A PRELIMINARY STUDY INVESTIGATING THE FACTORS INFLUENCING STEM MAJOR SELECTION BY AFRICAN AMERICAN FEMALES

by

Tiffany Monique Ray
B.S. May 2007, Old Dominion University
M.B.A. December 2009, Old Dominion University

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

DOCTOR OF PHILOSOPHY

HIGHER EDUCATION

OLD DOMINION UNIVERSITY
December 2016

Approved by:

Dana Burnett (Director)

Melva Grant (Member)

Ellen Neufeldt (Member)

ABSTRACT

A PRELIMINARY STUDY INVESTIGATING THE FACTORS INFLUENCING STEM MAJOR SELECTION BY AFRICAN AMERICAN FEMALES

Tiffany Monique Ray
Old Dominion University, 2016
Director: Dr. Dana Burnett

The purpose of this study was to investigate the significant factors influencing STEM major selection by African American females. A quantitative research design with a qualitative component was employed. *Ex post facto* survey research was conducted utilizing an online questionnaire to collect data from participants. African American undergraduate females that had declared a major in STEM comprised the target population for the study. As a basis for comparison, a second data collection ensued. All non-African American undergraduate females majoring in STEM also received the survey instrument to determine if there was a significant difference between factors that influence STEM major selection between the two groups.

The Social Cognitive Career Choice Model comprised the conceptual framework for this study. Frequencies and percentages illustrated the demographic characteristics of the sample, as well as the average influence levels of each of the items without regard for level of significance. The researcher conducted an independent samples *t*-test to compare the mean scores for undergraduate African American females majoring in STEM and non-African American females majoring in STEM on each influential factor on the survey instrument. The researcher coded responses to open-ended questions to generate themes and descriptions.

The data showed that African American female respondents were very influenced by the following items: specific interest in the subject, type of work, availability of career opportunities after graduation, parent/guardian, precollege coursework in science, and introductory college

courses. In addition, the majority of respondents were very influenced by each of the confidence factors. African American females were overwhelmingly not influenced by aptitude tests. African American females were more influenced than their non-African American female counterparts for the following factors: reputation of the university, college or department, high level of compensation in fields, religious leaders, precollege coursework in mathematics, confidence in mathematics ability, confidence in ability to be successful in mathematics in college, confidence in science ability, and confidence in ability to be successful in science in college. Non-African American females were more influenced than African American females by the precollege coursework in technology and the precollege STEM experience factors. Four themes emerged regarding the items that most influenced success in STEM for African American females: high level of compensation in the field, parents/legal guardians and family members, specific interest in the subject, and confidence in science and math ability. One theme emerged regarding the items that least influenced success in STEM majors for African American females: personal interactions with individuals excluding family members.

This dissertation is dedicated to all the courageous African American young women ready to change the world.
You got next.

"Courage is like—it's a habitus, a habit, a virtue: you get it by courageous acts. It's like you learn to swim by swimming. You learn courage by couraging."

– Marie M. Daly, First female African American to earn a PhD in Chemistry

ACKNOWLEDGMENTS

I have been utterly humbled by this educational experience. I have never experienced such gut-wrenching torture with such overwhelming gratification. I am happy to have shared such a challenging experience with my chair, Dr. Dana Burnett. I learned so much from this man. Dr. Burnett witnessed my growth from an unruly, lost undergraduate student to a slightly less unruly, less lost doctoral student. Thank you for your guidance and support. Thank you for believing in me. This could not have happened without you.

I would like to thank the rest of my committee, Dr. Melva Grant and Dr. Ellen Neufeldt. You heard the pleas of a desperate doctoral student hoping to assemble a committee that supported her research. I appreciated your candor, advice, and patience. Thank you for taking your time to go on this (long) journey with me. This could not have happened without you.

To the outstanding faculty in the Higher Education program, thank you for providing the educational foundation necessary for success and for the support you provided along the way. I would like to especially thank Dr. Chris Glass and Dr. Dennis Gregory. We'll always have London, Edinburgh, and Dublin! I also would like to acknowledge my cohort. When our lives converged that fateful summer, we knew we were changed forever. You're the real MVPs. This could not have happened without you.

