were obscured; their contribution to the field of mathematics was overlooked because of racism and their work unrecognized or undervalued (Walker, in press). Because of their race and gender, Black women have made positive progress not only by inspiring others to pursue education and mathematics but also by increasing the number of students of color with PhDs in mathematics. Walker (in press) reported that, in 2014-2015, of 1,901 new PhDs in mathematical sciences 880, or 46%, were US citizens; of the nationals earning a PhD, only 20 were Black (2.27%), ten were Black men and ten were Black women, a significant increase from the days when Euphemia Lofton Haynes earned her PhD.

The Achievement Gap in Context

Despite improved social and economic conditions over the years, there continues to be an achievement gap between minority students and their White counterparts. Consequently, over the past twenty-five years, studies and reports document the abysmally low numbers of minority students graduating with science, technology, engineering, and mathematics degrees (Johnson, 2012). Statistics indicate that this trend is not improving. Data from a 2009 census show that although African Americans formed 13% of the population they represent just 11% of all students who graduate from post-secondary programs. Further, African Americans received 7.5% of all bachelor’s degrees in STEM subjects, 4% of master’s degrees; 2% of PhDs. That same year, African Americans received 4% of the degrees in mathematics and statistics (National Center for Education and Statistics,

2009).

The gap between minority students and their White and Asian counterparts occurs at all levels of education. It is a troubling factor for educators who believe that early intervention is the best remedy and that policies to address the problem should begin in elementary school and continue through high school. The achievement gap has generated research about differences in students' preparedness and abilities. Educators and policy makers have sought solutions to closing the gap (Education Trust, 2003). Experts in the field, including Johnson (1984), Fryer and Levitt (2004), and Oakes (1988) argue that the school environment, not student ability, is responsible for the deficit in test scores between minority students and White students, but Barton and Coley (2009) argue that the achievement gap is based on several factors. These factors show a correlation; the gaps exist from the time of birth, for example, and continue through the school experiences of minority groups and low income children.

One study found no gap between Black and White children when they initially enter school for the first time (Fryer and Levitt, 2004). Cox (1988) said by the time Black students entered fourth grade, they were lagging behind their White counterparts. On the other hand, Phillips, Crouse, and Ralph (1998) and Johnson (1992) posit that the home environment is the primary factor that contributes to the achievement gap. Research reveals a correlation between income level and academic achievement. As such, the test scores of Black students are lower than their White peers of higher incomes (Phillips, Crouse, & Ralph 1998). Sadowski (2006) assert that researchers today still apply the 1998 Brookings Institution book *The Black-White Test Score Gap*, in which the researchers found that about half of the Black-White test score gap at twelfth grade was directly related to gaps that existed from the

first grade. Researchers have now made this exact claim about other ethnic groups. Sadowski said that in examining eight national studies of racial differences in school performance, Phillips, Crouse, and Ralph posture a bold challenge: “We could eliminate at least half, and probably more, of the black-white test score gap at the end of twelfth grade by eliminating the differences that exist before children enter first grade.”

Research has shown that parents who take interest in their children’s education have substantial impact on the academic achievement of their children (Fan & Chen, 2001; Barnard, 2004). Becher’s (1986) literature review on parent involvement has established strong evidence that demonstrates that parents who are involved with the education of their children increase the overall intellectual performance of their children. The National Assessment of Educational Progress (NAEP) has reported that the level of education attained by parents and the parents’ participation in the schools their children attend determine the academic performance of their children. The NAEP data reported a 30-point scale differential on standardized achievement tests between students with involved parents and students whose parents were not (Dietel, 2006).

A similar study found a connection between underachievement and parental involvement. It claims that African American students are not successful in academia due to lack of parental involvement in school activities (Johnson, 1984). Banerjee and Lamb (2016) claimed that a direct correlation between factors of poverty and lack of parental guidance and low test scores put minority students at a disadvantage who seek to enter higher education. A lack of preparation among Black students entering higher education also exists. The researchers concluded that students who are not prepared will be at a disadvantage in the areas of mathematics and science.

Studies examining the educational achievements of immigrant children have found that they acquire greater socioeconomic success than native-born Americans, be they Asian, Latino, or Blacks (Portes & Rumbaut, 1990). Complex skills and personality attributes such as self-regulation, persistence, motivation, and confidence instilled at the early years of child development influence intellectual development and learning (Pager, 2011). Among foreign-born Blacks 25 years and older 25% have a bachelor's degree compared to 16% of the US-born Blacks (US Census Bureau, 2004). Additionally, African émigrés are considered the more educated group; the educational achievement of their children at 11 years of age exceeds other ethnic groups, particularly Whites and Hispanic children, who do not achieve the same level of education until they are 12.9 and 13.1 years of age, respectively (Logan and Deanne, 2003). The children of African immigrants are more likely to succeed educationally and professionally than other racial groups.

Self-Efficacy

The literature on the self-efficacy of various groups seems disconnected. What factors influence African émigrés to perform at a high academic level? Does this group have a higher level of self-efficacy than other groups? Van Laar (2000) and Massey et al. (2003) reported that African Americans' self-esteem is equal to or greater than White self-esteem. Bachman, O'Malley, Freedman-Doan, and Trzesniewski (2011) concur that African Americans score higher levels of self-esteem. Brooks and Van Noy (2008) found that although Black American men and women had high rates of self-esteem, the

existence of social and cultural capital did not affect their academic performance. It was cultural capital obtained in high school in the form of cognitive development that had the greatest effect on academic performance. Human capital, especially that acquired through investment in education and training, is the ability and skill of any individual that enhance potential income earning (Collins English Dictionary, 2014). It is the collective skills, knowledge, or other intangible assets of individuals that can be used to create economic value for the individuals, their employers, or their community. Education, therefore, is an investment in human capital that pays off in terms of higher productivity.

Cultural Differences in Perception

There is a gap between African Americans and African immigrants. Cultural capital is having assets that give us social mobility. These assets are both tangible and intangible, as with skills and music taste; but importantly, they are not related to income, net worth, or any financial measure. Cultural capital falls into three categories: institutionalized (education or specialized knowledge), embodied (personality, speech, skills), and objectified (clothes or other belongings). Given these varied elements, cultural capital is difficult to measure objectively.

These differences have created a deep division, according Doodoo, who argues that the disparities have roots in experiences with White people. To African Émigrés White people are missionaries, doctors and teachers. In contrast, Black Americas have learned the history of slavery and the cruelty it inflicted on their people coupled with the legacy of racism, which has furthered divided the groups (Doodoo, 1997). African Americans,

according to Doodoo (1997), see racism as the primary cause of poverty among their people and the absence of opportunity for advancement. Also, there is a tendency to blame slavery for most of the problems they face today. They do not get involved in ongoing civil rights issues, which have angered African Americans. It has been argued that Caribbean Blacks have been more successful than American Blacks because of selectivity, cultural differences, and White favoritism (Waters, 1999). Another strand of debate is the view that the Caribbean conceptualization of their ethnic, racial, and cultural identity does not hinder their growth or progress. They identified themselves as Jamaicans, Guyanese, or West Indian instead of African American (Portes & MacLeod 1996; Waters, 1999; Zéphir, 2001). There is a strong contrast between the African Caribbean and his /her identity. "I consider myself Caribbean American," Wollaston (a Caribbean American) told *Caribbean Today* recently. "Yes I am black, but only to identify myself as an African American would be a betrayal to my upbringing, my culture, and my ancestry". Caribbean immigrants acknowledge that slavery carried their ancestors to the islands and countries and colonialism shaped their culture and the values they have inherited. They see education and the American way of life as an opportunity to improve their lifestyle. This evidence justifies putting the three groups into separate categories because of differences in racial, cultural, and social values.

Federal Remedies

The No Child Left Behind Act of 2001 was instituted “to bring up the bottom... but students continued to perform well below readiness for college” (Epstein, Pianko, Schnur, & Wyner, 2011). Finkel (2010) observed that the National Assessment of Educational Progress (NAEP) tests showed measured improvement in test scores for Black students since the 1980s, and the gap has narrowed since 1970 (Jencks & Phillips, 2011). Yet “some activist groups and educational researchers fear the systemic federal evaluation conducted under No Child Left Behind has given districts powerful incentives to move low achieving students in their general education population to special education placement, alternative schools and elsewhere” (p. 26). Such policies will decrease the pool of African descent students prepared to study mathematics and related fields in college and university settings. Another disadvantage of No Child Left Behind is that it has encouraged the redirection of funds to low-income underperforming school districts. According to Epstein et al. (2011), this has resulted in the uneven distribution of rigorous coursework for academically advanced students in favor of less rigorous coursework in schools that serve low income students “and recent reports show that the fastest growing gap between Black and White students is at the advanced levels of achievement” (p. 49).

Consequently, new legislation and policies including Race to the Top and Common Core state standards were adopted to level the playing field for all students. To improve graduation rates, President Obama launched Race to the Top in 2009. Its objective was to provide resources and foster best practices in education. The main premise of the new legislation provides parents with alternative school choices, stricter

teacher evaluations, and incentives for effective teachers (Obama, 2009). Another game changer in education reform, the Common Core, is aimed at improving academic success and college readiness for all students. Forty-eight states, two territories, and the District of Columbia have adopted it (Epstein et al., 2011). A 2013 follow-up report revealed, however, that the gap between minority and White students still exists. Figures for all Black students show that, high school graduation rates are low, dropout rates are high, and males are less likely than females to attend college (Stillwell, Sable, & Plotts, 2013). The report failed to mention that there is considerable opposition to Common Core among parents, political officials, and teachers (Epstein et al., 2011).

Black Participation in Higher Education

In any society higher education is a key to economic prosperity (McDonough, Korn, & Yamasaki, 1997; Gladieux & Swail, 1998; Carnevale & Rose, 2003; Louie, 2007). Therefore, it becomes essential for students to acquire a college degree. Social, economic, and racial inequality continues to exist in the United States (Levin, Belfried, Muenning & Rouse, 2007). Opportunities and available resources are unevenly distributed. By understanding a student's socio-economic status (SEC) and how it affects students' transition into college, high schools can modify their policies to address such inequalities. Knowledge and attitudes about college vary based on social class and race (McDonough et al., 1997, Adelman, 2006). Although the number of minority students in post-secondary education has increased significantly over the past decades, there exists a gap between in-degree

completion for Whites and Asians on one hand and Latinos and African American on the other (Adelman, 2006).

The percentage of Black students taking college admission or placement tests, according to the National Science Board (NSB, 2012), was lower than for other ethnic groups. The United States Department of Education, Office of Civil Rights, (2014a, 2014b) stated that deep disparities exist in high schools in three areas: level of course work available, experience level of teachers, and access to guidance counselors. Therefore, it is critical in developing effective policies and practices to address these issues (Bryant, 2015).

Sociologist Andrew Billingsley (1992) indicated that “education is the traditional opportunity through which Black families find their place in life. And having found it, they replicate their experiences again and again through their children” (p. 172). Yet despite the importance of higher education and Black family commitment to it, Black students have not fully availed themselves of the rewards of higher education.

African American women earn undergraduate degrees roughly in proportion to their representation in society at large (Corbett, Hill, & St. Rose, 2008). Black male students, on the other hand, are disproportionately absent from higher education. Black males attend and graduate from college at much lower rates than Black females. According to the *Journal of Blacks in Higher Education*, “Black women currently earn about two thirds of all African-American bachelor's degree awards, 70 percent of all master's degrees, and more than 60 percent of all doctorates. Black women also hold a majority of all African-American enrollments in law, medical, and dental schools” (Journal of Blacks in Higher Education, 2018, p. 1).

Griffin and colleagues (2010, p. 236) note that the stigmatization of Black males skew teachers' and counselors' perception, resulting in a lack of information that can shape educational opportunities. Educators, the gatekeepers of valuable information about college opportunities, may be shirking their responsibilities by not providing clear information about the admission processes, funding, and programs for men and women of African heritage (Chen, 2013). On the other hand, colleges and universities recruit aggressively, competing for talented Black males in a duel for brain versus athletic skills. The outcome, most often, is that the spoils go to the highest bidders. Garibaldi (1992) noted that the lucrative nature of amateur sports allows colleges and universities to provide academic scholarships to students' in exchange for their commitment to participate in sports. Likewise, "The National Collegiate Athletic Association and other organizations are designed to encourage Black men to pass up education in exchange for athletic pursuits" (Watkins, 2010), thereby contributing to the brain drain in academia.

Barriers to the Study of Mathematics

Approximately 10% of Black students major in STEM subjects. In contrast, about 30% of Asian students choose STEM majors, and about 17% of White student enroll in STEM majors (2015). Barriers to these majors can be attributed to several social and economic issues. Central to this problem is the lack of guidance and support from family and peers, lack of information from academic advisors, and media information (Nettles & Millet, 2006).

Students usually choose a major based on the type of careers they intend to follow.

Black males choose to major in math and math related subjects when they enter college at more than three times the rate of Black females: 6.8% vs. 2.0% (National Science Foundation, 2017), but the pipeline of students prepared for STEM careers is less than full. Finding suitable role models can be problematic for Black males since studies have shown that role models outside the family are lacking, particularly in professional fields (Bridgall & Gordon, 2004). Most significant is a lack of role models in the public school system, where many Black male students attend. Frierson and Tate (2011) observed that although there has been an increase in the number of African Americans and people of Hispanic heritage attending institutions of higher learning, there are few Black male mathematics teachers in the public school system. Page and Page (1991) concur that African American teachers have dwindled since 1970. Consequently, the most abundant source of guidance, which comes from role models, is lacking.

Peers can be influential in changing the self-perception of Black male students in relation to the study of mathematics. Part of the enormous influence that peers have is linked to racial identity and can result in peer pressure that is not always positive. Studies have identified the link between peer pressure and mathematics as a choice of study for Black males. Hinton and Jinks (2009) note that mathematics majors are usually high achievers and are considered among the brightest and best. Being smart, however, can be construed as turning against the race. Fryer (2006), Cook and Ludwig (1997) observed that Black students who have academic success are often viewed by their peers as acting White (Ogbu, 1987). Lack of approval from peers can create fear of not fitting in. To curb this tendency, students need to be informed as to their identity, culture, and most important their purpose in life. These character traits, which are required to advance

beyond the “acting white” characterization, and how young African American men become successful in their undertakings in the field of mathematics are well expostulated by Stinson (2004) in his dissertation. They had peer support among themselves and ignored the community “acting white” philosophy and succeeded.

Walker’s (2006) conceptualization of mathematics education is different from the generally negative perception of teachers and Black students and their underperformance in mathematics. Walker puts forward the idea that mathematics learning and development of such skills need not be centered in the classroom. They can be found in the community where students belong to peer groups so that they can support one another in the field of mathematics. Doing this could help to bridge the achievement gap. Walker (2006) found that peers encountered a double role as tutors and tutees and did not restrict the discussion of mathematics to the classroom; teachers used the environment to discuss mathematics in a larger context. Family members took an active role in the mathematics education of their children. The teaching and learning of mathematics is not an individual activity. Success in mathematics requires the participation of students, family members, peer groups, and teachers. These collaborative social networks can promote competition in urban schools and reduce the achievement gap.

Community involvement not only reinforces individual commitment and self-confidence; it also strengthens social networks, which increase the flow of information. Several authors argue that the type of information students receive can affect the choice of majors for African American students. Griffin, Jayakumar, Jones, and Allen, (2010) argue that school policies, practices, and individual agents such as teachers and counselors can influence the experiences and choices of African American males. For

example, teachers' low expectations and academic tracking, based on perceived ability, are two practices that may prevent teachers from sharing valuable information with students and their families.

Broadcast media also contribute to the Black male brain drain in mathematics and the sciences. Notably, famous and successful Black males in sports and entertainment receive disproportionate media coverage compared to their academic counterparts. McGee and Martin (2011) observed that media influences have created the real and acute pressure many Black males face, particularly through commercialized music and sports. Young Black men are made to believe that they are better suited for sports and entertainment rather than academia (Watkins, 2010). Sports over mathematics are a conscious choice for Black males from low income families.

Factors that Contribute to low Retention and Graduation

As highlighted in the literature, circumstances that contribute to low retention and graduation rates for Black, Latinos, and Native Americans in mathematics and other related STEM subjects can be seen as early as in the elementary schools due to the existence of institutional barriers that limit opportunities for rigorous preparation in the K-12 classrooms (Bonous-Hammarth, 2000). Nevertheless, a number of students may drop out of college because of personal, medical or academic reasons. Conclusion: Attrition from any program of study may have emotional and social consequences for the individuals concerned. Hinton and Jinks (2009) stated that health problems will always

be a factor affecting attrition rates in undergraduate programs. The study revealed that 10% of the students surveyed indicated medical and personal issues as reasons for them not completing the program (p. 5). While health problems are usually beyond a student's control, personal decisions can influence educational outcomes. "Nationally, high school graduation rates are low for all students with only an estimate 68% of those who enter 9th grade, graduating with a regular diploma in 12th grade. According to the calculation used in this report, in 2001 only 50% of all Black students, 51% of Native American students, and 53% of Hispanic students graduate from high school. Black, Native American and Hispanic students fare even worse: 43%, 47%, and 48% respectively. The United States is allowing a dangerously high percentage of students to disappear from the education pipeline before graduating from high school" (Orfield, Losen, & Wald, Swanson, 2004).