To all the individuals that supported, comforted, encouraged, assisted, and prayed for me along the way – thank you. Thank you to Dr. Tisha Paredes, Dr. Kim Sibson, Ms. Janina Arrington, Ms. Lucinda Rush, Dr. Phil Pons, Mrs. Terry Hinders, Mrs. Kris Rarig, Dr. Dan Lufkin, and Dr. Darryl Tyndorf. Thank also you to my friends and family. I ~~won't~~ may not be crazy anymore! Finally, thank you God. ALL OF THIS definitely could not have happened without You.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

In the United States, participation in the disciplines of science, technology, engineering and mathematics (STEM) is at a record low, creating a shortage of STEM professionals prepared for the workforce (Charleston, 2012). Scientific advancement and innovation are crucial to maintaining national security, economic competiveness, and quality of life (Ong, Wright, Espinosa, & Orfield, 2011). The United States awards fewer bachelor's degrees in science than several other industrialized nations, making it especially vital for the United States to develop a highly trained STEM workforce to ensure economic vitality (Perna et al., 2009). At the same time, the number of high school students expressing interest in STEM disciplines has also declined, which could result in fewer than 2% of high school graduates receiving a STEM degree from a 4-year institution (Moakler & Kim, 2014). The United States trails all but one country in the proportion of STEM majors compared to all other majors, even though approximately 30% of college freshman intend to major in STEM fields (Scott & Tolson, 2009).

These declines in STEM participation have disproportionately affected historically underrepresented populations, including individuals that identify as women of color (Espinosa, 2011). A failure to advance the pursuit of STEM careers for these populations could negatively affect the Unites States socially, technologically, and economically, threatening the country's global authority in scientific and technical fields (Ong et al., 2011). This disparity is occurring even though women outnumber men in terms of college attendance and woman of color express a greater interest in STEM fields at undergraduate institutions compared to their White female counterparts (Johnson, 2011; Ong et al., 2011). In one recent study, for example, excluding Asian Americans, 16% of women of color demonstrated interest in majoring in a STEM discipline compared to 13.4% of White females (National Science Foundation [NSF], 2011). While disparities in actual participation exist, women of color continue to express an interest in pursuing STEM careers (Malcom & Malcom, 2011).

Statement of the Problem

According to projections, by the year 2050, minorities will comprise half of the U.S. population (Jackson, 2013). This demographic shift may render traditional pipelines for talent impractical, specifically the White male population (Ong et al., 2011). Despite this impending shift, STEM fields continue to be primarily dominated by White males (Malcom & Malcom, 2011). It is imperative to promote equity in the career opportunities available to underrepresented populations, in part due to the demand for talent in these fields (Perna et al., 2009). Of all populations, women of color are the most underrepresented in STEM disciplines (Espinosa, 2011). A failure to invest in the academic preparation of a suitable workforce affects women of color more so than any other population (Espinosa, 2011; Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013). Encouraging diversity in STEM is a critical objective due to the aforementioned impending decrease in the talent pool of individuals educated in STEM disciplines (Tsui, 2007).

Researchers, policymakers, and educators have become increasingly interested in the underrepresentation of African Americans in STEM (Haun-Frank, 2011). African Americans, as a group, represent a smaller share of the recipients of bachelor's degrees in STEM fields, and representation among African American women in STEM fields is significantly lower than that of their African American male counterparts (Perna et al., 2009). Only in the biological sciences are African American women receiving the majority of bachelor's degrees awarded to all African Americans (Perna et al., 2009). Research suggests that African American female students are less likely to select a STEM major despite demonstrating interest in the disciplines, thus identifying factors that influence this population's decision to pursue STEM fields can contribute to building a viable STEM workforce (Moakler & Kim, 2014).

Much of the available research had used a deficit approach to describe the experiences of African American females. Studies focused on exploring the factors that prevent participation by African American females, such as the lack of academic preparation or lack of encouragement, rather than the factors that motivate participation and enable this group to overcome the "leaky pipeline" (Hernandez et al., 2013; Waller, 2006). Rather than examine the barriers and challenges preventing African American females from pursuing STEM majors, this study focused specifically on the beginning of the pipeline. Here, influences include the students' personal experiences, background, learning experiences, self-efficacy, goals, and outcome expectations. Specifically focusing on African American females permits provides a window into the unique influences impacting the decision-making process of this underresearched group.

Purpose Statement

The purpose of this study was to investigate the significant factors influencing African American females' STEM major selection.

Research Questions

This study investigated the significant factors that led a group of undergraduate African American female students to select STEM majors at a 4-year university. The research questions that guided this mixed-methods research study were:

1. What are the factors, if any, which influence African American female undergraduate students to select STEM majors at a public research university in southeastern Virginia?

2. What are the statistically significant factors, if any, unique to African American female undergraduate students as compared to non-African American female undergraduates which influence STEM major selection at a public research university in southeastern Virginia?
3. What are the factors, if any, which impact the success of African American female undergraduate students in STEM majors at a public research university in southeastern Virginia?