Choices that students make can have far-reaching impacts at the undergraduate level. For instance, delaying college enrollment (stop-outs) is a common practice for African American students. Sibulkin and Butler (2005) contend that delaying entry from high school to two-year colleges (even for those who state that they are working on a bachelor's degree) is negatively associated with obtaining a bachelor's degree. Even more significant is the decision to have children just before entering or during college. Further, Sibulkin and Butler (2005) conclude that parenthood is a factor in the graduation gap between Black and White students at all levels of higher education. Findings revealed that Black students reported significantly higher rates of having children than White students. Twenty-three percent of Black men compared to 4% of White men in their study reported having a child prior to beginning college or soon after starting college; 46% of Black males graduated compared to 73% of White males (p. 343). Black males

with children face the added stress of contributing to financial support. Working to financially support a child is a diversion of money and time away from completing a degree (Sibulkin & Butler 2005). Hinton and Jinks (2009) found the challenges of balancing childcare and domestic responsibilities negatively affected attrition rates in operating department practitioner education. Economic stability then, is integral to academic success. While many students depend on financial support, disparities based on family income and resources still exist between Black and White students. Sibulkin and Butler (2005) point to a Census Bureau report that shows 65% of students whose parents earn \$75,000 a year attend college compared to 24% of families who earn less than \$25,000. Moreover, the average family contribution to college expenses for Black and Hispanic students is 33% and 44%, respectively, compared to 60% for Asians and Whites (Fischer, 2007). Financial aid can offset negative factors such as low family income in undergraduate programs. For most minority students, especially at graduate and post graduate levels, college financing often means working through college, or taking on great debt which can prove to be even more stressful (Fischer, 2007). Stress can have a negative effect on academic self-efficacy, a quality integral to student success.

Attitudes that block students of African descent from pursuing mathematics education may result from stereotype threat, a situational predicament in which people feel themselves at risk of confirming negative stereotypes about themselves (Ambady, Shih, Kim, & Pittinsky, 2001; Steele & Aronson, 1995). If negative stereotype threats are present regarding a specific group, individuals may become anxious about their performance, which may hinder their ability to perform at maximum levels. For example, stereotype threat can lower intellectual performance of Africans Americans taking SAT

tests, used for college entrance in the United States, owing to the stereotype that Blacks are less intelligent than their White and Asian counterparts (Steele & Aronson, 1995).

Steele and Aronson (1995) found that Black students at Stanford University performed poorly when queried about their ethnicity prior to taking the Graduate Record Examination (GRE) General Test. Those who were not asked about their ethnicity performed better. The group that performed poorly was concerned about negative racial stereotypes regarding their intellectual ability, and the probing disrupted their performance. This effect was not only replicable but also substantial according to Steele and Aronson. What is unclear is the influence of self-efficacy on African Americans. When compared across race, Graham (1994) has shown that students of African heritage are highly positive and possess optimistic self-regard when it comes to their expectancy beliefs. This is true even when the students experience failure. Yet, research shows that people of African heritage who are confident about their mathematics self-efficacy still demonstrate own mathematics self-efficacy (Pajares & Kranzler, 1995).

There are multiple factors that explain why many students drop out of college and fail to graduate; these reasons can range from economic to psychological. These reasons are complex and students leave because of a combination of inter-related factors (Long, Ferrier, & Heagney, 2006). Jones (2008) identified several explanations why students withdraw: "Poor preparation for graduate school; weeklong institutional and/or course match, resulting in poor fit and lack of commitment; unsatisfactory academic experience; lack of social integration; financial issues; and personal circumstances." Jones (2008) listed a number of factors that affected students' attrition in higher education most of which are related to personal issues:

1. Many students are admitted into institutions of higher learning with spotty academic qualifications particularly in science and mathematics (STEM) subjects and writing,
2. Some students are uncertain about whether they possess the academic ability to succeed in their college career. Other students come highly motivated with expectations to succeed, but then they experience a few setbacks (they receive low test scores), and question their ability to complete their original goal.
3. As their self-efficacy flounders (fails), their motivation to succeed fails. This behavior by students reinforces Albert Bandura's theory about self-efficacy.
4. Many students today are indifferent to ethical issues such as cheating on an examination or plagiarism when writing papers.
5. It has been reported by Walter Mischel of Columbia University that students who delay gratification perform better academically.
6. There is a disengagement from the university environment for some students, particularly those students who find difficulty in fitting in.
7. For many students coping with work, school, and family dropping out even before they enter the environment of the university is a given.
8. Issues of academic trajectory implies that students are likely to perform better at high academic level when they believe that they have an academic
9. "Some students experience substance abuse problems, others experience problems in their relationship with their partners, yet others experience

psychological problems which might be treated or untreated. Then there is to consider learning disability issues and general health problems.

10. Some students drop out of college because of financial problems. These students may have difficulty coping with school, work, and family.

As we can see, many factors that have demonstrated how these problems are experienced in universities globally. These issues show social factors differ among groups. But, most of the issues students confront are based on their self-esteem, which refers to their self-worth and whether they have an encouraging assertiveness about themselves (Rosenberg, 1965). Self-efficacy refers to one's self-perception of his/her likelihood of success for a given task or behavior (Bandura, 1977). Self-esteem and self-efficacy have been academically and contextually defined in both global and domain-specific terms. In a global sense they refer to one's overall evaluations about oneself. Global self-efficacy has also been referred to as having an "internal locus of control" (Rotter 1966). The domain-specific concepts tap into how confident or positive one feels about his or her abilities in an educational setting, for example. Research has found that academic-specific esteem and efficacy are more strongly related to academic outcomes (Zeldin & Pajares 2000; Usher & Pajares, 2008); however, the global measures are still often found to be significant when domain-specific measures are unavailable (Friedlander, Reid, Shupak, & Cribbie, 2007). African heritage students have stayed away from higher education, this attitude has been fixed in the mindset of young men and women of African heritage for years (Johnson, 1987; Matthews, 1987). Their attitudes may result from stereotype threat, a situational predicament in which people feel themselves at risk of confirming negative stereotypes about themselves (Ambady, Shih, Kim, & Pittinsky,

2001; Steele & Aronson, 1995). If negative stereotype threats are present regarding a specific group, individuals may become anxious about their performance, which may hinder their ability to perform at maximum levels. For example, stereotype threat can lower intellectual performance of African Americans taking SAT tests, used for college entrance in the United States, owing to the stereotype that Blacks are less intelligent than their White and Asian counterparts (Steele & Aronson, 1995).

Academic Self-Efficacy in Relation to Student Success

The principal questions in this research are: “*What is the influence of self-efficacy on motivation of women and men of African heritage, and how does this influence their academic achievement at the collegiate level?*” Motivation propels individuals to act. In social learning theory there are three mechanisms of motivation: self-efficacy, goals, and self-evaluation (Bandura, 1986). Bandura (1986, 1993, 1997) asserts that learners are more likely to attempt tasks for which they have a sense of efficacy. When learners fail, it is either because they lack the skills, or they have the skills but lack the efficacy to use the skills well. He suggests the individual’s perception of self-regulatory efficacy is determined by the ability to change perception behavior (Bandura, 1986a). In other words, students will learn if they believe that they are good at managing their strategies in a positive manner. As such, self-efficacy motivates and challenges students.

Bandura’s concept of academic self-efficacy refers to the belief that one can meet the demands of one’s academic environment. Researchers have investigated the concept

with mixed results. Schunk (1995) hypothesized that if students have high self-esteem, it is a strong indication that a high level of motivation exists. Furthermore, Schunk contends that regardless of the domain, self-efficacy predicts a positive relationship between motivation and performance. Another point of view advances the theory that the student environment plays an important role in influencing performance, which in turn influences skill acquisition and access to resources (Ericsson, Krampe, & Tesch-Romer, 1993). The policies of most institutions of higher learning are geared towards assimilation (Green 2008). Further, Green observes that the majority of African American students in PhD programs attending predominantly White institutions (PWIs) lose confidence in their ability to compete simply because they do not know how to navigate the system. In addition, minority students may face racial hostility on campus, which inhibits their adjustment to college life. Hearing derogatory remarks made by fellow students, professors, or college staff, receiving unfair grades because of race; or being discouraged from taking classes or pursuing a course of study because of race are factors that can discourage Black students (Fischer, 2007). Fife, Bond, and Byars-Winston (2011) observe that student interest in positive outcomes and faculty encouragement are positively correlated with self-efficacy. Institutional policies that negatively affect minority students, however, are not limited to PWIs; they also exist in historically Black colleges and universities. According to Reynolds (2012), even Morehouse, a HBCU with a long tradition of educating Black men, is reexamining how it carries out its mission. These authors agree that it is necessary to make changes from within the educational system if institutions want to see better outcomes for Black and Latino males.

With regard to the concern that Black men are not performing well academically, particularly in the area of mathematics and science, self-efficacy offers a framework that can help transform their condition. This paradigm has been used by several researchers, and it has been shown to work. In fact, existing evidence suggests that people with high self-efficacy work diligently to become successful (Bandura, 1986a, 1986b).

Research Studies in Self-efficacy Pertaining to Mathematics and African American Students

The literature relating self-efficacy of Black students in higher education is not robust (Gainor & Lent, 1998), yet it suggests that self-efficacy is correlated with self-esteem and the ability to cope with stress. Pajares (1997) wrote that self-efficacy research has paid attention to three areas: discovering the correlation between teacher effectiveness and student performance (Ashton & Webb, 1986) and exploring the relationship between self-efficacy and academic performance; investigating the contribution of enactive attainment, the resilient efficiency required for overcoming obstacles through persistence, to self-efficacy (Lopez & Lent, 1992), which supports Bandura's claim that past experience is the most important of the four principles of self-efficacy; and examining the relationship between perceived self-efficacy and choice of major (Gainor & Lent, 1998).

Lent and colleagues (Lent et al., 1994, as cited by Gainor & Lent, 1998) have examined the correlation between academic self-efficacy and achievement-related

outcomes for students of color and extended Bandura's social cognitive career theory (SCCT) (1977, 1982a) to the study of mathematics and science choices and related it to academic behavior and career development. In a study of 164 Black college students, 114 women and 50 men in a predominantly White institution (PWI), 85% of the African heritage group identified themselves as Black Americans. Using regression analysis, the researchers found that Black students' mathematics self-efficacy and outcome expectations were jointly predictive of their mathematics-related interests. Consequently, interest in mathematics related activities may increase when students believe in their mathematics capabilities and expect that engaging in such activities will produce positive outcomes. In other words, mathematics self-efficacy appears to influence students' majors as well as enrollment in mathematics courses (Gainor & Lent, 1998). However, researchers disagree on the effects of self-efficacy across gender and ethnicity (Caraway, Tucker, Reinke, & Hall, 2003; Stevens et al., 2004). Some studies (Betz & Hackett, 1983b) have shown that self-efficacy of male undergraduates is higher than that of female undergraduates. But Patton (2005), using independent t-tests, found no significant difference in mathematics performance and self-efficacy based on gender. Their results were consistent across two subjects –calculus and algebra.

A qualitative study (Griffith, 2015) challenged the one-dimensional character of deficit frameworks by examining the motivation of nine Black high-achievers attending a public university. Self-determination, socio-cognitive, and attribution theories cannot by themselves explain the motivations of those Black high-achievers. Instead, a multidimensional framework that incorporated all three models and highlighted internal and external sources of motivation best accounted for these students' experiences.

Quantitative measures can be one dimensional, but qualitative measures are generally intended to be multidimensional (Patton, 2008); one measurement provides predictive behavior while the other describes rich cases. Noble (2009), in an investigation of African American males who excelled in mathematics, wanted to understand the impact of their self-efficacy on their motivation and subsequent academic achievement in mathematics at the post-secondary level. Noble used autobiographies and interviews, from which he concluded that enactive attainment (the resilient efficiency required for overcoming obstacles through persistence) and vicarious experience (the knowledge gained through means other than direct experience) were influential sources for these African American men's self-efficacy. These men were supported by family, friends, and peers. Vicarious experience, however, appeared to be more influential than enactive attainment. This finding may contradict Bandura's (1986a, 1997) claim that enactive attainment has the most significant impact on self-efficacy; in contrast, it supports other claims, for example, that peers play a major role in the development of attitudes towards academics for African American men (Hrabowski & Maton: 1995; Hrabowski, Maton, & Greif, 1998; Kunjufu, 1986; Taylor, 1989). Those students who become successful in mathematics are those who make use of past experiences as a source for inspiration (Pikula, 2000).

From a sample of 50 African American families in a low-income school district, Gutman (2006) examined student survey data and open-ended parent interviews. Findings indicated, first, that students who espoused more mastery goals—i.e., are concerned with the growth of new skills, scholarship about new material, and refining previous performance—in high school mathematics experienced more positive changes

in self-efficacy and higher grades in mathematics during high school transition than did their peers. Second, students who perceived more mastery and fewer performance goal structures in their mathematics high school classroom experienced more positive changes than did their peers. Third, adolescents whose parents espoused mastery goals had higher grades than their peers whose parents did not espouse mastery goals. Results suggest mastery goals may be more influential in determining achievement and motivation for African American students than performance goals during high school transitions (Gutman, 2006). Attaway and Bry (2004) looked at the association between parenting styles and academic achievement. Using descriptive statistics and correlational matrix analysis, they found a significant correlation between the grade point average of adolescents and mothers with high belief in control of their children's activities. The researchers might infer, however, that complete parent control with negligible input from children leads to a decline in self-efficacy. This relationship would eventually lead to a decline in academic performance, but researchers were uncertain of the causal direction in the relationship between parental beliefs and control and academic performance (Zimmerman, Bandura, & Martinez-Pons, 1992; Pajares, 1996; Pajares & Graham, 1999; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004; Zimmerman, 2000). Research focusing on schools and teachers has found that teacher perceptions and expectations are more important to and have a greater impact on the behavior of Black students; perhaps teacher expectations become self-fulfilling prophecies (Jussim, Eccles, & Madon 1996; Casteel, 1997). Massey et al. (2003) found higher levels of self-esteem present among Latino and African American students than among White counterparts.

Brooks and Van Noy (2008) found that only two factors influenced African heritage male students' self-esteem: which were the level of their father's education and taking calculus in school. On the other hand, only one factor had a positive correlation to their self-esteem, taking calculus in high school. Also, having parents involved in their children's education and having counselors who were encouraging about college were positively related to self-efficacy. Cultural capital, the feeling that one belongs in high school and that school provides a positive supportive environment had a positive relationship with self-esteem for White and Mexican American students but not for Black Americans. Brooks and Van Noy found little evidence to support the view that Black men and women have their self-esteem or self-efficacy positively reinforced by the social and cultural capital they obtain from teachers, peers, and counselors.

Researchers working with Bandura's social cognitive theory have expanded on his theory of self-efficacy. Although the investigations are directed primarily at elementary and secondary education, and occasionally at the collegiate level, the studies share a common thread. Their findings support Bandura's SCCT; in the majority of instances there is a strong correlation between self-efficacy and motivation and college students' careers (Hackett & Betz, 1989).

Some students are over confident in their abilities to do mathematics (Pajares & Kranzler, 1995). Students of African background show strong self-efficacy in their abilities, yet their mathematics performance does not match their efficacy (Pajares & Kranzler, 1995). A logical conclusion is that either they are overconfident, poorly prepared, or the tests are biased.

Most studies of self-efficacy have relied on quantitative measures, which show a correlation between self-efficacy and motivation, validating Bandura's theory (1977, 1986a). Agreement on whether self-efficacy is a cause or an effect of mathematics learning remains unanswered. Qualitative studies, while fewer, show that socioeconomic status and motivation are used to describe academic success for Blacks (Noble 2009). Treisman (1992) found that professors in his study thought that Black American students were unsuccessful in their academic accomplishment because they were from lower class families and lacked motivation. He discovered, however, that students from low income families had a strong desire to learn and their families' income status was unimportant.

Graham (1994) has put forward the idea that more research should be conducted on the effects of self-efficacy on motivational factors, but not much has been done in response to his appeal. Attention has been directed to the representation of African American men and women in academics, and there are a variety of measures from which this phenomenon can be addressed. Whiting (2006) brings some of these issues to the fore by asking: "Where do [African American students] find their identities, their self-efficacy and source of pride in the academic setting?" (pp. 223-224). Whiting claims that to understand African Americans' lack of achievement and representation in exceptional programs one is required to study their scholarly identity—their perception of themselves as students.

Whiting's model of scholarly identity depends on self-efficacy, which is the foundation on which positive scholar identity exists. He further suggests that self-efficacy is the tool used by African American Blacks in rejecting stereotypes and preserving in the face of uncertainties. How do individuals develop self-efficacy over time? At what age do

we expect the emergence of Black self-efficacy? How do we pass on or circulate this knowledge in a way that would benefit parents, educators, researchers, and students (Whiting, 2006)?

Chapter III

METHODOLOGY

Setting

This study applied qualitative methods to describe the underlying sense of self-efficacy that guided African Americans, African Caribbean, and African immigrants in the United States to excel in the fields of science, technology, engineering, and mathematics. It utilized auto-biographical statements and in-depth semi-structured interviews to uncover the feelings, behavior, and attitudes that have contributed to the academic success of a group of Black professors at various campuses at a Public University. Participants in the study were asked to define and reflect on their beliefs and the impact of their beliefs on their motivation and academic achievement in mathematics (Noble, 2009).

Researcher's Positionality

Chinua Achebe wrote, "Education is life itself," in his 1958 book *Things Fall Apart*. My education in research evolved when I took a course with Dr. Erica Walker. I had to find a dissertation, read it, analyze it, and present it to the class. I stumbled on Richard Noble's (2009) thesis, "The Impact of Self-efficacy on Mathematics

Achievement of American Males in Post-Secondary Education.” While reading the thesis I encountered the concept “Achievement Gap” which refers to any significant and persistent disparity in academic performance or educational attainment between different groups of students, such as Whites, Latinos, Native Americans, and Blacks or similar disparities between students from low-income families and those from middle- or upper-income levels (Ansell, 2011; Reardon, 2013).