Delimitations

The following delimitations were associated with this research study:

1. The study was restricted to one large, public, 4-year research institution in southeastern Virginia. The results may not be generalizable to different institution types in other locations.
2. The study focused exclusively on female African American undergraduate students who declared a major in STEM. This study did not address other underrepresented populations, graduate students, former students, or faculty. Additionally, this study did not address students pursuing a minor in a STEM discipline.
3. A survey instrument was employed comprised of closed and open-ended questions for data collection purposes.

Significance of the Study

Research specific to African American females in STEM fields is limited, despite efforts designed to improve representation in the literature (Borum &Walker, 2012). Johnson (2011) asserts that this is due, in part, to the low number of underrepresented women in the field, rendering results from any sample potentially insignificant. While there has been a slight increase in the amount of research focused on women of color, much of the existing literature has not addressed the racial and ethnic differences among women of color, particularly African American females (Johnson, 2011). The research related to women of color in STEM disciplines tends to treat females from distinct racial and ethnic backgrounds as a homogenous group, despite inherent differences in experience (Johnson, 2011). Additionally, very little research exists studying the significant influences which impact on African American females' decision to select STEM majors once they matriculate at undergraduate institutions (Espinosa, 2011).

Broadening participation among underrepresented populations, particularly women of color, is a national priority (Hernandez et al., 2013). Increasing the number of African American females in the STEM workforce can offer diverse experiences and perspectives to the field (Espinosa, 2011). By focusing on African American females, this study expands the current body of knowledge available regarding African American females in STEM.

Definition of Key Terms

The following defines the important terms used frequently in this dissertation.

African American. Citizens or legal residents of the United States of Black African descent, as self-reported by participants.

Female. The self-reported gender identity of an individual.

Major selection. An officially declared undergraduate academic major.

STEM fields. Subjects in the natural sciences, engineering, engineering technologies, and computer and information technologies, as well as mathematics (NSF, 2011). This definition does not include social science and psychology fields. By excluding social science and psychology fields, a clearer picture of the marginalization of woman of color in STEM fields emerges (Johnson, 2011).

Undergraduate. A college or university student pursuing a bachelor's or equivalent degree.

Outline of Dissertation

There is a critical need to build the STEM workforce in the United States. However, populations that traditionally enter the workforce may be unable to support this demand. Exploring how undergraduate students who are traditionally underrepresented in STEM fields decide to entire the pipeline contributes greatly to the current body of research. With this in mind, the goal of the present study was to conduct a preliminary investigation into the factors that influence STEM major selection by undergraduate African American females.

In Chapter 2, the literature relevant to African Americans and women in STEM fields is summarized. The literature review explores the Social Cognitive Career Choice Model and its foundation in the concepts of self-efficacy and social cognitive theory. The literature review highlights the literature related to academic major selection, the challenges confronted by African American females in STEM, as well as the aspects that contribute to the success of African American females in STEM fields. The literature review also identifies gaps in the current body of literature and provides additional support for this research study.

In Chapter 3 the quantitative and qualitative methodology employed in designing and conducting this research, including the research design, setting, population and sample, and instrumentation is presented. Additionally, the data collection procedures, ethical considerations, data analysis methods, and limitations are discussed. This chapter also includes a comprehensive report of the demographics of undergraduate STEM majors at research site.

In Chapter 4, a comprehensive overview of the findings of the study, beginning with the statistical analyses of the factors that influence undergraduate African American females to select STEM majors is provided. Additionally, a summary of a qualitative analysis of the open-ended questions illustrates the emergent themes related to the factors that impact the success of undergraduate African American females in STEM disciplines. Finally, in Chapter 5, the research, a summary, conclusions, and recommendations for policy, practice, and future research is presented.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Chapter 2 provides a review of the literature and theoretical framework pertaining to STEM major selection by undergraduate African American females. The literature review serves as a foundation for this study and establishes the importance of the study in reference to the findings in previous research (Creswell, 2003), providing additional background for the study. First, the chapter discusses the Social Cognitive Career Choice Model (SCCCM), and its precursors, the social cognitive theory (SCT) and the construct of self-efficacy. This is followed by a discussion of academic major selection and specifically STEM major selection as it relates to selection behavior, and finally, women of color and African Americans in STEM.

Self-Efficacy and Social Cognitive Theory

The concept of self-efficacy has been used to explore the low enrollment and success of underrepresented populations (e.g., females) in male-dominated academic majors (Zeldin, Britner, & Pajares, 2008). Self-efficacy is the primary construct in the SCT (Bandura, 1977), and explains an individual’s belief in his or her ability to succeed in a specific context. Self-efficacy has been used as a gauge for testing competence and persistence (Bandura, 1977; Kiran & Sungur, 2012). Self-efficacy beliefs help to determine an individual’s choices, effort expenditures, and emotional reactions to challenges (Bandura, 1977). Thus, human functions including choice are greatly influenced by self-efficacy beliefs (Kiran & Sungur, 2012).

Social cognitive theory combines the concepts of personal learning and observed learning, as well as reinforcement and self-control (Bandura, 1977). According to the SCT, self-efficacy beliefs are influenced by mastery experiences, vicarious experiences, verbal persuasion, and emotional arousal (Bandura, 1977). Mastery experiences are the most influential source of self-efficacy: a student's ability to complete a task successfully increases the student's belief that he or she will be successful with subsequent tasks; failures weaken a student's belief in his or her own capabilities (Bandura, 1977; Kiran & Sungur, 2012). Academic self-efficacy impacts educational and occupational interests and expectations, as it provides students the confidence in their ability necessary to complete tasks related to their future occupation (MacPhee, Farro, & Canetto, 2013).

Social Cognitive Career Choice Model

Researchers in vocational psychology have sought to understand the factors that promote choice and interest in mathematics and science-related fields for some time (Lent, Lopez, Lopez, & Sheu, 2008). Using the SCT as a foundation, Lent, Brown, and Hackett (1994) developed the Social Cognitive Career Choice theory, and subsequently, a framework for career development and decision-making, known as the SCCCM. The SCCCM provides a basis for career development, and has been used to study the vocational interests of ethnic minorities and women (Lent, Brown, & Hackett, 1994; Scheuermann, Tokar, & Hall, 2014).

The SCCCM solidifies the relationship between academic major choice and future career choice through various factors including personal experiences, background, learning experiences, self-efficacy, and outcome expectations (Moakler & Kim, 2014). The model captures the intersection between cognitive and behavioral functions that influence career interests and performance behaviors (Lee, Flores, Navarro, & Kanagui-Muñoz, 2015). The SCCCM provides a theoretical framework for understanding vocational interests and individuals' decision-making processes (Lent et al., 1994). At the center of this framework is the concept that a person's background (e.g., gender, race/ethnicity) and contextual affordances (e.g., access to social networks) contribute to career-related learning experiences, which directly impact self-efficacy beliefs (Thompson & Dahling, 2012). This framework thus links career-relevant interests, academic and career choice, and performance and persistence in educational and occupational pursuits (Lent et al., 1994).

The SCCCM theorizes that career and academic interests are inspired when individuals have confidence in their ability (i.e., self-efficacy) and anticipate positive consequences or outcome expectations (Lee et al., 2015). Self-efficacy, outcome expectations, and interests then shape the occupational choice goal (i.e., the intent to pursue a particular vocational interest; Lent et al., 2008; Scheuermann et al., 2014). Goals are affected by social supports and the absence of barriers (Lent et al., 2008). Personal experiences and background can include gender and racial minority status, precollege academic preparation, and parental socioeconomic status (Moakler & Kim, 2014). Additionally, realistic self-assessment of ability can also influence career and academic major choice (Moakler & Kim, 2014).

The model is rooted in the relationship between individuals' cognitive processes and their environment (Thompson & Dahling, 2012). The factors that influence academic career choice interact to allow individuals to develop academic and career interests, to make and revise educational and vocational plans, and finally, to achieve performance at different levels based upon these interests (Lent et al., 2008). According to the SCCCM, students are less likely to turn their interests into goals when they believe they will have difficulties overcoming barriers in their environment (Inda, Rodríguez, & Peña, 2013).

The SCCCM has been used to study STEM career development with African American populations (Scheuermann et al., 2014). Since gender is not used as a moderator in the SCCCM, the predictive utility of social cognitive variables is valid for women as well as men (Inda et al., 2013). The model has been supported when testing hypotheses in the context of STEM majors (Lent et al., 2008). Previous studies using the SCCCM have showed that African American students' self-efficacy in completing engineering degrees predicted engineering major choice goals, with similar findings in computer science-related disciplines (Lent, Lopez, Sheu, & Lopez, 2011; Lent, Sheu, Gloster, & Wilkins, 2010).