Scholars on the subject of the achievement gap have looked at the issue from a negative perspective; they have looked at research that examines students of African heritage and focused their attention on students who came from poor families in urban environments who have had problems with mathematics. These students more often than not were labelled as problematic and were referred to programs that aimed to improve their performance in mathematics. I read several articles on the achievement gap and at the end I was disappointed in the context of the literature because the participants in the study had different experiences from my own.

First I was from a rural region of a foreign country, and I wanted to know why people of African heritage had difficulty coping with mathematics. What steps were taken to address the educational challenge of students of African heritage here in the US? Second, my socioeconomic background was one of poverty. It seemed awkward for scholars to pay attention to students from poor backgrounds who had achieved educational success, when in 2015, 13.5% of Americans (43.1 million) lived in poverty. Yet other scholars underscore the number of people in the United States living in "near-poverty," putting the number at around 100 million, or nearly a third of the US population

(Haymes, 2017). Third, growing up in a third world country I did not experience difficulty in mathematics as described in the literature, moreover only two of my classmates (from a class of 24) had difficulty with the subject matter mathematics, one male and one female.

After reading different articles on the subject, the achievement gap, I became curious and wanted to find out why students of African heritage in urban areas were repeatedly studied by researchers. Why were these students compared to White and Asian students? What type of information was generated by these studies? What image did researchers desire to present to the public about students of African heritage and why? What was the underlying objective of researchers in portraying students of African heritage in this particular light? Finally, how do African Americans develop and implement strategies to change this perception of students of African heritage that researchers have used to label African American students?

My principal concern was the following: Are researchers aware that African Americans have achieved academic success? Or have they made the foregone conclusion that no such success is possible? Logically, they were aware of African diasporas' achievements, but they are more apt to discuss the fractured education of the African Americans in a negative light.

Although there are discouraging materials on the issue (Shorettee & Palmer, 2015; Goings, 2016; Harper & Wood, 2016; Brooms & Davis, 2017; Jett, 1917) several authors have portrayed African American students as persistent and mathematically successful in their pursuit of higher education. The success of these students of African heritage

served as paradigm for my research. At age 17 I commenced my teaching career as an elementary school teacher. After completing my professional training at Teachers College in Guyana, I taught mathematics at the high school level. Later, I migrated to the United States, and after completing graduate training went on to become a lecturer at a private business college and an adjunct professor at a public college in the Northeast. I acquired a substantial amount of experience in teaching mathematics, and it encouraged me to conduct this study. During my tenure teaching I observed a distinctive attitude of African American male and female students towards education. These students lacked motivation in mathematics and the STEM subjects.

I have acquired considerable experience in teaching mathematics at both the high school and collegiate levels. However, I lament my observation. In my native country students were energetic and motivated to learn because parents encouraged and stressed the importance of education, also education was done on a competitive basis whereas, the students here in the US demonstrated a different attitude towards education. I learned through my observation that students of African heritage did not show the enthusiasm towards education as students did in my native Guyana. These experiences informed my desire to conduct this research. As a student, my parents instilled in me, from an early age, the importance and value “of a solid education.” It was essential for each person to acquire a sound education; it was the ultimate goal to achieve excellence in educational attainment. No one can take away what you have gained. Mathematics is the discipline that is regarded as the mother of all sciences. It is ubiquitous in every other discipline. I have a strong interest and appreciation for mathematics. The subject content is diverse

and rich, elegant, and rigorous. The National Science Foundation probably said it best: “Mathematics is deeply interwoven in all of modern life”

As an adjunct lecturer, I observed students who showed a lack of interest in mathematics. Their reasons varied: “I had a bad math teacher in junior high and I lost interest,” “I was never good at math,” and “What is the purpose of math anyway, you don’t use it real life.” Students showed more interest in professional sports and entertainment. I was curious why so many young African American males were so encouraged to enter professional sports or entertainment. Was it the money offered, stardom, or the popularity gained? From this we can apply Bandura’s (1969) observational theory that these men and women patterned their behavior after sports personalities who were already established in the industries. Although the picture painted by the media is not based on reality, young men and women strive to achieve these goals of money and stardom and forsake mathematics and education generally but not necessarily in that order.

Applying Bandura’s social learning theory, which states that people learn from one another through observation, imitation, and modeling, young men and women of African heritage can learn from the men and women they admire in sports and entertainment and can model that behavior towards mathematics and education, but the opportunities must exist if the theory is to become a reality. In other words, a theory can only affect change if social structures in society are capable of providing the human and material resources to make it realistic.

Bandura's social learning theory is not without merit, but it has many challenges attached to it. The literature on the achievement gap has portrayed students of African heritage in an unfavorable way because of the inherent system of discrimination (Bonilla-Silva, 2015) and the conceptual belief that African American students are inherently challenged academically (Delpit, 2012) coupled with issues such as Steele's (2003, 1999) stereotype threat, and Ogbu's (1992) acting white.

Questions come to the fore: "Why are there not more examples of African American male and female academic achievement, and why are they not publicized?" Fortunately, we do have examples of men and women who have been successful in academia. Jackson and Moore (2006), note that the existing literature on these issues is limited. Although a negative picture of African American students exists there is a glimmer of hope because there are students grappling with mathematics and STEM related fields who are doing exceedingly well, setting a stage for the younger generation to follow. The success stories of these students can provide inspiration and motivation and in the process act as a paradigm for the success of young minds in the African American community. In this way more students are attracted to mathematics, and more examples of successful African American students are portrayed in a better light. This research on academically successful African American students became the focal point of my investigation

Participants

This study's population consisted of a subset of faculty members at different institutions belonging to a large public university system. From an original pool of 30, 10 men and women of African heritage in the field of mathematics participated. Each of the original 30 (selected from 18 public universities) had given assurance that they wanted to be a part of the study, but when it was time for them to submit their individual mathematics auto-biography 20 of the prospective participants lost interest in the study. They noted that the time was inconvenient; pressing schedules did not afford them the time; and others did not return my phone calls. The 10 participants were selected from various public university campuses; the mathematicians were placed in one of three categories. The first category consisted of African American professors who received all of their education and training in America. The second groups of professors (African émigrés) include lecturers who received some of their education and training in their native countries or in the United States. Finally, there were African-Caribbean professors, who, like their African counterparts, most likely received some, if not all, of their education and training in their country of birth. I have looked at three groups separately because of strong social differences.

Participants in this study included male and female full-time faculty who were identified as African Americans, African Caribbean, and African immigrants. To identify the participants, I contacted the administrative secretaries of the mathematics departments for each college and inquired about the number of full-time staff members that were

classified as African American, African West Indian, and African émigré. I contacted 10 professors. This method, purposeful sampling, is subjective and is a nonprobability sampling technique. The ten participants were a subset of those I contacted from 18 public colleges.

Procedure

This dissertation asks three questions: (1) What factors contributed to the mathematics success of mathematicians of African heritage? (2) What beliefs do mathematicians of African heritage have about their self-efficacy? (3) How do mathematicians' experiences with mathematics inform their suggestions for improving the mathematics performance and participation of students of African descent? To explore mathematicians' beliefs about their self-efficacy I asked each participant to provide a mathematics autobiography of his or her journeys through mathematics from kindergarten to the present day. The experiences covered school and out-of-school careers: for example, first being drawn to mathematics, the initial realization of a talent for mathematics, who pointed out the talent, retrospective feelings about the talent, and experiences and feelings for mathematics teachers.

I expanded on the autobiographies and validated them with semi-structured interviews that follow Walker's (2009) protocol. Walker (2009) interviewed 30 Black professors of mathematics in person or by telephone. Her objective was to discover the salient factors responsible for the self-perseverance, self-efficacy, and the self-interest these mathematicians had in pursuing careers in mathematics education despite the social

revolutions that were in existence. In this way, Walker was to present a historical overview of the experiences of Black mathematicians and their balancing mathematics and the world outside their profession. Her semi-structured interviews extracted data based on participants' experiences and philosophies. I wanted similar data that would enable me to answer my research questions.

My questionnaire was divided into three sections. The first addressed the participant's childhood development and who helped realize that talent, potential, and ability. These questions highlighted mathematicians' coming of age: Who propelled their advance in mathematics? What encouragement did they receive from teachers, family members, and peer groups? With these data, I looked for common themes and patterns. The autobiography was an attempt to present diverse descriptions of life experiences that did not suffer from interview bias. The autobiographies gave their authors freedom of expression and ideas. The autobiographies had no pre-set questionnaire to which to respond (Heuer & Reisberg, 1992). I provided specific details about the participants' intellectual growth, teaching ability, and the capacity to function at the highest level in academia. I drew conclusions about the factors that influenced decisions to major in mathematics. What signs did the participants provide at an early age that indicated that they had a penchant for mathematics? I expected the data to show how the participants displayed similar characteristics in early motivation, encouragement, growth, and learning.

The second part of the interview specified the type of college attended and what influenced the decision to major in mathematics. What prior mathematics experiences prepared participants? These questions inquired about individual self-efficacy and the

ability to promote individual self-interest. The final part of the interview asked how participants set goals and achieved success (obtaining a terminal degree in mathematics or mathematics related subject) at the highest levels. The questions assumed that success resulted from community oriented efforts. When success was achieved it became community property. Participants learned to give back to the community. The data allowed me to explore how young men and women of the African community advanced in STEM subjects.

Related to my first research question, what factors constitute the success of mathematicians of African heritage? I ask about education, training, experiences, environment and motivation. Was it parents, teacher, or other significant persons who influenced them? The autobiography and interviews provided opportunities to explore these factors.

My second question addressed how mathematicians of African heritage explain and use self-efficacy to achieve academic success. The mathematics autobiographies and interviews provided the information. Of particular importance was how participants fared when they realized that they had the ability to do mathematics well. What was the role of positive reinforcement? Did it provide motivation? How did it affect the experience of hardship? The autobiography and the interviews provided opportunities to explore these factors.

My final question queried how self-reflection can aid Black mathematicians in evaluating students' behavior towards mathematics. The question required a degree of reflection about experiences, knowledge, and, most important, personal philosophies. The autobiography and questionnaire directed participants to relate their individual

experiences of mathematics to their relationships with school, family members, and their social environs. I further inquired how they may use their experiences to influence students to advance their mathematics skills and training.

Data Collection

After selecting the names of the perspective participants, I contacted each of the ten participants by telephone and explained the nature of the study. I began with the mathematics autobiography. The autobiographies were no more than 900 words. Within a week of reading the autobiographies I asked follow up questions in the interviews. The interviews were scheduled to last no more than one hour.

Data were likely to be sensitive and were treated confidentially. Participants chose the interview location for comfort, convenience, and privacy. The participants reviewed and had the opportunity to correct their autobiographies.

In gathering the data I allowed some participants to write their response rather than sit for an interview. Had I not done this I would not have been able to interview ten respondents. For the purpose of face-to-face interviews my physical presence may have created a degree of bias. It was easier for me to interview male respondents, being male. They were forthcoming and unabashed, but women were different. They pulled back from answering some questions, such as: Who recognized your talent in mathematics? How was your talent advanced? Are any family members in school involved in mathematics? Creswell, (2009) talked about “making sense out of the text” (p. 183) in the

analysis of data. To correctly interpret what a respondent was saying may prove difficult particularly if the respondent's first language is not English. Interpreting a respondent may lead to misinterpretation or misunderstanding.

Data Analysis

Data were collected, organized, and the results written up. I planned a finished product that would have validity and reliability (Gibbs, 2007). Therefore, it was important to record the procedures taken in the interviews and the autobiographies.

The mathematics autobiography was used to present an individual's mathematical growth, self-efficacy, and career trajectory over a period of time. The analysis discerned patterns of behavior that appeared in individual portfolios.

A close reading of transcripts ensured a well-structured analysis (Cuba & Lincoln, 1994; Krueger & Casey, 2000) and validated the findings (Creswell, 2009). I incorporated strategies suggested by Creswell, (2009): triangulation; rich, thick description; bias awareness, discrepant data detection; and peer debriefing (Noble 2009). Triangulation refers to finding and documenting various respondent perspectives, while rich thick description refers to the detailed account of the field experiences in which the researcher makes explicit patterns of cultural and social relationships and puts them in context (Halloway, 1997). Bias refers to the researcher influencing the preconceived results. Discrepant data refers to instances in which the data may not support the preliminary conclusions. This type of data, however, must be rigorously examined along

with supporting data to determine whether findings are to be retained or modified. Finally, member-checking is when data, analytic categories, interpretation and conclusions are tested with members of the groups from whom data were originally obtained (Heuer & Reisberg, 1992). This aspect of member-checking is a valid technique for establishing credibility. Lincoln and Guba, (1985) posit that this is viewed as the most crucial technique for establishing credibility. The interviews and data from autobiographies were coded so that associations between the two instruments can be ascertained. In triangulating the data, the author examined the interviews and questionnaires to establish a rational justification for the themes that appeared from the data. The author provided each participant with an audio tape of his or her interview. The participant reviewed the interview to edit and provide additional information. This was essential to avoid misrepresentation of opinions or philosophies (Noble, 2009). I have quoted the participants in my analysis, using a pseudonym.

The data showed similar cultural experiences. I expected rich, thick descriptions, and robust thematic perspectives. I hoped to show sensitivity to these issues and awareness of potential bias. I anticipated that my academic experiences might be similar to that of the subject population and might lead to oversensitivity in the data analysis. Although this group of participants was not educated in the time frame when state sanctioned segregation and discrimination were accepted practices in the United States (Walker, 2009), Black students still experienced discrimination. I included participants' responses that were contrary to the themes to provide a balanced viewpoint.

In our interview the mathematics professors shared stories and memories of schooling, relationships with peers and teachers, and experiences in learning and teaching mathematics (Mensah, 2009). Finally, in peer debriefing, the researcher had someone review and ask questions about the study to determine whether the study resonated with people other than the researcher (Noble, 2009).

Chapter IV

FINDINGS

Introduction

In chapter I the research questions were identified, and in chapter III, I explained the study methodology. In chapter IV, I detail the results from participants' semi-structured interviews and their mathematical autobiographies. My research questions focused on the influence of self-efficacy on the motivations of male and female mathematicians of African heritage and how self-efficacy influences academic achievement in mathematics at the doctoral level. Here, I present a profile of each participant. I then consider several guiding questions, identifying and summarizing themes that emerged from the participants' mathematics autobiographies and interviews. Specific questions I ask include: (1) What factors contribute to the success of mathematicians of African heritage? (2) What beliefs do mathematicians of African heritage have about their self-efficacy? (3) Why do so few African Americans pursue mathematics education? This study used data collected from ten men and women of African heritage to explore how their beliefs in their mathematical abilities contributed to academic success at the doctoral level.

Profiles in Education

Four of the ten respondents were Caribbean women immigrants who had acquired US citizenship, and one was an African American woman. Five of the respondents were men, one African American, three African Caribbean, and one African émigré. In addition to their terminal degrees, one respondent had an MA in psychology, and seven in mathematics or mathematics related fields. One man and one woman had a PhD in mathematics. The remaining eight respondents had EdDs in mathematics education. The five women were on average forty-eight years old. The men, on the other hand, averaged 45 years. Several themes which fit within the framework of social cognitive theory emerged from the data.

Respondents had: (a) a strong interest and aptitude in mathematics from an early age (perception of mathematics); (b) a strong familial influence and encouragement; (c) meaningful experiences in being exposed to mathematics and relationships with peers and teachers; (d) a problem-solving approach to career, life, or understanding mathematics; and (e) teachers of African heritage. These themes influenced the respondents' decisions to pursue a PhD in mathematics or an EdD in mathematics education. Table 1 contains a summary of participant characteristics compiled from their autobiographies and interviews.

Several themes emerged from the data. The respondents can be seen as individuals who have strong self-efficacy towards mathematics (teachers got the respondents to believe in his or her personal abilities to perform competently in the field of mathematics). The respondents reported positive reinforcements from their teachers,

professors or their parents when their performance was satisfactory or unsatisfactory (opportunities were provided for the respondents to experience successful learning as a result of successful teaching). There were several instances that demonstrated aspects of the respondents' environment or their immediate setting that influenced their individual ability to successfully complete a doctoral degree in mathematics. (That is the respondents made their environmental surroundings conducive for improved self-efficacy to provide appropriate support and materials, which came from teachers, parents, peer groups, and libraries). We also have the respondents' own influence on the environment. After completing their terminal degrees they returned to their alma maters to give back to the community. The data reveal that some respondents seek to interest their students in STEM subjects. These respondents, although they act independently, engage as a group in search of common benefits; as such they act as a collective agency. The researcher observed that the respondents act as a human agency. These respondents decide on engaging in certain activities such as making efforts to promote mathematics interest in the community to encourage more participants in the field. This adopted behavior anticipates the outcome of certain actions: for example, by providing symposiums and introducing professors of African heritage who address young minds and promote educational advancement of African heritage. The educational system needs reconstruction and an influx of qualified African heritage teachers because we want to construct and regulate appropriate behaviors in the field of mathematics or more generally education. Self-reflectiveness comes in the respondents' ability to reflect and evaluate the soundness of their cognition and behavior in the environment in which they find themselves.

Table 1. Characteristics of Study Participants

Name	Gender	National Background	High School Diploma Obtained	PhD/EdD	University Attended
Ms. Amsterdam	F	American	US	PhD	Private in the US
Ms. Butler	F	Caribbean	Caribbean	EdD	Public in the US
Ms. Green	F	Caribbean	Caribbean	EdD	Public in the US
Ms. Lavantel	F	Caribbean	Caribbean	EdD	Private in the US
Ms. Linden	F	Caribbean	Caribbean	EdD	Public in the US
Mr. Bridgeport	M	American	US	EdD	Public in the US
Mr. Mahaica	M	Caribbean	Caribbean	EdD	Public in the US
Mr. Northbrook	M	Caribbean	Caribbean	EdD	Public in the US
Mr. Nile	M	African	Africa	PhD	Private in Africa
Mr. Templeton	M	Caribbean	Caribbean	EdD	Public in the US

Each participant noted an interest in mathematics and how these interests directed their paths as mathematics majors in college.¹ For example, Mr. Northbrook reported that mathematics was not one of his favorite subjects when he was younger. In fact, he did not exert much time and effort on the subject; he had a greater interest in subjects involving reading. Mr. Northbrook was a graduate from a private university in the North, where he obtained an EdD in mathematics education. He is Caribbean-born and of African heritage. He eventually developed an appreciation for mathematics: “When I was in

¹ To insure anonymity, a pseudonym was used for each respondent

elementary school I had a teacher by the name of Mr. Winthrop. He was meticulous and demanded a high level of work from each scholar. We were required to present our work with “neatness and correctness,” which was his motto, and to show step by step how we arrived at solutions...He imposed on students the idea that mathematics was a discipline which had to do with logical reasoning in problem solving and understanding what [had] to be done to solve the problem.” In secondary school, at the age of 14, Mr. Northbrook was drawn towards mathematics because his performance had been excellent. Later, he migrated to the United States and after some years returned to school, completing an MA in mathematics. He then went on to earn an EdD. He recounted that when he was in college, on occasion, he was the only student of African heritage in some of his mathematics classes.

Mr. Bridgeport is a graduate with an EdD in mathematics education from a well-known online university. He is African American and since early in his academic career he has shown a natural ability to do mathematics. He recalled that in elementary school he had had difficulty with division, in arithmetic, but his brother showed him an easy method that he understood and liked. When Mr. Bridgeport was in secondary school, apart from helping other students with mathematics, his class teacher allowed him to go to the board to show his classmates how he solved homework problems. Bridgeport, said “I knew from then on that I wanted to do something in mathematics.” Mr. Bridgeport went to college to major in mechanical engineering, but this was not to be. He devoted his time to off-campus entertainment, and his academic performance suffered. He dropped out of college after attending several private universities. He found gainful employment, but some years elapsed before Bridgeport was motivated to return to

college. This time he went to a public college and majored in mathematics. One of his professors told him that he would be able to do better at mathematics if he took on the role of a tutor. He did. Mr. Bridgeport earned two master's degrees online before he went on to earn his EdD. He currently teaches at a community college in a public university.

Mr. Nile graduated with a PhD in mathematics from a university in Africa.

Although he is an African émigré, he has become an American citizen. Mathematics was not one of his early favorite subjects; however, it is a subject for which he has developed a penchant:

Mathematics being a subject that incorporates the logic of numbers and technical applications was a very tough call for me from the beginning. My elementary experience was very odd, passing all other subjects with distinction and then went crumbling in mathematics. A situation that was hard for me to figure out and the reason for non-performance was completely out of range. I began searching for the solutions as early as I could remember. There was a gradual improvement in my performance as I moved up the grades through the high school and college [levels]. I mustered all the help I could get from family members, neighbors, and teachers.

Although Mr. Nile struggled with mathematics early in his academic life, he persevered. "I decided to major in mathematics when I discovered that I had developed a high degree of mastery and proficiency in various aspects of mathematics. My family was happy with this decision."

Mr. Templeton is another EdD holder, who, as an undergraduate, attended a public college and majored in mathematics. When he was in parochial school, in the Caribbean, he did not establish a strong interest in mathematics. Mr. Templeton was born in the Caribbean and lived there for a number of years before migrating to the United States, after he graduated from high school. He had difficulty remembering his multiplication tables. His performance in mathematics, however, improved because he

did well in a local examination that earned him a scholarship to an exceptional secondary school. At the end of his first academic year in high school, his performance in mathematics fell precipitously and his mother immediately procured a governess to tutor him. While in high school Mr. Templeton encountered Mr. Rockford, who saw his potential in mathematics and encouraged him. "He put me on a pedestal, and I felt great among my peers. I worked hard to maintain my high standard with Mr. Rockford, I liked being in his class because he made me feel that I had the ability to do any subject with confidence." Mr. Templeton entered college majoring in mathematics. On one occasion he and two friends entered an advanced mathematics class at the beginning of a semester. They were late and disrupted the class upon entering. The professor told them that they were in the wrong class. All the sitting students were White and the entering three were of African heritage. They gained admittance after presenting their bursar's receipts. Their performance in the class was exceptional. Mr. Templeton is presently a professor at a public college.

Ms. Lavantel is a professor at a public college. She attended a Catholic school for girls on a Caribbean island. After completing high school, in her native country, she migrated with her family to the United States. In elementary school she did well in mathematics because, she said, it came naturally to her. She liked mathematics, but did not give it much attention. It was not until she entered college that she began to take mathematics seriously as a discipline in which she could major. Ms. Lavantel did exceptionally well in mathematics. She received an A in additional mathematics, a program of advanced mathematics offered to high school students in British-colonial educational systems, and an A in pure mathematics at the Advanced Level for the

General Certificate of Education Examination (GCE). These were London-based examinations. In the United States, Ms. Lavantel attended a public college where she majored in mathematics. After completing her bachelor's degree, she went on to earn a MA in applied mathematics before returning to her alma mater to teach mathematics as an instructor. She admitted that on occasions she was the only female of African heritage in some of her graduate classes. "As a female, I came to a realization that not many women of African heritage enter this field [mathematics] and after completing a master's degree I thought long about it and decided to advance my studies. Not only would I be an exception, but I would also be a role model to young girls." She later completed her EdD with a concentration in mathematics at an online university. Ms. Butler is also from the Caribbean, and her major as an undergraduate was biology. Growing up in the Caribbean was fun. She attended an elementary school where she excelled in mathematics. She reports that students were not ashamed to learn; they were driven to become individual thinkers and to adopt a strong sense of self-efficacy when it came to their journey in education. She was the best in her class, but for a girl to be that good in mathematics was considered odd. In high school Ms. Butler did well in biology and wanted to become a medical doctor. She received an A in biology and an A in pure mathematics at the GCE Ordinary Level. Ms. Butler again received an A in biology and an A in both pure and applied mathematics at the GCE (Advanced Level). Her family came to the United States and she decided to advance her academic education.

With a strong background from the Caribbean she did well in calculus I and II, and she was noticed as an exceptional student in mathematics at the private university she attended. A professor asked her intentions. He told her that she should concentrate on

mathematics because there were not many African American women who have advanced degrees in mathematics. After a long consideration, Ms. Butler decided to change her concentration from biology to mathematics. She went on to earn an MA in applied mathematics and an EdD. Now Ms. Butler is an associate professor at a public college.

Ms. Green is from the Caribbean. In elementary school, mathematics did not interest her. It was not that her performance was poor; she had a proclivity for writing stories. In high school, this behavior continued. Ms. Green developed an interest in mathematics when she started college at the age of 20. She claimed that once the fundamentals were taught to her she became interested in the discipline and gradually excelled because teachers were patient and taught mathematics in a way that students could relate to it in everyday life. Professors advised her to be a tutor. In this way she could reinforce the concepts she learned. Ms. Green went on to major in mathematics. Ms. Green had formerly attended a private university to complete her baccalaureate and master's degree before completing her EdD online at a private university. She now works in a public college as a full-time mathematics instructor.

Ms. Linden is from the Caribbean and is of African heritage. From an early age this young child had an interest in mathematics. Ms. Linden was curious about how her father added numbers quickly. He taught her the technique, and a love for mathematics was born. In elementary school she did extremely well and did well also at the Ordinary Level in mathematics, earning an A in the General Certificate of Education Examination. After leaving high school, Ms. Linden went to work at a commercial bank in the capital city. For some years she remained a bank teller until her family migrated to the United States. She decided to return to school after successfully completing a GED (General

Education Development) program. Ms. Linden attended a public college and majored in psychology. In all her mathematics courses she performed well earning an A or A+. No one appeared to recognize her talent in mathematics. She went on to earn an MA in psychology. Ms. Linden was a tutor in mathematics at the learning center at a public college. On one occasion she was observed by a professor who happened to be sitting in the Center. At the end of her tutoring, the professor asked Ms. Linden her major in college. After a brief discussion he advised her to return to school and do a bachelor's degree in mathematics because she had the talent and skill. She took the professor's advice, completed the degree, and went on to earn a MA in mathematics education at another public college. She went on to earn a doctor of education in mathematics.

Mr. Mahaica was born in South America where he attended elementary and secondary schools. His performance in mathematics was unsatisfactory because he lacked knowledge of his multiplication tables. "At some stoic age I conquered it." When he was eleven or so he wrote the National Common Entrance Examination, which determined the type of secondary school he attended. "I was fortunate to score well. In fact, I had an overall placement of fifth amongst all the students... I did well and my mother was very proud of me."

His transition from elementary to secondary school was not as frightening as he had anticipated. At the end of his first academic year his performance in mathematics deteriorated and his mother was dissatisfied. She immediately arranged with a professional teacher to be his tutor in mathematics. "I was unhappy with this arrangement because I had to attend lessons on Sundays since Ms. Pilchard [his tutor] was a Seventh Day Adventist. So I had to temporarily abandon my Sunday worshipping to attend

classes...” The sacrifice paid off because Mr. Mahaica excelled in mathematics. It was in high school that Mahaica met a teacher who directed him towards mathematics. After high school, he and his family came to the United States to start a new life. He attended a university where the students were predominantly white. There he obtained his undergraduate degree. He then went on to obtain a master of philosophy. Later at a public graduate school he gained his EdD in mathematics education. Mr. Mahaica now sits as an associate professor at a public community college.

Ms. Amsterdam is an African American-born woman. Her mother is a high school teacher and her father an engineer. Her siblings are college educated with strong backgrounds in mathematics and science. Since early elementary school mathematics has been her favorite subject because she liked to solve problems. She remarked, “Mathematics is my favorite subject because I really enjoy finding answers to problems, particularly when it is complicated. It allowed me a feeling of accomplishment.” She spent one day in public school before her mother placed her in a private school. Ms. Amsterdam was bullied, and her mother placed her in a private school that was predominantly White. The students failed to associate with her because she was different. Ms. Amsterdam was determined to show her classmates who she was, so she excelled in every test in mathematics; from then on she had several friends. In high school Ms. Amsterdam took AP calculus and college credits. Additionally, she took the SAT and scored above 700 in mathematics on her first attempt. She earned a scholarship and attended a prestigious university where she completed her bachelors, masters, and PhD in mathematics. She is employed in a public college.

Factors Contributing to Success

The first guiding question in this study was, what factors contributed to the mathematics success of mathematicians of African heritage? For individuals in this study, several variables contributed to their academic success. Put into broad categories, these included social, academic, environmental, and demographic factors. The following specific themes emerged from the data compiled from the respondents: (a) interest and aptitude in mathematics, an affinity for numbers; (b) strong familial influence and encouragement; (c) exposure to mathematics; (d) the role of emotions; (e) peer influence; (f) the role of teachers of African heritage; (g) parental financial support; and (h) the effects of mathematics education on mathematics participation.

Interest and Aptitude in Mathematics, an Affinity for Numbers

The relationship between interest and career choice is closely linked. According to Moore (2006, p. 251), It is well documented in the research literature that certain interests that a person holds are usually the products of upbringing, environment, education, and cultural tradition.” The descriptions given by respondents showed their interest in mathematics, but this was a developmental process in most cases. Mr. Northbrook, who has become a US citizen and is a professor at a public community college, noted, “I was excited to know that my performance in school centered on mathematics; the reading subjects no longer attracted my attention as they once did.” This

response suggested that there was a new attachment and a gradual appreciation of mathematics, due to the environment in which he found himself and his subsequent relationship with his peers. Mr. Northbrook remarked, "My friends showed me several 'tricks' in problem solving and my curiosity was aroused, so was my motivation." A second participant, Mr. Nile, who studied mathematics as an undergraduate in Africa before receiving his PhD at one of the leading universities there, wrote, "[My] strong interest was developed in elementary school while trying to improve my performance in mathematics." Most other interviewees, but not all, also noted their early interests in mathematics.

Another participant, Mr. Bridgeport, an African American lecturer at a community college who completed his master's degree at a public college, expressed interest in mathematics: "I have always like[d] math because it seemed to come natural for me." This observation was similar to the one given by Ms. Amsterdam, an African American, who said, "I was drawn to mathematics since childhood. I always liked numbers and puzzles. They were appealing." A fifth participant, Mr. Templeton, illustrated a strong interest in mathematics: "I'm not sure when I was first drawn to mathematics or what drew me to it. What I do know is that I have always been good at and comfortable with the subject." Additionally, Ms. Lavantel, stated that she developed a gradual interest in mathematics because it was logical. "I had an interest in math, but like any other subject it did not hold my interest for long. It was not until I got into high school that I took an interest in math." Ms. Lavantel was attracted to mathematics because she did not see the relevance of history that dealt with dates and facts that had to be learned. She stated emphatically, "For math you just apply a formula, and you get the

answer.” Yet another respondent, Ms. Linden, stated enthusiastically that she became interested in mathematics as early as six years old. “The interest came because it was the most challenging subject for me.” What was noticeable was that irrespective of the respondent’s gender, an interest in mathematics was established. This indicates that these respondents were likely to major in mathematics or mathematics related fields because of their strong interest in mathematics coupled with family support and availability of resources and the respondent’s keen interest in the discipline.

Not all the respondents started out with mathematics as their favorite subject. Mr. Northbrook noted that “my peers were surprised that I was a good student in the reading subjects—English literature, history, and religious studies—but I had little interest in mathematics.” Mr. Templeton claimed, “I had an interest in math, but like any other subject it did not hold my interest for long.” While Ms. Lavantel said, “I first realized I was good at math after I started passing my exams with a better than average score.” Ms. Butler commented that “math came easier to me than ELA.” The evidence raises the question, “Are mathematicians born or bred?”

Strong Familial Influence and Encouragement

People pursue advance degrees in mathematics for various reasons—for example, the prestige of the profession, financial compensation, or interest in the subject matter. Although the reasons may vary, it is quite clear from my interviews that parents and family members play significant roles in the educational growth and development of each respondent. For example, Mr. Mahaica stated:

My father was a secondary school teacher. He taught mathematics and physics. So math and physics, were his thing, he liked those subjects very much. I think he wanted me to be either a mathematics teacher or a physics teacher. Either one would have satisfied him.

This respondent's narrative suggested that he wanted to please his father, an emotive response to mathematics. Mr. Bridgeport illustrated how his older brother helped him do long division and his subsequent attitude towards his fellow students:

When I was in the fifth grade, long division was giving me a little bit of trouble. My older brother helped me. He showed me what I was doing wrong and he corrected me. He also showed me a shortcut to doing long division. I thought that was so cool. I couldn't wait to show other classmates what I learned. My teacher said that I was to be commended because I helped other students with math.

Here we observe that the ability to help others and gain praise was acquired through his ability to do long division, which provided positive reinforcement. Mathematics, therefore, becomes a social activity not just a cognitive process. Mr. Nile is not much different from Mr. Mahaica. Mr. Nile explained how his cousins influenced his decision to pursue a career in the field of mathematics:

My close cousins living with us were studying mathematically related courses when I was very young. The strong interest was developed from the elementary school [w]hile trying to improve my performances in mathematics.

Mr. Templeton recalled:

At the end of my first academic year [in high school] my performance in mathematics deteriorated and my mother was dissatisfied. She immediately arranged with a professional teacher to be my governess [tutor] in mathematics.

This strong familial support was backed up with the wherewithal to hire a person who could help Mr. Templeton.

Ms. Linden, another participant, mentioned that her father's occupation as an entrepreneur who had to take up the duties of accounting amazed her. As a young child she would go down to her father's office to watch him. She recalled how he crunched numbers without a calculator; in fact, electronic calculators were nonexistent at the time:

I wanted to know how he was able to add that fast. One day I asked him and he said you add by tens. He said learn $1+9$, $2+8$, $3+7$, $4+6$... and you [will] be able to do what I do too.

Mr. Nile mentioned that his intellect and mathematical skills played a critical role in his decision to major in mathematics and so did his family's approval.

Bridgeport noted he was not doing well in college but turned his performance around with the support of his parents. He said, "My parents could not figure out why I wasn't doing well in school because they knew the material was not too difficult for me. I told them I just wasn't interested in the courses I was taking." Bridgeport dropped out of college but was determined to be successful so after some years he returned to college, and it was not long before he graduated. "I finally graduated, which seemed like forever, with a GPA of 3.5 and I graduated cum laude." Bridgeport said that although he dropped out of college, it did not define him: "This should not act as a deterrent; persevere to the end, remind yourself that you have an objective to fulfill and it must be accomplished regardless. Your self-efficacy, self-determination, self-interest, and values must be your guide also the training your parent gave you should never be abandoned." Bridgeport would tell students: "You have to study the contents of the subject carefully, research the subject, get involved with study groups, do not be satisfied with just doing the assigned homework. Do the whole exercise in the textbook. This way you improve your performance and you accomplish your goal."