Academic Major Selection

As critical shortages persist in some fields, like STEM, policymakers and higher education administrators have become interested in students' academic major decision-making process (Soria & Stebleton, 2013). Choosing an academic major is an important life decision that has often been classified as a "life regret" (Beggs, Bantham, & Taylor, 2008). Because college major choice influences an individual's subsequent career progress, it is important to understand how individuals select academic majors in order to ensure an efficient distribution of human resources and to reduce discriminatory obstacles (Montmarquette, Cannings, & Mahseredjian, 2002). The act of selecting a college major can have long-standing socioeconomic ramifications for the individual and the country, as graduates in specific disciplines are necessary to meet workforce demands (Soria & Stebleton, 2013).

Economic returns and cultural norms and expectations often govern the selection of majors (Lichtenberger & George-Jackson, 2013). Students' academic majors directly relate to job stability, job satisfaction, career opportunities, and salaries (Soria & Stebleton, 2013). There is also a dramatic difference in choice of college majors between males and females, which also has significant social and economic impacts (Zafar, 2013). According to Zafar (2013), males and females' disparate abilities and differences in preferences and beliefs explain this differentiation.

Many researchers have investigated the factors that affect academic major selection including economic factors, gender-related factors, family educational and occupational backgrounds, academic preparation, and self-efficacy (Soria & Stebleton, 2013). Additional research further identifies these factors, also citing environmental influences, family influences, gender, race and culture, disability status, spirituality and religion, and sexual orientation (Duffy & Sedlacek, 2010). One study identified four distinct categories that incorporate the aforementioned factors: (a) sources of information and influence (i.e., individuals, events, print media), (b) job characteristics (i.e., intrinsic and extrinsic rewards of the job), (c) fit and interest in subject (i.e., aptitude and interest in subject), and (d) characteristics of the major (i.e., faculty reputation, ease of earning degree, etc.; Beggs et al., 2008).

According to Duffy and Dik (2009), family expectations and needs are the most significant external factors in an individual's career development. Several studies have indicated that parental influence, parental occupation, and recommendations from relatives have a strong effect on major choice (Beggs et al., 2008). Another important factor is life circumstances, which refers to "all of the uncontrollable situations that occur at an individual and societal level that may constrain career decision making" (Duffy & Dik, 2009). Additionally, faith plays an important role in the decision-making process for spiritual and religious individuals (Duffy & Dik, 2009).

STEM Major Selection

Despite the nation's dependence on science and technology, fewer college-bound students enter STEM fields (Moakler & Kim, 2014). The demand for STEM graduates continues to grow at a steady rate (Wang & Degol, 2013). The number of students that express interest in STEM has declined, leading fewer than 2% of high school graduates in the United States to receive 4-year degrees in STEM disciplines (Moakler & Kim, 2014). There is a need for greater participation of STEM graduates in the workforce, as the diminishing talent pool means there are fewer individuals to promote the economic and technological advancement of the United States (Moakler & Kim, 2014; Wang & Degol, 2013).

Much of the literature in STEM education focuses on STEM career aspirations, career guidance, increasing interest in STEM, persistence, and degree completion. However, little research has examined students' choice of STEM majors (Moakler & Kim, 2014). According to Moakler and Kim (2014), selection of a STEM major is an important step towards pursuing a career in STEM. There are several indicators related to a student's decision to enroll in STEM to include demographics, academic qualifications, and motivation (Lichtenberger & George-Jackson, 2013).

African Americans and Women of Color in STEM

According to Johnson (2011), while there has been a slight increase in the amount of research regarding women of color, much of the existing literature does not address the racial and ethnic differences among women of color, particularly African American females. Women of color (i.e., African American, Asian American, Latino American, and Native American women) present a major opportunity to grow the STEM workforce (Ong et al., 2011). In some studies, Asian American women have been excluded due to their relatively high representation in STEM fields (Johnson, 2011). In 2010, this group represented 20% of the population between the ages of 15 and 24, which is the prime age for college attendance (Espinosa, 2011). However, this population accounted for only 12% of the total bachelor's degrees in STEM fields. According to the National Science Board (2014), between 2000 and 2011 the proportion of bachelor's degrees awarded to women in science and engineering remained flat and declined in the areas of computer science, mathematics, physics, and engineering.

Research specific to African American women in STEM fields is limited (Borum & Walker, 2012). The research on women of color in STEM disciplines tends to treat females from distinct racial and ethnic backgrounds as a homogenous group, despite inherent differences in experience (Johnson, 2011). Johnson (2011) asserts that this is due in part to the low number of underrepresented women in the field, rendering results from any sample potentially insignificant. Incongruously, women attend college and express interest in STEM at higher rates than men (Johnson, 2011; Ong et al., 2011). Only in the biological sciences have women achieved parity with men, as it relates to major selection, although this is not reflected in the current STEM workforce (Espinosa, 2011).