Attitudes Towards Mathematics

A common thread among the respondents was the strong support they received from different sources. Parents, teachers, peers, family members, and faculty, each in their own way, showed their willingness to lend support to individual respondents. Ms. Amsterdam would complete her class assignment quickly so that she could be given harder work sheets than her curriculum required. Ms. Amsterdam liked to be challenged. She wanted to advance her skills and relied on her teacher to provide the resources to make her succeed.

The stories respondents told were about increasing their mathematics confidence through (1) consistency and hard work; (2) solving real-life problems; and (3) helping other students. Mr. Nile's perception of mathematics changed when he recalled, "My confidence in mathematics improved and my timidity and nervousness disappeared." Confidence was established through consistency and hard work. Mr. Nile discussed the consequences of having a particular attitude towards mathematics if a person was unwilling to put in the work. Mr. Nile said he frequently hears students of African heritage say, "I hate math," "It is too difficult and boring," "It makes no sense." If this mindset is established at a young age, then, as Ms. Linden concluded, "The further you go along the worse it gets." Thus, by the time many of these men and women of African heritage get into college mathematics courses, she continued, they "develop an attitude, I just can't do it, it is too hard, and I am not good at it."

Mr. Templeton and Ms. Green agreed with Mr. Nile's claim about the amount of work that was necessary and the influence of past experiences. "They see numbers, and they see that they don't do well, or they see that it requires a lot of work, and they instantly turn away from it." Mr. Templeton believed, however, that it was possible to understand mathematics if men and women of African heritage attempted to establish connections and ask for help. "People don't grasp the concepts and instead of looking for similarities between concepts and making things easier or going to ask for help, they completely block it out and forget it." Mr. Mahaica's explanation for people of African heritage not doing well in mathematics emphasized that students from elementary school through high school did not understand the long-term benefits of doing mathematics, such as getting into college, receiving a scholarship, or getting a job. To illustrate the point, he provided an example of a student he was tutoring. The student had an ambition of becoming a physician but was not doing well on mathematics tests. When Mr. Mahaica asked why she was not doing well, she replied, "I just don't get it; it is frustrating. I don't care anymore." Then Mahaica asked why she did not care, to which the student responded, "Well, it does not matter. Everyone can't be a doctor."

Mr. Templeton noted an additional benefit of hard work when he declared that the amount of effort he put into his work enabled him to realize that mathematics could be related to the real world. Templeton noted, "This helped me to become confident in my ability to be accurate not only in measurement but in the drawing of polygons." Templeton concluded, "From this experience I became aware that math can be applied to many real-life situations." Mr. Green's perception of mathematics changed because of his feelings towards the subject: "I felt more confident and started even to tutor my fellow

classmates in math and this gave me more confidence to go further; and to think at one-time I was far removed from math.” Ms. Lavantel’s perspective was not much different from that of her cohorts. Eventually, “I took pride in my math homework and my accounting homework. Nothing else mattered to me.” As a junior in high school, Ms. Lavantel helped a senior solve a mathematics problem and she exclaimed “I felt like a genius...” while Ms. Linden’s perception was that “I felt empowered when I realized I was good at mathematics. I like being able to analyze and solve difficult math questions and I always wanted to challenge myself.”

Discovering how to overcome everyday mathematical difficulties encouraged some respondents. Mr. Northbrook’s perception of mathematics was affected by his teacher’s general advice “...not to be afraid to make errors because people learn by trial and error.” His teacher showed him how learning can be motivated; the teacher inspired learning by encouraging his student to be constructive in thinking and by solving a problem step-by-step, showing him how the solution was derived. Mr. Northbrook’s ability to perform well in mathematics was centered on his sense of feeling good, which came from his realization that he could solve what otherwise seemed intractable problems.

Peer Influence

Peer influence can have contradictory effects. Ms. Butler claimed, “I never excelled at math, mostly because I didn’t want to be a ‘nerd.’” This student knew her mathematical ability, but refused to demonstrate her excellence in the subject because of her perception about how she would be viewed by her peers. Several of the respondents did not start out with mathematics as their favorite subject, but their interest was nurtured by an environment of teachers, peers, and family members in which they found themselves. Of course, not everyone received positive reinforcement. Mr. Nile who was educated in Africa wrote, “My kindergarten experience was very odd, passing all other subjects with distinction and then went crumbling in mathematics.” In determining why this happened Mr. Nile said that there was a disconnection between him and his teacher. Peers mentioned in this research model showed positive behavior. Because they demonstrated cooperation, healthy competition among groups, care and friendship, they had the ability to exert influence on their fellow peers. Mr. Northbrook recalled, “I was encouraged to do mathematics on a competitive basis with my friends. I began to challenge my classmates and our scores showed our competitiveness.” Likewise, Bridgeport, in the interview revealed that his competitive spirit was aroused by his peers: “I could now compete with my colleagues who were proficient in mathematics from the early onset. I felt good about myself and saw the need to constantly improve.” This form of socialization emerged as a common theme among some of the respondents. Mr. Nile, said “I used to participate in group studies with my peers where we attempted to solve

difficult math problems at the same time, we also socialized. We became a social group, so much so, that we became soccer players for the same team.”

The Role of Emotions

To what extent does emotion influence the ability to excel in mathematics? Mr. Nile, like Mr. Northbrook, had an emotional connection to mathematics. The behavior of these two respondents who grew up on different continents reflected a desire for social involvement and social satisfaction in their school performance. In this study, respondents claimed that they developed an interest in mathematics because of peer influence among other influences. For example, Mr. Northbrook indicated that his interest in mathematics started when he was an adolescent: “I was about 14 years of age when I was first drawn to mathematics. My classmates Haley and Ramchan were very good at algebra, arithmetic, and geometry. I was not...They took turns in teaching me mathematics...I was encouraged to do mathematics on a competitive basis with my friends.”

The Role of Teachers of African Heritage

Without exception, respondents identified a teacher as having great impact on their academic careers. References to patience, motivation, methodology, strategy, and the ability to meet the needs of students showed that teachers mentioned by those in the study were conscientious in performing their duties and responsibilities. The role of the teacher cannot be ignored. Teachers, in the classroom setting, must use pedagogical strategies that will increase the students' academic and career development particularly students of African heritage (Flowers et al., 2003; Ford & Moore, 2004; Ford, Moore, & Milner, 2005). Respondents observed that some teachers were mathematically skilled. Others provided encouragement, and yet others gave students enhanced roles, for example, teaching other students. Teachers provided books and advanced work sheets so that recognized talent could be advanced. Mr. Northbrook was positive that a teacher had made a difference in his mathematics skills. He said "I encountered a teacher of mathematics who was exceptionally good. He encouraged me to develop my mathematical skills by lending me textbooks based on mathematics. "When I encountered difficult problems I would ask the teacher to assist me in solving the problem."

Mr. Nile modestly wrote, "My teachers were always ready to assist me whenever I encountered a difficulty." Ms. Linden reported, "The teachers in my secondary school supported my mathematical learning. They provided free tutoring after school to ensure I was always abreast of my mathematics class; they kept me in tutoring for longer hours when I had major exams coming up." Mr. Templeton singled out "one teacher in particular, Ms. Patterson, [who] took great interest in me, advancing my studies in math.

She gave me additional work to develop my skill set in the discipline and problem solving. She loaned me books, and she allowed me to help my classmates who were struggling. This activity made me feel good about myself, and I thought that I was smart.” Mr. Templeton received encouragement, skill enhancement, and purpose—helping others.

Ms. Lavantel’s situation, although similar, was straightforward:

Ms. Lavantel went on to say:

In secondary school I joined the math club and one teacher in particular, Ms. Patterson, took great interest in me advancing my studies in math. She gave me additional work to develop my skill set in the discipline and problem solving. She loaned me books and she allowed me to help my classmates who were struggling.

Ms. Butler had a similar experience:

The best math teachers were Miss Reid and Miss Constantine; both were primary school teachers. They made the topics fun and genuinely cared about students’ learning and scholastic abilities and performance. Positive reinforcements were used in the forms of stars to drive learning through the means of creating constructive competitive learning. Students were not ashamed to learn, they were driven to become individual thinkers and to adopt a strong sense of self efficacy when it came to our journey in education.

Participants whole-heartedly mentioned how open they were to the experiences offered by their favorite teachers. Participants spoke of those teachers in the highest regard. Most of those exemplary teachers were males. Several of the teacher characteristics stood out: passion for teaching, caring, commitment, motivation, knowledge, and meticulousness (Noble, 2009). Participant Mr. Nile, like Ms. Lavantel, explained that, “I saw my fellow classmates succeed in their mathematics journey where they became teachers and professors, and I used this to motivate myself.” Ms. Linden also reported this definitive behavior. In her response she stressed:

When I see someone succeed, especially if it is someone close to me or someone I look up to, I become more inspired to achieve my goals. I usually ask that person how they handled any obstacles and how they persevered to achieve their successes. From their experiences I become motivated to pursue my goals knowing that if they can do it, I can do it too.

Ms. Amsterdam expressed gratitude towards her high school teacher Mr. Johnson:

“Apart from his competence, I liked his style of teaching; it was simple and straightforward. He advised me to do calculus I and II.” Mr. Johnson respected her talent and ability, and he helped her advance her knowledge in mathematics. According to Mr. Mahaica, “An interest in mathematics was developed when I was in high school. Mr. Gilbert was very instrumental in helping me realize that I could have a career in mathematics.” This teacher, according to Mr. Mahaica, helped him accept his ability to follow mathematics as a career. Ms. Lavantel was attracted to Mr. Gilbert because he was intelligent and smart, coupled with the fact that, “I also liked that he pushed me to do better.” On the other hand, it was not until Ms. Lavantel entered college, and Professor Doran’s class, that she made a connection with mathematics. “I started to enjoy math because she broke things down in a logical manner, and I was able to see the concrete connection between mathematics and the real world.” This experience boosted Ms. Lavantel’s confidence, and from then on, there was no turning back. Professor Doran was concerned with the success of each individual student, and this appealed to Ms. Lavantel.

Consequently, she put more effort into her mathematics courses because she wanted to be like her professor. Mr. Northbrook, whose mentor was of African descent, mentioned that his decision to complete an EdD in education was influenced by his teacher who was of African heritage. A PhD in mathematics was ideal, or an EdD in

mathematics education would be great. He exclaimed, “If I go for the EdD then it was advisable to get the MA in applied mathematics before moving on.” Here, Mr. Northbrook wanted to improve his qualifications with the hope of fulfilling his dream of becoming a head-teacher in his native country. He changed his goal and attained a master’s degree in mathematics. “It was my high school teacher and a desire to make a difference that propelled me to go forward to achieve my advance degrees.” I was curious to find out about the teachers that the respondents were exposed to from elementary to high school.

The seven respondents from the Caribbean all had had teachers who throughout their entire educational careers were men and women of African heritage, although they might not have been a native of their country. What was evident was that the teachers were concerned with the education of each individual student. Nile, who was from Africa, recalled that most of the teachers came from neighboring countries with substantial unemployment, but they were well qualified and conscientious in their profession. On the other hand, the two Americans said that their teachers were White. They were never taught by a Black teacher in mathematics, but the teachers respected their talent, gender, and race and in these instances promoted their student’s mathematics potential. It is dangerous to attempt to make a generalization from these data, yet we may conclude that irrespective of one’s race or where one is born —South America or the Caribbean or Africa or North America—teachers impart knowledge to students because they want students to learn and succeed.

Parental Financial Support

Mr. Northbrook clearly stated, “I took to private tutoring to make a living,” while Bridgeport was financially independent: “...I made about \$80,000 a year.” Nile said, “My parents...they were good role models. They supported me with both material and human resources.” Mr. Templeton depended on his parents for financial support: “I was not an independent student.” It is rather difficult to determine Mr. Mahaica’s position on financial matters. He mentioned that his family was “not very supportive.” Beyond this point assumptions cannot be made. Ms. Linden in the interview recalled that her family was supportive “...and I did private tutoring.” Ms. Amsterdam wanted to enter the work force after completing her master’s degree but her family disagreed. “When I told my parents my intention they disagreed and told me they wanted me to complete my PhD in mathematics. The entire family was willing to support me.” Student success depends on available financial resources. The evidence has shown that the respondents see education as an investment in the future that pays dividends. They saw that education is a human capital development for economic growth and a mechanism for social equality, the reason why family and parents supported respondents with whatever resources they had. In some instances, the respondents supplied their own financial resources.

These responses reflected the optimism and confidence of the participants’ mathematics self-efficacy. So, from the reports of respondents, we have a glimpse into the attitude of parents, family members, and peers. They provide guidance, support and encouragement, particularly when critical decisions had to be made. The research literature has shown that parental and familial support has significant impact on

children's academic performance in school (Greif et al., 2000; Herndon & Moore, 2002; Moore, 2000b).

The Effect of Mathematics Education on Mathematics Participation

How do mathematicians' experiences with mathematics education inform their suggestions or improve their mathematics performance and the participation of students of African descent? All the participants at some point in time experienced failure and hardship, but they persevered despite the challenges they encountered.

Their perseverance depended on the social constellation of forces the students encountered and strategies to overcome the barriers that African descendant mathematicians faced. Many of the challenges my respondents faced—diminished expectations, stereotypical attitudes about abilities, lack of positive role models—are echoed in the US educational system. Several respondents noted those shortcomings.

Mr. Northbrook reported, "At the age of fifteen I took a foreign examination (The College of Preceptors Examination) TCPE and failed mathematics because I had difficulty in memorizing theorems and performing proofs, but all this was erased when I later took another examination, the LCCE (London Chambers of Commerce Examination), and passed mathematics with distinction." He went on to say: If you want a degree in mathematics and that is your desire, then do not allow anyone to discourage you. Stay steadfast irrespective of the hardships. Do not give up...Be firm, be committed and you will be successful. I was on that path and many times things were done to discourage me. I wanted to give up, but my grandmother encouraged me to

continue the fight. You will encounter discrimination. People will mock and laugh at you because of who you are. You will be given grades that do not reflect your ability or performance. Do not be dismayed or discouraged take it with a grain of salt and prevail. Success will come. Because of Mr. Northbrook's, experience he can provide valuable information to students of African heritage who want to pursue degrees in mathematics. He asserted: This [ability to persevere] is important for young people to become scientists and engineers if they want to make a positive contribution to the development of their country.

Ms. Linden suggested: "To inspire young students of African heritage to pursue a math degree in college, I would share my experiences with them and let them know that I was once in their shoes. I would encourage them to read about the influence people of African heritage had on mathematics. I would share my good and bad experiences with young Black college students, for example, how I struggled with geometry in grad school because I lacked the foundation and how I had worked extra hard to overcome my deficiencies."

Overwhelming evidence suggests that the teaching of mathematics has changed over the last 20 years. Each respondent asserted this claim stating that technology has transformed the teaching and learning environment because of computers and mass media. Students and teachers have to keep up with today's modern technology. Ms. Linden lamented that during her training in college many things were not available to her, but today with the advances in technology students of African heritage have a better chance to advance in the STEM field particularly in mathematics. According to Ms. Linden,

My experience in mathematics today is very different from 20 years ago. Today, I have access to more resources on the internet to help me with various concepts. I can Google a specific topic and can find tons of information and examples of what I researched. I can also watch videos on YouTube to help me work out problems. I think given opportunities and being able to get the same type of resources and support as their White counterparts will help to improve Black students' performance as well as their participation in mathematics. Also, being able to see more people of their ethnicity in the classroom will help.

Ms. Lavantel, echoing Ms. Linden, claimed:

I would aim to show them the long-term effects of pursuing a degree in mathematics is not only a financial benefit but is also needed for intellectual growth and development helping to serve one's community and be a role model.

She added:

While sharing both the good and the bad experiences, I will add the lessons that were learned from each as well, noting that the bad experiences should not act as a deterrent to give up but as a motivation to complete one's degree. Twenty years ago, a lot of mathematics was done mechanically while today it is done with a lot of automation because of advances in technology.

Mr. Templeton agreed but pointed out that technology cannot replace sociality:

Yes, there are many differences today than when I attended graduate school. Technology has improved remarkably and help is soon sought outside the classroom, despite these nuances there is need for human contact with your classmates as well as your advisors. Do not isolate yourself in your own world. Ms. Lavantel claimed that "students have a wide range of learning apparatuses available, so that teachers are no longer instructors but facilitators of the educational process today." Ms. Butler also agreed with the other participants when she said: The level and multitude of knowledge and experience attained in the latter years are greater compared to 20 years ago. Teaching students has changed remarkably because of modern technology. The role of the teacher has also changed and as a result learning has also transformed expectations. Today is far more demanding than 20 years ago for both teacher and student.

We observe that some respondents believed that students were not prepared properly by high schools for college, so their performance in mathematics was far from satisfactory.

On the other hand, other respondents were of the belief that because of modern technology high schools are meeting the need of the students. The difference of opinion

could be attributed to misinterpretation of academic performance in mathematics compared to overall academic performance.

In an effort to recruit or attract more students to studying mathematics, Ms.

Lavantel suggested:

What would be needed is to take a holistic approach to the issue and revamp the educational system from its elementary level up to secondary school level to benefit the whole population and not a specific group. Opportunities and resources must be available to encourage disadvantaged groups to realize their full potential.

Again, Mr. Northbrook, who was thorough when he lamented his experiences, complemented Mr. Bridgeport, Ms. Linden, Ms. Lavantel, and Mr. Nile. Because he was involved in the educational system here and he is aware how it functions, he argued with confidence:

The educational system in the United States needs revamping. We must get rid of the system of tracking students. This social construct does more harm than good not only to the scholars but to the community and society as a whole. Talent must be recognized and developed. Establish programs to promote the STEM fields. Scholarships should be awarded to talented students. Employ the brightest and best to teach in the public Schools. Pay teachers an attractive wage. Encourage students who are inclined to do mathematics well to join clubs where they can meet other students who share a passion about mathematics. Here they not only meet and discuss the history of mathematics and mathematicians but collectively work together on problem solving. Invite prominent mathematicians particularly Black mathematicians to present papers or give a talk on mathematics or hold symposiums. The general purpose is to develop talent in mathematics.

Mr. Templeton was straightforward in his response. From his prior experience he believed that the educational system in the United States should be revised and in so doing provide opportunities for students of African heritage to take advantage of their talents and use them not only to benefit themselves but society. The government must act as a steward and sensitize policies in this diverse culture. Mr. Templeton appealed to the

state: In my opinion, I personally think that the entire mathematics curriculum has to be revised and certain principles instituted in the curriculum. Children must memorize their multiplication tables and not rely on the calculator. It takes away from a student's creativity and learning activities. Multiple choice questions should be discarded because they encourage students to play the guessing game. Because I am a specialist in the teaching of mathematics does not mean I am an expert in English. But those who write test questions must be pragmatic and precise and avoid ambiguity. If we want Black children to excel then we must have their interests in mind and squash the tracking that goes on. Expose the students to higher level of math instead of recursive mathematics. We must endeavor to get more students to appreciate mathematics and avoid saying that mathematics is fun. Mathematics is the mother of all sciences and the first step to overcome it is to be proficient in multiplication tables.

Awareness of Self-Efficacy

The second guiding question was, "What beliefs do mathematicians of African heritage have about their self-efficacy?" To respond to this question, I looked at participants' responses to specific questions because I wanted to find out how men and women of African heritage use self-efficacy to influence their motivation to achieve academic success.

The questions were centered on the effects of persistence in mathematics. Ms.

Butler stressed:

Failures may deter one from their goal momentarily, but success is imminent through perseverance. I learnt this lesson to try until I succeed[ed] when I did poorly on exams. For me, failure was not an option. These are ideologies instill[ed] in me from my parents and teachers.

When respondents faced difficult problems in mathematics they took the opportunity to consult with their peers and professors and to conduct research. Ms. Linden said: “I would visit book stores and libraries to find books that explained concepts and problem-solving strategies. My classmates and I would meet in the school or public library to discuss difficult concepts in mathematics, how to write up proofs, and strategies that can be used in problem solving.” Respondents were interested in finding the solutions to problems and understanding the concepts involved in solving the problem and strategies that could be employed to produce the desired results. Self-efficacy involved achieving success in one’s endeavors, and here we observed the strategies employed to achieve that success through cooperation among students. These respondents wanted to succeed, and these problem-solving challenges showed how respondents used available resources.

Enactive Attainment

Self-efficacy beliefs tell us how people feel, think, motivate themselves, and behave. Respondents recalled significant moments that sparked positive beliefs about their mathematical abilities. Enactive attainment or the experience of mastery, which

Bandura (1986a) believes has the most significant effect on self-efficacy, refers to the effects of experiences on efficacy. Mr. Bridgeport had an experience with his teacher that illustrates the principle well:

When I was in high school and I was doing geometry with one teacher, she was getting a little confused on something, and I was explaining how I saw the problem. So I was almost teaching that subject during my second year of high school, and I kind of knew I was heading towards a math education career.

After individuals establish a strong sense of self-efficacy, rare failures produce minimal effects on perceptions of abilities. In addition, efficacious individuals attribute poor performance to poor preparation or flawed strategies. For example, Mr. Northbrook said, “When I started on my journey to complete a MA in mathematics a few people discouraged me... Although these remarks were troubling, they did not interfere with the desire and determination to succeed.” Mr. Northbrook wrote, “I find that perseverance and self-control were the main reasons why I graduated in the end.” Ms. Linden noted:

I felt empowered when I realized I was good in mathematics. Being able to analyze and solve difficult math questions, I always wanted to challenge myself more. My math teacher, Ms. Isaacs, made me realize that I was good at mathematics. She built up my confidence and made me feel comfortable to go to the blackboard to work out problems.

Mr. Nile claimed:

I have had many successes which were very much related to passing my exams with much-deserved grades, and the failures were the moments when I obtained grades that I did not deserve. I have been able to deal with either case with the notion of challenges that must be properly negotiated. I always choose to follow the footsteps of successful people in order to achieve a similar effect, and I also take positives from the negative situations in order to avoid similar errors.

Here, Mr. Nile showed enactive attainment, which is paramount for self-efficacy and self-awareness. Mr. Nile seemed to see grades as indicators of knowledge retention rather than rewards for correct answers, information rather than reinforcement. He is also saying that he takes cues from successful people. Finally, he addresses a psychological tactic—taking the positive from the negative—in overcoming failure. This self-awareness and self-efficacy comports with the theory of self-efficacy.

Mr. Templeton recounted:

My performance in math was always outstanding. I felt confident when I took math exams and was always certain that I would perform well. Some students complained about math anxiety, which I did not understand. I was always confident about my ability in math so I decided to major in the subject.

Bridgeport not only had set high goals but also had a strong belief that he could achieve his objective. “I have had some negative criticisms in relation to my career goal accomplishment and I have always taken them with a grain of salt...The need to be successful, the need to help others, the need to acquire and disseminate knowledge forced me to persevere.” Ms. Linden was no exception. She experienced success as well as failure:

I thought because of not taking mathematics since my first undergrad degree, I would have struggled, but with perseverance I did well in my first calculus class and ended up tutoring some of my classmates. A failure was in my geometry class at grad school. It was [a] struggle to keep up in class because I was learning the material for the very first time and teaching myself from an elementary book at the same time. I took the course over and passed with an A, amazing.

Ms. Butler surmised, “the success of others becomes a motivational tool to encourage personal growth and development in one’s scholastic achievements.”

Response Consequences

Another factor leading to a sense of self-efficacy were grades earned throughout academic careers in mathematics. Participant reactions to grades are an example of what Bandura (1986a) calls response consequences, which serve several functions. They (1) provide feedback on the structuring of behavior to achieve a desired outcome; (2) provide encouragement for positive behaviors; and (3) automatically strengthen responses. For example, Ms. Lavantel noted, “Well, I worked day and night, and I did pass with an A.” Ms. Linden commented, “My teacher and parents expected As and nothing less.” Ms. Amsterdam: “I maintained As in math throughout my stay at this school.” Teachers made students see themselves as outstanding. I discussed with the respondents what it felt like when they were experiencing difficulties in particular topics in mathematics. Mr. Northbrook’s approach was ingenious; he felt difficulties were not a problem because his friends tutored him, “They took turns in teaching me mathematics.” When Bridgeport had a problem in long division, his older brother helped him. He showed him what he was doing wrong and corrected him. How these respondents handled setbacks is interesting. This behavior carried over from secondary school to college. Most respondents directed their critiques toward themselves. They attributed their poor performance to being unprepared. They concluded that they had to be better prepared by studying harder,

reviewing notes, or visiting the professor to clarify points they believed they missed or did not understand fully.

Vicarious Experience

Vicarious experience occurs when individuals believe in their ability to achieve certain results after observing other people who have engaged in the same activity and have acquired success (Bandura, 1986). In this situation, individuals convince themselves that if others are capable of being successful, then so can they. The participants in this study identified several vicarious experiences that helped structure their mathematics self-efficacy. Those experiences involved teachers, peers, and family.

To get a perspective on how seeing others perform well in mathematics affected their self-efficacy, I asked participants whether there was a person or persons whose mathematics performance they have tried to emulate. If so, could they explain their selection criteria and identify specific ways they have tried performance behavior(s) based on the person they tried to emulate. Most of the participants did pattern their mathematical performance after someone. The choice was usually a peer, although two respondents chose their fathers. Selection criteria varied. Ms. Lavantel stated that she patterned her mathematics performance after her father. Choices were often based on whom the participant was competing against. If on a test peers scored higher than the respondent, the respondent, Ms. Lavantel was sure “to put in an extra effort to make sure that her performance was the best in the class.”

Mr. Mahaica admitted, "I admired the way my friend did his work. It was neat and well organized, so I patterned my work after him." "I aimed to use his style and do better than he did on his tests." Ms. Linden and Ms. Amsterdam are the only two who felt they need not pattern their mathematics performance after anyone. However, their reasons differed. Ms. Linden said that she had no role models because her goal was always to do better at mathematics than her classmates. Ms. Amsterdam found herself in a school where she had to prove herself. She claimed, "I did not pattern my mathematics performance after anyone. I had to prove that I was capable of doing better than the entire class." Ms. Lavantel was philosophical. She noted, "I used to pattern my mathematics performance after my father, but that changed. As I grew older, I realized that to compare myself with others would always leave a sense of inadequacy because there will always be greater and lesser people than yourself. I challenged myself to always do my best." Ms. Butler declared, "The successes of others become a motivational tool to encourage personal growth and development in one's scholastic achievement."

Verbal Persuasion

Another source of self-efficacy that I found in this research was verbal persuasion, which is used to convince people that they possess the characteristics necessary to achieve a certain outcome (Bandura, 1986a). Those who provide verbal persuasion have to be deemed competent by the person who is being persuaded. Additionally, the effects of verbal cues should appear important in the construction of positive perceptions of mathematics ability (Noble, 2009).

When the participants were asked to identify anyone who gave them verbal cues about their mathematics ability and explain the effects of those cues on their own judgment of their mathematics ability, participants stated that the cues came from various sources, but the outcome was the same. It made them feel confident and reinforced the perceptions of their abilities. Mr. Northbrook, who received his compliments indirectly from his teacher and peers, stated:

We interchanged with one another as to who got first, second, or third place depending on our carefulness or carelessness...My teacher noticed my improvement and made a personal visit to my mother to report my academic advancement. He told her that I would do well if I continued to be driven.

Mr. Templeton indicated that he received compliments as well and added, "This activity made me feel good about myself, and I thought that I was smart. This allowed me to develop a better appreciation of and understanding for mathematics."

Tutoring

One of the practical ways in which self-efficacy was boosted was through tutoring. Instructors frequently told respondents that they should volunteer to tutor students. Tutoring was a form of enactive attainment, but also played a role in the retention and proficiency of mathematics skills. Mr. Bridgeport, mentioned "...Professor Baldwin was always a good mentor here. He kind of steered me to tutor and he always said you'll learn more math by tutoring than you'll do in a classroom, which I felt was correct."

Ms. Lavantel told me:

I became a math tutor for college students. During this time, I enjoyed what I was doing. I remember in particular, one student who was not very good at math, and it was a challenge to apply Professor Doran's principles, and this student was able to succeed eventually after much trial and error, unlike another student I worked with under similar conditions who, although I applied the same methods but different strategies, turned out to be a failure. I came to a realization that not all the time success is achieved.

Ms. Linden agreed with Ms. Lavantel when she said, "I worked as a math tutor at the learning center of the college, I became a member of the math club and was on the planning and budgeting committee, and I did private tutoring." These respondents saw value in tutoring mathematics. Putting aside financial incentives, we see these respondents actively working hard at mathematics to understand the subject matter and taking the time to show others that it could be done with dedication, participation, and being unafraid to be challenged.

Why do so few African Americans Pursue Mathematics?

With the final research question it is necessary to examine the extent to which African heritage respondents' experiences were reflections of their performance and participation. Eight of the respondents were from foreign countries, and these participants came to the United States with an established foundation in mathematics. Mr. Nile, for example, successfully completed his terminal degree in Africa. The two American-born participants had their education and training in the United States. Seven of the respondents who had migrated to the United States embarked on a journey of mathematics with prompting from a professor, tutor, or peer. Respondents were aware of

who they were; they knew what their strengths and weaknesses were; and they knew independently that they had a talent for mathematics.

I asked respondents why so few men and women of African heritage pursue mathematics. My inquiry triggered several responses, with respondents emphasizing the lack of role models, downplaying the importance of mathematics, the perceived difficulty of mathematics, fearing the challenges that mathematics presents, reluctance to expend the required effort, lack of quality teachers, and lack of teachers to whom students can relate. Respondents mentioned being discouraged from studying mathematics. For instance, one respondent, a female from the West Indies did not realize that women could major in mathematics. She believed that mathematics was a rather difficult subject and was taught by men not women. Mr. Mahaica was discussing this very question with his mother, and he concluded that most people think mathematics is hard and that most are scared off before they even get started. Mr. Mahaica believed that such a mentality becomes ingrained; as a result, people will not really try when they are confronted with the subject matter. Another implication of Mr. Mahaica's experience was that people around him were not actively working hard at mathematics or taking the time to show it could be mastered. "But there were those who did not like math because they believed it was much too difficult, and, above all, they did not see the need for it in real life."

Mr. Bridgeport provided a direct answer to the question:

I think they need more [B]lack teachers; especially [B]lack males. With more math role models that students can relate to, this opens up doors for the future generation. It is not a falsehood that biases are formed both from the teachers' and students' point of view before either enter the classroom. Keeping this in mind, [W]hite teachers cannot fully understand the [B]lack culture in all of its genuine characteristics...[If] more [B]lack teachers are teaching [Black] students, who can relate to them, this offers a reality that is reachable, therefore encouraging new

and upcoming students to follow in their path. This will promote a continuous cycle that is much needed among this minority group.

Ms. Butler agreed (in part) with Mr. Bridgeport: (in part)

It's important to create friendly competition among peers in the classroom to enhance learning. We have to get more role models in the classroom. There is a need for both male and female African American teachers of mathematics. Teachers and parents must stress the STEM fields and encourage students to take a more active role in these subjects.

Ms. Linden agreed with the earlier participants, carefully writing:

I think given opportunities and being able to get the same type of resources and support as their [W]hite counterpart will help to improve Black students' performance as well as their participation in mathematics. Also, being able to see more people of color in the classroom will help.

But a question that looms over this inquiry into the disproportionately few mathematicians of African descent is: How does discrimination affect mathematics self-efficacy? How do overcoming stereotypes and hostile environments influence mathematics success (those men and women of African heritage who have completed their terminal degree in mathematics or mathematics related subjects)? Most of the respondents were foreign-born and migrated to the United States where they were exposed to diverse cultures that may have been absent from the respondents' previous background. That diversity entailed encounters with prejudice. For example, Mr. Northbrook lamented:

You will encounter discrimination; people will mock and laugh at you because of who you are. You will be given grades that do not reflect your ability or performance; do not be dismayed or discouraged take it with a grain of salt and prevail. Success will come... Looking back, I find that perseverance and self-control were the main reasons why I graduated in the end.

Mr. Nile noted the role injustice played in his mathematics education when he referred to an example of failure. He wrote "Failures were the moments when I obtained grades that

I did not deserve.” From Mr. Nile’s point of view, some form of discrimination was levelled against him by teachers, and this constituted his dissatisfaction. Ms. Lavantel explained that she took a Chaos Theory course in graduate school and dropped it because, “I hated it immensely and the instructor just had an ‘air’ about him that made me feel like I was not just ill-prepared for the course but [I was] not worthy [of] the time [so that it could be] explain[ed] to [me].” Mr. Templeton recalled:

I attended a predominantly White institution. My parents believed that I would get a great education like any other American student...I struggled to do well in this environment...To succeed I endured many unhappy situations, but I was determined to be successful by graduating from this school.

Ms. Amsterdam provided the final example of discrimination when she wrote that she spent only one day in public school. Her mother removed her because of bullying. “I was picked on because of my physique.” This respondent was slim and proved an easy target for classmate bullying. Ms. Amsterdam was placed in a predominantly White school and was initially unable to fit in. This was the second school she attended and to change the situation in her favor she earned a perfect score in her first mathematics test. “I had made a number of friends with my perfect math score,” she commented. The potential psychological effects of discrimination might include mental anxiety, decreased self-esteem and confidence, and negative experiences with social interactions. Discrimination might cause individuals to withdraw socially, but none of these behaviors were reported by our participants.

In conversations off the record one respondent said that minorities are no better off now than they were 60 years ago. I asked for an explanation of the assertion. The participant said that despite *Brown vs. Board of Education*, school systems in the United

States continue to be separate and unequal, nothing has changed. The participant continued: let us assume that Blacks and Latinos will become the majority in the near future, then the percentage of White students in our educational system will shrink. This means that the American society will be left with an education system that does not serve the majority of its students effectively or efficiently; the gaps in our educational system will continue and prove particularly problematic in the long run.

Summary

My main research questions—what is the influence of self-efficacy on the motivation of male and female mathematicians of African heritage, and does self-efficacy influence academic achievement in mathematics at the doctoral level? —had three auxiliary questions. The first was: What factors contribute to the mathematics success of mathematicians of African heritage? Participants demonstrated that their mathematics success depended on family members, teachers, peers, peer research, dedication, and commitment on the part of the participants.

The second question asked: What beliefs do mathematicians of African heritage have about their self-efficacy? Participants generally expressed positive beliefs about their self-efficacy. They were confident, persistent, had tenacity, and had achieved in an educational setting, and so they expressed optimism about their self-efficacy. Respondents were confident in their ability to do mathematics. In most instances, respondents showed an interest in mathematics from an early age. There is no traditional developmental literature on the making of mathematicians. The evidence available from

the interviews showed that men and women who earned a PhD in mathematics or an EdD in mathematics education exhibited a strong interest in mathematics. An early interest in mathematics revealed that the person, irrespective of class, race, or gender, was likely to succeed in earning terminal degrees provided that they have the skill, talent, or the ability to persevere. Because when faced with difficulties the respondents did not surrender; they repeated courses they failed and performed well. Respondents overcame the small setbacks because they persisted, and they succeeded.