When discussing women of color in STEM, many reference the concept of the *double bind*, as coined by Malcom, Hall, and Brown (1976). This concept depicts the experiences of women scientists from underrepresented minority groups and the unique challenges they face. As both a gender minority and a racial or ethnic minority, women of color in STEM fields simultaneously experience discrimination based on sex and race (Johnson, 2011; Ong et al., 2011). These discriminatory practices severely impact women's intent to pursue STEM majors upon matriculation. Furthermore, much of the research presumes that efforts targeted towards either racial or ethnic minorities or women adequately address the challenges of women of color (Ong et al., 2011).

Concerns of negative stereotyping (i.e., stereotype threats) also impact the likelihood that women will pursue disciplines in STEM, as well as their performance and career aspirations (Shapiro & Williams, 2012). This can be tied to gender-related stereotypes as well as racial or ethnic stereotypes. For example, in a study conducted by Steele and Aronson (1995), African American students underperformed in relation to their actual abilities on a standardized test when asked to disclose their race prior to the examination. The authors concluded that this could be attributed to the pressures associated with stereotypes about African Americans' lack of intellectual ability (Shapiro & Williams, 2012). Stereotype threats are situational in nature and do not necessarily mean that the individual subscribes to the stereotype (Smith, 2006).

In 2006, African American students received only 8% of STEM bachelor's degrees as compared to 77% of White and Asian American students (NSF, 2011; Stolle-McAllister, St. Domingo, & Carillo, 2010). Though minorities are just as likely to enroll in STEM programs as their White counterparts, African American students are less likely to complete a STEM program. Low participation in STEM fields can be attributed to cultural expectations, historical policies, and systematic discriminatory practices targeting African Americans and other underrepresented minorities. Most importantly, low participation can also be attributed to the absence of precollege coursework in science and mathematics (Tsui, 2007).

Undergraduate experiences directly contribute to degree attainment in STEM fields (Borum & Walker, 2012). While pursuing STEM degrees, African American females face numerous challenges, including lack of academic preparation in mathematics and science, issues with the classroom and environment, and isolating institutional climates (Jackson, 2013). For minority and low-income students, low levels of science and mathematics preparation originate from the lack of rigorous coursework at the K–12 level as well as the lack of qualified teachers (Perna et al., 2009). Perna et al. (2009) found that financial challenges also present barriers to educational and occupational attainment.

There are number of factors that influence degree attainment and success in STEM fields, such as gender and race (Jackson, 2013). Faculty members also assume an important responsibility in shaping the experiences of African American females, as they can foster supportive academic environments that encourage success and influence motivation (Jackson, 2013). Peer relationships and support from family, mentors, and the community also influence the completion of a STEM degree (Ong et al., 2011). Psychological constructs, such as self-efficacy and stereotype threats, as well as the perceptions of faculty and classmates regarding the abilities of African American females further impact success (Jackson, 2013).

Summary

Individuals develop career interests and select academic majors for a variety of reasons. Self-efficacy is a key influence in the academic major selection process, as confidence in one's ability directly influences career choice. As such, the SCCCM provides a suitable framework to ascertain the relationship between academic major choice and career choice. African American females must confront a number of challenges, including stereotype threat and the double bind, when entering the STEM career pipeline. The following chapter describes details specific to the research design, methodology, population and sample, instrumentation, data collection and procedures, data analysis, and limitations of the study.

CHAPTER 3

METHODOLOGY

This mixed-methods study investigated the significant factors influencing STEM major selection by African American female undergraduates at a research university in southeastern Virginia. The level of influence on each survey item measured these factors. This chapter provides an overview of the methodology used in the study, including the research hypothesis, design, setting, population and sample, instrumentation, data collection and analysis procedures, and limitations.

Hypothesis

The following hypothesis applies to Research Question 2, written in the literary null hypothesis form, which is concept oriented and nondirectional (Creswell, 1994). Only one hypothesis applied to the research, as Research Question 1 was descriptive in nature, and Research Question 3 was analyzed using a phenomenological qualitative approach.

Research Question 2: What are the statistically significant factors, if any, unique to African American female undergraduate students as compared to non-African American female undergraduates which influence STEM major selection at a public research university in southeastern Virginia?

Hypothesis 1: There are no statistically significant factors influencing STEM major selection unique to female undergraduate African American students as compared to non-African American female undergraduates at a public research university in southeastern Virginia.