For these respondents, success may not have been achieved had it not been for strong familial influence and encouragement. Irrespective of race, gender, or socioeconomic background students need support and assistance for their academic careers from family members and parents (Hrabowski et al., 1998; Hrabowski et al., 2002; Moore and Hernodon, 2002). Family is a mainstay in providing guidance, and encouragement particularly when decisions have to be made on choosing a career.

A growing body of literature has shown that parental guidance has influenced the academic performance of students). Dick and Rollis (1991) claim that parents play a significant role in the decision making for students who want to enter the STEM fields. This argument is associated with Smith and Hausfaus's (1998) thinking that students of African heritage perform better in science and mathematics when their parents take an active role to advance their children's education. If parents do not take on such a role, could an argument be made that those children of African heritage are much more likely

to succumb to negative effects of unequal access to educational resources, including skilled teachers and quality curriculum, than they are to suffer from racial discrimination?

The third question was: Why do so few members of the African diaspora pursue mathematics education? The respondents provided several answers, but a consensus was that more role models are needed in the classroom to attract young men and women of African heritage to the STEM fields. More information should be disseminated to recognize the contribution of African heritage scholars to the field of mathematics.

Chapter V

SUMMARY, DISCUSSION, AND RECOMMENDATIONS

Summary of Study

Earlier in chapters I and III the justification for the study was provided as well as a historical review of education of African American scholars. This chapter provides a more detailed analysis of male and female mathematicians of African heritage who have obtained their terminal degrees and demonstrates motivation, persistence, determination, overcoming hardships, and obtaining support from family, peers, and friends.

The American educational system faces several challenges. It has become important for educators, elected officials, entrepreneurs, and policy makers to address existing disparities in education and implement policies to provide opportunities at every stage in a child's educational development, irrespective of class, creed, gender, or race. The purpose of this study was to understand the role of self-efficacy in overcoming educational disparities and to find out how men and women of African heritage have succeeded in earning PhDs in mathematics or EdDs in mathematics education. My objective was to discover how those who have been successful achieved their goals and what lessons can be learned from their careers.

The six themes identified explored the factors that influenced men and women of African ancestry to pursue a PhD in mathematics or EdD in mathematics education. Among the ten participants who were successful in completing their advanced degrees in mathematics, most, but not all, possessed strong mathematical interest from an early age. These recipients received support and encouragement from several sources, including school teachers, peers, and family members. Respondents willingly shared their mathematical skills by tutoring other students and engaging in enrichment programs that promoted the interests of students of color in primary and secondary schools and in colleges.

Discussion

The following themes emerged from the autobiographies and interviews: (1) family influence; (2) teacher influence; (3) peer influence; (4) problem-solving approaches; (5) perception of mathematics; (6) prior experience; (7) and individual perseverance (determination) and commitment (obligation). These thematic responses were generally consistent across respondents although in some instances experiences differed, which offered alternative scenarios for future investigation.

Family influence focuses on the role parents, siblings, and other family members play in the growth, development, and progression of the respondent's academic education and most important in participants' self-efficacy. Teacher influence focuses on the role

teachers play in providing feedback to students (enabling students to know their place in the field of mathematics). Teachers often reveal information about participants' academic performance and their potential through verbal cues, and they provide a supportive and caring environment for the success of participants. The theme of peer influence highlights the role that friends and classmates play in reinforcing mathematics self-efficacy. The awareness of mathematics theme highlights how other men and women of African heritage view mathematics and subsequently avoid it. Problem solving is a cognitive tool that advances STEM learning and is present in the success narratives that the respondents presented. The prior experiences theme focuses on the role early achievement in mathematics plays in encouraging further pursuits in mathematics. The individual perseverance and commitment theme draws attention to the character and value system that participants possess and that propels them to advance to the summit of academia.

The study looked at ten responses of men and women of African heritage who have been identified as successful in mathematics at the doctoral level. To receive their terminal degrees, two participants attended HBCUs, six attended private universities (five in the US and one in Africa), and the remaining two received their advanced degrees from public universities. Ms. Linden, one of the respondents originally majored in psychology at the undergraduate and master's level before switching to mathematics. The other respondents majored in mathematics at undergraduate and masters' levels. Three studied mathematics education at the master's level, and four had master's in pure or applied mathematics. Two had PhDs in mathematics. The others had EdDs in mathematics education. The purpose of this investigation was to have participants define,

discuss, and reflect on their beliefs about their motivation, academic achievements in mathematics, choices of interest, perseverance, effort, and commitment.

Each participant felt they possessed high levels of mathematics self-efficacy. Only one participant, Ms. Linden, stated that her confidence in her mathematics ability declined over time. She thought the decline was attributable to the remedial courses that she had to teach consistently. These courses did not challenge her mathematical intellect and the training she received in graduate school.

This study provides evidence that higher expectations have a positive impact on others. Let us examine Mr. Bridgeport's high school career. His teacher found explaining a particular concept in geometry difficult. So, Bridgeport demonstrated to the teacher how she should teach the concept. This moment led Bridgeport to realize, "...I kind of knew I was heading towards a math education career." He went on to state "I, finally, realized this was where I should have been years ago. The adrenaline I got from teaching math to students was the best I have had in a long time. I finally realized my destiny." Ms. Butler claimed that her teacher was special because she made her students aspire for greater goals. "You felt a sense of belonging and a part of something special because of the time this teacher invested in knowing the scholastic aptitude of each student to advance their talent." Again, Mr. Mahaica reported, "I wanted to be seen as an educator that could do something for my people. So, I decided to advance my education to the next level." Ms. Amsterdam recounted that her high school teacher Mr. Smith "...paid attention to my work and my relationship with other students in the classroom. He did not have to ask me to assist my fellow classmates. I did that on my own. He admired that quality in me and advised me to concentrate my efforts on mathematics."

On the other hand, people of African ancestry have been labeled: dangerous, jail bound, criminal minded, endangered, thugs, brutes, suspect, or persons of interest, and unemployed (Hum, 2016). These remarks seemed to support the view that African American men, despite interventions, have continued to underachieve on most academic indices (Howard, 2008). This study has provided robust evidence that people of color can advance their knowledge to levels of high expectations. These high expectations come from several sources.

Noble (2009) declared that teachers are prominent in the lives of students and are in the business of persuading as well as providing information about students' self-efficacy. Teachers provide their students with verbal cues on how to improve and reinforce their self-efficacy. Teachers are committed to the task of doing all they can to promote boys and girls to higher standards and academic expectations. Teachers who have this mind set are ensuring their students' academic success in the classroom.

In my study, each respondent faced episodes of failure and still succeeded. A limitation inherent in this study is investigating only mathematicians who successfully completed terminal degrees. Nonetheless, we can certainly conclude that failure does not always lower self-esteem; it can act as a motivator. From respondents, I gathered relevant evidence to support this theory. Mr. Northbrook, for example, experienced failure in mathematics, but this did not discourage him. He went on to successfully complete a bachelor's, master's, and a doctoral degree, although many people discouraged him. He said, "I know what I wanted and continued my endeavors." Mr. Bridgeport claimed that, "I was a mechanical engineering major and I enjoyed my time

living in the dorm and making all kinds of new friends. The problem was I was not motivated to go to class.” He lacked interest in academia and gave priority to his self-indulgence. Bridgeport dropped out of college. To his parents and siblings, he was a failure because his brother had successfully completed a bachelor’s degree at another university. However, Bridgeport returned to college some years later and completed his bachelor’s degree in mathematics and two master’s degrees in mathematics education. Mr. Nile articulated that he was pleased with his performance at the master’s level and desired a greater challenge. “This I can do with a PhD degree.” Mr. Nile was confident of his ability to advance his knowledge and talent and completed the terminal degree. Recall that earlier in Mr. Nile’s education he was failing mathematics, but this did not discourage him. Mr. Templeton was like his colleagues; he said “It was my high school teacher,” Ms. Patterson, “and a desire to make a difference that propelled me to decide to go forward to achieve my advanced degrees. I did not regret it.”

Ms. Green on the other hand reported “...Ms. Rutherford recognized my talent, but she did not support me in any way.” Ms. Green did not allow her teacher to retard her mathematics advancement, she went on to attain a terminal degree, recognizing that few women of color have that distinction. Ms. Butler, unlike Ms. Green, received strong support from her teachers and was encouraged by friends and family to pursue bachelors and master’s degrees before moving on. “After completing [my] undergraduate. I attended [my] master’s, and the next step was to earn my PhD. I knew it would not be an easy task because it was a male dominated field.”

“My family members were not really impressed with my choice of major... was not medicine, lawyering, engineering or, management – none of the traditional

professions. They were not very supportive.” Mr. Mahaica, was not satisfied with his accomplishments after successfully completing a masters’ degree in mathematics. There was a deep desire to do more “I was not satisfied, so I decided to go for the doctorate.”

Unlike Ms. Linden who experienced failure in geometry at the graduate level; she had never done geometry before in either high school or in baccalaureate program. In her quest to complete her master’s degree in mathematics education Ms. Linden had to complete a required course in geometry. She lacked the foundation to do the course, but this did not deter her. She said, “I was always encouraged to reach [my] full potential,” so, after my failure, she continued “I took the course over and passed with an A, amazing.” Finally, Ms. Amsterdam, had completed her master’s degree in mathematics and was prepared to enter the work force but her parents objected. They wanted Ms. Amsterdam, to advance her education. They wanted her to get that PhD in mathematics because the entire family was ready, willing, and able to support her in her endeavors. Ms. Amsterdam took up the gauntlet and embarked on the mission and completed it.

The reports presented are first and foremost direct sources of self-efficacy through the experiences of the respondents. Each respondent has shown success by obtaining a first degree which increased self-efficacy and the pursuit of a master’s. Having achieved this success by mastering the task and controlling surroundings, respondents reported an increase in self-esteem. Although there were reports of failures, they did not undermine that efficacy belief. The respondents who experienced failure had a resilient sense of self-efficacy, made possible by overcoming obstacles through effort and perseverance (Akhtai, 2008).

How then do we deal with those individuals who have a mindset that mathematics is too difficult? What about those who give up easily because they have experienced failure from early on and have expressed low self-efficacy (Bandura, 1986b)? Those who exhibit these predispositions have no commitment to achieve academic success. Noble (2009) claimed that respondents of that mind set are satisfied with mediocrity and failure, which is why some respondents admitted that not many men or women of African heritage pursue mathematics. We have to change the mindset that mathematics, “does not make sense.” “It does not relate to my life.” “I hate math.” “I have never been good at math.” “I do not see the need for math.” “Who made math anyway?” “It is too boring.”

Most respondents attended public institutions for their baccalaureate degrees. Undoubtedly, there has been a great increase in the number of students of African heritage who attend public colleges and universities because of greater access to higher education than was previously available. This does not mean that public institutions have served their purpose. In fact, they are much more needed now than before. Public university graduates have performed well professionally. People are expected to have experience that will enhance their self-efficacy for performing a task well when they observe people of the same racial group succeed at the task (Inouye, 1978; Bandura, 1981). Bandura (1986) and Schunk (1995) contend that similarities in conceptual models tend to analyze similar behavior patterns and outcomes.

The respondents in this study were confident that having teachers of African heritage boosted their confidence because they could relate to the instructors and presumably their instructors could relate to them. Most were exposed to teachers – from elementary to high school and even in college – who encouraged and advised them, who

were aware of their needs and abilities, and who knew how to motivate them to perform their best, thus the reason why these respondents advocated for more African American professors of mathematics in the classroom. Mr. Bridgeport suggested, “I think we need more black teachers; especially black males.” Ms. Butler agreed with Mr. Bridgeport when she said, “There is a need for more male and female African American teachers of mathematics.” Mr. Mahaica also claimed, “first and foremost, there is a lack of minority teachers in the classroom.

Our children do not have adequate role models to inspire them.” Ms. Amsterdam’s comment must be noted in its entirety because of its impact:

I think that more African American men and women are needed in the classrooms to act as role models. This would influence the social morale of students to believe that they can achieve the same as their teachers particularly in the STEM fields. Parents also have a responsibility to tell their children that they all need not be basketball players, or football players or rappers, they can still be in the different fields participating as accountants, sports medicine, economics, managers and the like. These professionals make a very respectable living. Everyone has the same goal to graduate and get a decent paying job.

Furthermore, attending a public institution is beneficial not only to the recipients, but to the community at large (Attewell & Lavin, 2009).

Recommendations for Teachers of Students of African Heritage

Teachers of students of African heritage have a responsibility to encourage their students from an early age to get involved in the STEM fields, so that later they can persevere in the field of mathematics and related subjects. This goal requires a stimulating curriculum that promotes more participation in advanced mathematics

courses and provides access and opportunities for all students in mathematics related fields such as physics, engineering, computer science, and astronomy. America is a cosmopolitan society with people drawn from different backgrounds and cultures. Therefore, teachers should become more cognizant and sensitive of cultural differences that may exist in their classrooms. This difference does not necessarily come only from students but also from teachers themselves (Irvine, 1990; Obidah & Teel, 2001).

Many of the respondents addressed the need for more teachers of African heritage to be present in the classroom. Could it be that having more teachers of African heritage would prove beneficial to African American students? Mr. Bridgeport, Mr. Mahaica, Ms. Linden, Ms. Green, and others are of the firm conviction that having more African American teachers in the classroom would be more attractive to African American students and thereby promote more passion and excitement in helping these students. The common thread in this discussion was the presence of someone in the classroom with whom students could identify and relate.

It is important that teachers, in the classroom setting, develop pedagogical strategies that are projected to intensify the educational and career hopes of Black students (Moore, 2006, p. 258). According to Moore (2006), teachers can demonstrate the relationship between schoolwork and careers when they use (a) vocational, career, and other job-related examples in their classroom work; (b) ascertain students' interests and relate those interests to possible vocations or careers; (c) stress the acquisition of skills needed to master prerequisites for specific vocations or careers; (d) point out the relationship between success in the school and success in work; and (e) assure students

that everyone has attributes that, properly coupled with training and aspirations, can lead to a successful and rewarding career.

What many of the respondents noted was the type of relationship they had with either their primary or secondary school teachers. The respondents received positive encouragement, which had a profound impact on their educational aspirations (Moore, 2006). They appreciated their teachers and improved their academic performance because of encouragement that enhanced their self-efficacy. If teachers create a positive environment it tends to promote learning because students feel connected to the teacher and feel motivated (Howard, 2003; Moore, 2006).

Recommendations for Parents of Students of African Heritage

The family is a dynamic institution that greatly influences members' academic growth and development (Johnson, 1992). A host of authors (Johnson & Prom-Johnson, 1984; Scott-Jones, 1984; Hrabowski et al., 1998) have supported the view that the family is a strong agent for advancing academic success. There is no doubt that from an early age family member such as parents, aunts, uncles, and grandparents set the tone under which the child will be educated. Thus, the child's attitude and behavior towards education is dependent on the exposure to mathematics he or she receives from prekindergarten to high school. Participants in this study received positive family influence and support for their continued success. Each participant expressed

appreciation for the support they received from parents and family members. Their responses support the findings of Hrabowski, Maton, and Greif (1998).

Parents should become more involved in their children's education. They should attend Parent Teachers' Association (PTA) meetings and advocate for more advanced classes in mathematics and mathematics-related subjects. Respondents in this study received praise from parents when their performance was outstanding and encouragement, including prodding, when they were not performing at their best, patterns that parents should continue and about which they should intercede to provide outside assistance in a particular subject when possible and necessary. If this cannot be achieved because of financial constraints, then schools should provide these services to the community. Parents should be careful not to compare their child's performance with another student to critique or praise their child. This could have serious repercussions (Bandura, 1986, p.422). If such a comparison comes into being the child may believe that others are greater or lesser persons than him or herself.

Herndon and Moore (2002) have argued that African diaspora parents have the ability to influence their children more than any other people. Therefore, parents have the power to instill in their children, at an early age, the importance of education and their expectations of academic accomplishment. The more parents reinforce their expectations, the more African American students are likely to commit themselves to school – studying, learning, and performing well in school. Parents should provide discipline combined with encouragement, support, and help navigating the different levels of the educational pipeline (Hrabowski et al., 1998).

Recommendations for Future Studies

It would be useful to further investigate the theory of self-efficacy as it relates to men and women of African ancestry. The study has brought awareness of several areas of importance to the forefront where attention should be directed. The first area to cover is teacher expectations. Teachers' expectations, perceptions, and behaviors are vital to the achievement, attitudes, and motivation (Russell, 2005) of their students, particularly in mathematics. Students of African heritage are underrepresented in mathematics programs at the doctoral level for multiple reasons, including that they lack the necessary foundations. According to Johnson and Kritsonis (2006), men and women of African descent in education today are often exposed to low-level, watered-down curriculums, negative perceptions about their ability, and low expectations regarding their academic achievement. The philosophy that runs rampant is that relationship of children of color to mathematics has been racially normalized (McLeod, 1991). In contrast, White children's mathematics behaviors and performances have been normalized as the standard for all students (Martin, 2009). The research practice of referring to Black-White gaps in mathematics achievement and closing the gaps by raising Blacks achievement level to meet the White achievement level gives credence to this normalization (Johnson & Kritsonis, 2006).

A disparity exists in the educational environment. Researchers have observed that students who are poor, female, and minority tend to have lower academic achievement than other students (Johnson & Kritsonis, 2006). They have reasoned that there exists in

schools a “hidden curriculum,” which maintains the belief that science and mathematics are “White male” subjects (Hrabowski, Maton, Greene, & Greif, 2002) and these subjects are accessible to White, middle- and upper-class students who are categorized as gifted and have at their disposal an enriched curriculum. On the other hand, African American students who find themselves in the same environment, are often over represented in the school discipline system (Ferguson, 2001; Gregory & Mosley, 2004) and are more likely to be placed in special education courses or labeled learning disabled.

More often than not, decisions by teachers, counselors, and administrators result in standardized tracks and ability groups (Johnson & Kritsonis, 2006). As a result, children of color who exhibit lowered expectations receive fewer opportunities for exposure to science and mathematics. From a very early stage these children has been labeled. Consequently, many boys and girls cannot gravitate towards mathematics at the doctoral level because of a lack of role models and little encouragement for them to enroll in college preparatory tracks, advanced mathematics, or science courses (Catsambis, 1995; Atwater, 2000). What is needed are positive role models that can inspire the aspirations of young boys and girls to study in the STEM field.

The results of this study suggest ways in which parents, peers, and teachers can increase the number of men and women of African heritage who pursue STEM fields, particularly mathematics. Furthermore, teachers, students, parents, and school counselors can work collaboratively to ensure academic exposure to career awareness about mathematics, they can also assist in encouraging men and women of African heritage to be more open-minded and expose themselves to different career opportunities in mathematics. For example, educational professionals may collaborate with parents and

other individuals in the community to create mathematics career awareness programs that focus on the different careers available to students in mathematics. In addition, teachers can collaborate with school personnel and parents to ensure that students are taking academic courses (physics, algebra II, pre-calculus, and calculus) that are important for students who want to pursue mathematics as a career, that is, to earn a PhD or an EdD in mathematics education or careers that require a strong background in mathematics (Moore, 2006).

The educational system in the United States pays little attention to the underrepresentation of men and women of African ancestry in the STEM fields, particularly in mathematics. Disparities exist among these groups, and opportunities must be made available to correct these deficiencies. If not, America becomes dependent on foreign talent, and the talent that is underdeveloped here (in America) leads to a waste of economic resources that can never be regained in the community. One approach to remedying these deficiencies is to apply the use of models of success. One purpose of this study is to uncover why some men and women of African heritage can take advantage of opportunities to participate in STEM fields.

My sample size is not large enough to make generalizations, especially about how African émigrés, Caribbean immigrants to the United States, and African American students differ. There is a remarkable similarity of educational development among Africans, South Americans, and Caribbean people. This similarity is directly related to the inherited English colonial system. In those places, educational development is similar because of colonialism, which could be seen in London-based examinations such as the GCE (ordinary and advanced levels). Their cultures are not so different educationally.

I should note there is a current debate centered on the interpretation of the achievement gap as it relates to education – in its measurement – on standardized tests between White and Black students. The assumption in the debate is that equal opportunity now exists, therefore, the continued low achievement attained by minority students is not the responsibility of the educational system but a direct result of the students; their poor academic performance can be attributed to genes, culture, or a lack of effort on the part of the students (Herrnstein & Murray, 2010). A counter argument can be substantiated to show that genes and culture can be excluded from this analysis and focus attention on the government that is responsible for public education. If schools are dominated with incompetent teachers and watered down curriculums, then minority students will perform below expectations, and underachievement will ultimately show up in their under representation in universities and the work force.

Despite these remarks the respondents are inclined to support the view that culture, context, and cognition are the necessary ingredients to a successful mathematics career. The social aspects of learning cannot be ignored because it is relevant within and outside the school environment and attention must be paid to the network of communities, interest groups, and practices important to mathematics education. If we accept this as true then there is a need for discourse to address the multiplicity of social practices and connections between them (Black, Mendick, & Solomon, 2009). Other authors have articulated the relevance of this discourse, which cannot be overemphasized, because mathematics is a gateway to opportunities and employment without which society stagnates. If society is to advance technologically and economically, attention

should be directed towards gender differences, ethnicity, class, and linguistics to promote mathematics education and simultaneously promote social justice within communities.

It is difficult to determine when exactly young African American students' self-efficacy emerges. Based on the responses of the participants in this study, we observed that from an early age, respondents showed an interest in mathematics: Mr. Nile, Mr. Mahaica, Ms. Linden, and Ms. Amsterdam developed an interest in mathematics at an early age. But Ms. Green, Mr. Northbrook, and Ms. Butler, and the others were late developers in mathematics. There is no direct time span in which an individual's mathematics self-efficacy kicks in. Neither is there a timeline in which it kicks out. Responses showed that mathematics self-efficacy acts on individuals differently. It depends on the environment, teachers, parents, peers, and the individual concerned.

Future research should consider examining the timeline when mathematics self-efficacy emerges in African heritage students and by what age, if any, it dissipates. I make this suggestion based on the argument that African American students leave the pipeline to higher education as early as elementary school (Oakes, 1990) and are completely off the track by high school. Additional research can examine the emergence of mathematics self-efficacy and how to develop and maintain it. Future research is also needed to examine vicarious experiences because they appear to have tremendous impact on respondents' mathematics self-efficacy. Finally, future research should explore the mathematics self-efficacy of African American students to produce a comprehensive understanding of African American students and their place in the world of mathematics.

Limitations of the Study

Limitations are the shortcomings, conditions, or influences that cannot be controlled by the researcher but place restrictions on a study's methodology or conclusions. My study was designed to incorporate a broad perspective on African American students' mathematics self-efficacy by exploring the experiences of those who have earned a PhD in mathematics or an EdD in mathematics education. I employed qualitative methods, including semi-structured, open ended interviews, which were on occasion taped and then transcribed. I used this method to exploit the strengths of the interview process while at the same time minimalizing its weaknesses.

There were several limitations in this study typical of interviews (Creswell, 2004). Every individual is unique, and English may not have been the respondent's native language. As a result, responses to questions diverged. Second, my original purpose was to conduct face-to-face interviews with each respondent, but this was not to be. For convenience, it was necessary to allow the respondent to submit the interview in written form.

Finally, there were only ten respondents, which limited the scope of this research. Also, I might not have been able to capture the correct spirit of the lived experiences of the respondents, particularly those respondents from foreign climes, because of cultural differences; their experiences in attending school in their respective countries is different from the schools, environments, curriculum, and teachers here in the United States. These respondents might have stylized their domestic experience to fit

their American experience so a true picture is never attained. The findings of this study can serve as a foundation for future research concerning the mathematics self-efficacy of men and women of African heritage. It seems that the biggest limitation, of this study is that I (the researcher) interviewed only successful candidates. Each succeeded, and as a result, we know little about the barriers to success. Thus, cultural expectations of professors largely from foreign countries may not fit experiences from the United States.

Final Remarks

This was a challenging experience for me; it brought out a consciousness outlook about my journey in mathematics and the similar experiences people may have even when they may come from different parts of the globe. Several things attracted my attention to which I must pay homage. First, many respondents were in debt to the teachers to whom they were exposed, teachers of African heritage. They showed interest in their students' education, they motivated them, and they advanced their progress in mathematics by providing extra work sheets or assisted them to better understand the material. These teachers showed that they cared and did everything in their power to promote the interest, wellbeing, and education of their students. There were instances when I was surprised by a respondent saying that she was not aware that women could major in mathematics as a profession. I noted the difficulties and grit of respondents who were uncomfortable with their grades but were powerless to get justice or who found themselves the only students of color in a classroom. This has impressed upon me the

desire to further explore the predicament of education for African American students in American educational institutions. Success is difficult, but there are no laws that prevent someone from dreaming. There will be more successes in mathematics if young men and women of African heritage dream about becoming mathematicians and work diligently toward this task. Because people of African heritage achieve success at the graduate level, those who have been successful possess the knowledge, experience, motivation, and above all the self-efficacy that contributed to their success. These they can pass on to the current generation.

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Appendix A

Mathematics Autobiography

This Mathematics autobiography was adopted from Richard Noble III. The Impact of Self-efficacy of Mathematics of African American Males and Females

Instructions

You have one week from the receipt to complete the questions below. Your response in each question should be typed; single spaced, and should not exceed 1.5 pages per question. Please number each response according to the question that you are answering (i. e. Response # 1 would correspond to the “Identity” and write about significance ...”).

1. Identify and write about significant moments you have had with mathematics from kindergarten to graduate school. Please include both positive and negative experiences. The experiences can be either during school career or out-side-school career.
 - a. When were you first drawn to mathematics?
 - b. What is it that drew you toward mathematics?
2. When did you first realize that you were “good at mathematics?”
 - a. Describe and elaborate on this memory.
 - b. How did you feel when you made this realization?
 - c. Who helped you realize you were “good at mathematics?”
 - d. Do you feel the same way about your abilities now?
3. Describe the best mathematics teacher you had?
 - a. What was it like to be in this teacher’s class?
 - b. What qualities or characteristics influenced your thoughts about the teacher?
 - c. How was this teacher different from other teachers?
4. Can you distinguish between self-efficacy and self-esteem?
 - a. Can you give an example of success and an example of failure in your mathematics career?
 - b. When we see someone succeeds we tell our self we can do the same. How did such situations increase your desire to attain your goals or how did a negative situation discourage you from achieving your intended objectives in mathematics?

- c. Did anyone during your mathematics career spoke negatively towards your ability to achieving a PhD in mathematics? What was your reaction?
- d. What really motivated you to enter a world of mathematics and continue to survive in it?

Appendix B

Interview Protocol

This appendix is a duplicate of Dr. Walker's (2009) questionnaire to obtain data for a study that was conducted earlier.

Part 1.

1. How early in your childhood did you become interested with mathematics? How did you become interested in mathematics?
2. Were any family members mathematically inclined? Please explain.
3. Please tell me about an experience from your {elementary/secondary} school days that were important to your mathematics thinking.
4. Did your teachers in elementary/secondary school support your mathematics learning? If so how?
5. Did you talk with your friends about mathematics? Did you participate in math clubs, etc., in elementary/secondary schools? What kinds of mathematics experiences did you have with friends in and out of school?

Part 2.

6. For your undergraduate education, did you attend a historically black college or university (HBSCU) or a predominantly white institution (PWI)?
7. How did you decide to major in mathematics in college?
8. What was the response of your family/friends/teachers to that decision?
9. What kinds of out-of-classroom activities did you participate while in college that supported your mathematics learning.
10. Did you talk with your college friends about mathematics? What kinds of mathematics experiences did you have with friends in and out of school?

Part 3.

11. How did you decide to continue your education to get the PhD in mathematics?
What factors contributed to that decision?
12. Who were your mentors? How did they mentor you?
13. Have you sponsored any PhD students yourself? How is your relationship with them similar/different to the relationship you had with your PhD sponsor? Why is it similar/different?
14. What would you describe as your priorities as a mathematician? [probe: research/teaching/pushing/mentoring/]
15. What kinds of mathematical experiences do you engage in with family members? [Nieces/nephews/children/grandchildren]? How are these similar or different from experiences you had as a child?

16. Are any of your family members:

- Participating in mathematics activities in secondary school.?
- Majoring in mathematics in college?

Part 4.

17. How would you inspire young students of African heritage to pursue a degree in mathematics?

18. What experiences would you share with young Black college students' who want to embark on a journey in the field of mathematics?

19. How are your experiences in mathematics today different from your experiences, say twenty years ago?

20. What course of action should be taken regionally to improve Black students' performance as well as their participation in mathematics?

21. Circle the most appropriate that describes you a) African American b) African West Indian (Caribbean) c) African Émigré.

22. Select the most appropriate a) Male b) Female c) Undecided.

Appendix C

Informed consent

Protocol Title: Career Trajectories of Mathematics Professors of African Heritage.

Interview Consent

Principal Investigator: Trevor Thomas, student Teachers College

929-240-5215, thomastrevor83@yahoo.com

Introduction

You are being invited to participate in this research study called “Career Trajectories of Mathematics Professors of African Heritage.” You may qualify to take part in this research study because you are over 18 years old, have taught for a minimum of 2 years and have graduate training in teaching mathematics. **You are of African heritage and a successful PhD in mathematics or an EDD mathematics education instructor. If you are presently participating in another study you can be part of this study.** Approximately forty-two people will participate in this study and it will take 3 hours of your time to complete.

Why is this study being done? **This study is being done to determine factors that propelled Black men and women to pursue a PhD in mathematics, and how best can we use the successes of their self-efficacies to motivate young Americans to follow in their footsteps? This study is done as part of the fulfillment of the EDD requirements.**

What will I be asked to do if I agree to take part in this study?

If you decide to participate, I will ask you to email me a 900-word mathematics autobiography focusing on your mathematics experiences from an early age through graduate school and beyond. At a later mutually convenient time you will be interviewed

by the principal investigator. During the interview you will be asked to discuss your graduate education experience and your experience as a professor. This interview will be audio-recorded. After the audio-recording is written down (transcribed) the audio-recording will be deleted. If you do not wish to be audio-recorded, you will not be able to participate. The interview will take approximately one hour. You will be given a pseudonym or false name/de-identified code in order to keep your identity confidential. All of these procedures will be done at a place and time that is convenient to you.

What possible risks or discomforts can I expect from taking part in this study?

This is a minimal risk study, which means the harms or discomforts that you may experience are not greater than you would ordinarily encounter in daily life while talking to a researcher. You might feel embarrassed to discuss problems that you experienced in graduate school or while working in your school. **However, you do not have to answer any questions or divulge anything you don't want to talk about. You can stop participating in the study at any time without penalty.** The principal investigator is taking precautions to keep your information confidential and prevent anyone from discovering or guessing your identity, such as using a pseudonym instead of your name and keeping all information on a password protected in a computer and other data locked in a drawer.

What possible benefits can I expect from taking part in this study?

There is no direct benefit to you for participating in this study. Participation may benefit the field of teacher education to better understand the best way to influence or motivate young minds.

Will I be paid for being in this study?

You will not be paid to participate; however, your transportation costs will be covered, if necessary. There are no costs to you for taking part in this study.

When is the study over? Can I leave the study before it ends?

The study is over when you have completed the interview. However, you can leave the study at any time even if you haven't finished. You will still be paid for your transportation costs. Protection of your confidentiality

The investigator will keep all written materials locked in a desk drawer in a locked office. Any electronic or digital information (including audio recordings) will be stored on a computer that is password protected. What is on the audio-recording will be written down and the audio recording will then be destroyed. There will be no record matching your real name with your pseudonym. The master list identifying the participant that carries the pseudonyms is kept separate from the list of code. Participants' confidentiality, in

this way is, protected. Regulations require that research data be kept for at least three years.

How will the results be used?

The results of this study will be published in journals and presented at academic conferences. Your name or any identifying information about you will not be published. This study is being conducted as part of the dissertation of the principal investigator.

Consent for audio and or video recording

Audio recording is part of this research study. You can choose whether to give permission to be recorded. If you decide that you don't wish to be recorded you will not be able to participate in this research study.

_____I give my consent to be recorded

Signature

_____I **do not** consent to be recorded

Signature

Who may view my participation in this study?

___I consent to allow written, video and/or audio taped materials viewed at an educational setting or at a conference outside of Teachers College

Signature

___I **do not** consent to allow written, video and/or audio taped materials viewed outside of Teachers College Columbia University

Signature

Who can answer my questions about this study?

If you have any questions about taking part in this research study, you should contact the principal investigator, Trevor Thomas, at 929-240-5215 or thomastrevor83@yahoo.com. You can also contact the faculty advisor, Dr. Philip Smith at 212-678-3381.

If you have questions or concerns about your rights as a research subject, you should contact the Institutional Review Board (IRB) (the human research ethics committee) at 212-678-4105 or email IRB@tc.edu. Or you can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY 1002. The IRB is the committee that oversees human research protection for Teachers College, Columbia University.

Participant's Rights

- I have read and discussed the informed consent with the researcher. I have had ample opportunity to ask questions about the purposes, procedures, risks and benefits regarding this research study.
- I understand that my participation is voluntary. I may refuse to participate or withdraw participation at any time without penalty. The researcher may withdraw me from the research at his or her professional discretion if the researcher knows the subject requires to discontinue the interview, or feel uncomfortable, or does not want to hand over the written mathematics autobiography.
- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue my participation, the investigator will provide this information to me.
- Any information derived from the research study that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.
- I should receive a copy of the Informed Consent document.

My signature means that I agree to participate in this study

Print name: _____

Date: _____

Signature:

1. Symbolizing Capability: People are affected not only by direct experience but also indirect events. Instead of merely learning through laborious trial-and-error process, human beings are able to symbolically perceive events conveyed in messages, construct possible solutions, and evaluate the anticipated outcomes.
2. Self-regulation Capability: Individuals can regulate their own intentions and behaviors by themselves. Self-regulation lies on both negative and positive feedback systems, in which discrepancy reduction and discrepancy production are involved. That is, individuals proactively motivate and guide their actions by

setting challenging goals and then making effort to fulfill them. In doing so, individuals gain skills, resources, self-efficacy and beyond.

3. **Self-reflective Capability:** Human beings can evaluate their thoughts and actions by themselves, which is identified as another distinct feature of human beings. By verifying the adequacy and soundness of their thoughts through enactive, various, social, or logical manner, individuals can generate new ideas, adjust their thoughts, and take actions accordingly.
- 5 **Vicarious Capability:** One critical ability human being featured is to adopt skills and knowledge from information communicated through a wide array of mediums. By vicariously observing others' actions and its consequences, individuals can gain insights into their own activities. Vicarious capability is of great value to human beings' cognitive development in nowadays, in which
- 5 most of our information encountered in our lives derives from the mass media than trial-and-error process.