Research Design

As discussed in Chapter 2, the SCCCM comprised the conceptual framework of this mixed-methods study. *Ex post facto* survey research utilizing a questionnaire to collect data from participants was conducted. Survey research allows the researcher to investigate a sample of a population to acquire information about a phenomenon (Leedy & Ormrod, 2013). *Ex post facto* research allowed the researcher to focus on the outcome group of African American females pursuing STEM majors by studying students that already selected a STEM major, as opposed to students that were planning to select STEM (Leedy & Ormrod, 2013).

An online questionnaire was employed to conduct the survey. This allowed for generalizations to be made about the population based on the results. The questionnaire was adapted with permission from an instrument developed by Malgwi, Howe, and Burnaby (2005), which was designed to gain information rooted in the constructs of the SCCCM. These constructs include personal experiences, background, learning experiences, self-efficacy, goals, and outcome expectations, which impact students' decisions to pursue STEM fields of study. The instrument included quantitative items, influential factors rated on a 5-point Likert scale, and two open-ended questions related to the factors that contributed most and least to the students' success in STEM disciplines. Additionally, the questionnaire included five demographic items related to the participants' current major, age, transfer status, intent to pursue secondary education track, and academic class.

Setting

The site of this study was a public, coeducational research university located in southeast Virginia. Old Dominion University, located in Norfolk, Virginia, was founded in 1930. The university has nearly 25,000 students (21,101 undergraduate) over its main campus and three satellite locations (Old Dominion University, 2016a). It has been ranked one of the best southeastern colleges by Princeton Review and offers 70 bachelor's degree programs (Old Dominion University, 2016a). Its business and research initiatives contribute nearly $2 billion to the economy, and the institution generates $88 million in annual research funding in several fields (Old Dominion University, 2016a).

Population and Sample

Table 1 illustrates the breakdown of all STEM degrees conferred by the research site. In 2014–2015, the university conferred 387 bachelor's degrees in engineering and technology and 642 bachelor's degrees in the sciences (including psychology). This accounted for 19% of the total degrees conferred at the university in the 2014–2015 academic year. Females accounted for 45% of the total STEM degrees awarded in 2014–2015.

Table 1

STEM Bachelor's Degrees Conferred by Gender 2014–2015

College	Gender			All
	Female	Male	Not Reported	
Engineering and Technology	51	336	0	387
Sciences	411	231	0	642
Total				1,029

Note. Source: Old Dominion University, 2016.

Tables 2 and 3 provide a breakdown of all students declared in a major in the College of Engineering and Technology and the College of Sciences for the Fall 2015 semester. A total of 1,495 students declared a major in the College of Engineering and Technology. Of these students, 204 students were females, 185 students were African American, and 24 students were African American females. A total of 1,502 students declared a major in the College of Sciences. Of these students, 729 students were females, 169 students were African American, and 103 students were African American females. It is important to note that as observed in the literature, only in the biological sciences have African American females outnumbered their African American male counterparts. In the College of Sciences, 80 African American females declared biology as their major in Fall 2015, compared to 33 African American males.

Table 2

Fall 2015 College of Engineering and Technology Headcount of Declared Majors

Program	Gender	Ethnicity								Total
		Blank	American Indian/ Alaska Native	Asian/ Pacific Islander	Black (N-H)	Hispanic	Missing/ Not Provided	Other	White (N-H)	
Eng. Tech.	F	1	0	0	2	0	1	0	1	5
	M	8	0	2	4	1	0	0	2	17
Civil Eng. Tech.	F	13	0	2	5	2	2	0	6	30
	M	64	1	5	19	5	2	2	61	159
Civil Eng.	F	18	1	3	4	1	0	0	12	39
	M	59	1	9	9	2	2	2	43	127
Computer Eng.	F	7	0	3	2	0	0	0	3	15
	M	20	0	7	8	2	1	0	23	61
Electrical Eng.	F	5	0	3	2	2	0	1	5	18
	M	65	1	14	21	5	3	0	53	162
Electrical Eng. Tech.	F	5	0	1	8	0	0	0	6	20
	M	64	0	13	26	4	3	0	47	157
Eng. Tech.	F	2	0	0	0	0	0	0	0	2
	M	15	0	0	4	2	1	0	10	32
Mech. Eng. Tech.	F	8	0	1	5	1	0	1	8	24
	M	79	0	4	17	6	7	1	91	205
Mech. Eng.	F	17	0	2	6	0	0	2	19	46
	M	106	3	19	37	15	4	3	134	321
Modeling and Simulation Eng.	F	4	0	0	0	1	0	0	0	5
	M	30	0	1	6	0	0	1	12	50
Total		590	7	89	185	49	26	13	536	1495

Note. Eng. = Engineering; Tech. = Technology; Mech. = Mechanical; F = Female; M = Male; N-H = Non-Hispanic. Source: Old Dominion University, 2016.

Table 3

Fall 2015 College of Sciences Headcount of Declared Majors

Program	Gender	Ethnicity								Total
		Blank	Amer. Indian/ Alaska Native	Asian/ Pacific Islander	Black (N-H)	Hispanic	Missing/ Not Provided	Other	White (N-H)	
Biochemistry	F	9	0	1	2	2	1	0	9	24
	M	3	0	1	2	1	0	0	7	14
Biology	F	250	4	33	78	18	7	1	126	517
	M	107	5	21	33	11	4	3	95	279
Biology: Teacher Preparation	F	12	0	0	2	0	0	0	4	18
	M	2	0	0	0	0	0	0	0	2
Chemistry	F	4	0	0	0	0	0	0	5	9
	M	7	0	2	1	0	0	0	8	18
Chemistry: Teacher Preparation	M	0	0	0	0	0	0	0	1	1
Computer Sciences	F	37	0	3	12	1	0	0	16	69
	M	181	0	17	25	10	4	2	97	336
Mathematics	F	21	0	2	3	2	0	0	6	34
	M	14	0	3	2	0	0	1	14	34
Mathematics: Teacher Preparation	F	13	0	1	6	1	0	0	6	27
	M	6	0	0	0	0	0	0	4	10
Ocean and Earth Sciences: Oceanogra-phy	F	9	0	0	0	0	1	0	7	17
	M	10	0	0	2	0	0	0	6	18
Ocean and Earth Sciences: Earth Science Education	F	0	0	0	0	0	0	0	3	3
	M	0	0	1	0	0	0	0	4	5
Physics	F	6	0	0	0	0	0	0	3	9
	M	36	0	1	1	2	2	0	9	51
Physics**:** Secondary Education	F	2	0	0	0	0	0	0	0	2
	M	4	0	0	0	0	0	0	0	4
Total		733	9	86	169	48	19	7	430	1501

Note. F = Female; M = Male; Amer. = American; N-H = Non-Hispanic. Psychology excluded. Source: Old Dominion University, 2016.

African American undergraduate females who had declared a major in STEM comprised the target population for this study. The Office of Institutional Effectiveness and Assessment identified students pursuing applicable majors during the time of data collection. These students received an e-mail invitation to participate in the study (see Appendix B). Due to the relatively low number of African American females majoring in STEM, the survey instrument was sent to the entire population in order to yield a substantial number of responses. In total, 210 African American females received the questionnaire. Forty-one responded yielding a 19.5% response rate. As a basis for comparison, a second set data was collected. All non-African American undergraduate females majoring in STEM also received the survey instrument to determine if there was a significant difference between factors influencing STEM major selection between the two groups. In total, 763 non-African American females received the questionnaire. Of this group, 178 responded equaling a response rate of 23.3%.

Instrumentation

The instrument was adapted from a questionnaire developed to determine influences on students' choice of business major called "Influences on Choice of Major" (Malgwi, Howe, & Burnaby, 2005). The original instrument contained items to collect demographic information including class standing, sex, age, transfer status, and number of major changes (Malgwi et al., 2005). Students also evaluated the influence of a list of factors on their original choice of a major on a 5-point Likert scale, as well as positive and negative factors following a change of major (Malgwi et al., 2005). The researcher administered the survey instrument (Influences on Choice of Academic Major Questionnaire) via Qualtrics, a web-based survey platform. The questionnaire included 34 items to collect quantitative data as well as open-ended questions to ascertain how influential particular factors were in STEM major selection, the factors most and least impactful on the students' success, and demographic characteristics (see Appendix C).

The first 27 items on the questionnaire collected data on the extent of the impact of various factors a 4-point Likert scale ranging from "not at all" to "very influenced," with an option for "does not apply." This allowed limited responses to discern significant influences on STEM major selection. Two open-ended questions further explored the factors influencing major selection and student success. The last five items collected information about the students' current major, intent to become a teacher in secondary education, age, transfer status, and academic class. All data collected were self-reported.

Pilot Study to Validate Survey Instrument

A pilot study was conducted to test the initial reliability and validity of the survey instrument. Reliability refers to whether the scores to items on an instrument are consistent across all constructs (Creswell, 2003). Validity refers to "the extent to which the instrument measures what it is intended to measure" (Leedy & Ormrod, 2013, p. 89). As a first step, experts in the field reviewed the instrument for face, content, and construct validity, ensuring that the questionnaire contained the appropriate items to obtain the desired information. Based upon the expert review, the preliminary instrument was amended from 26 to 27 items, splitting an item that had originally been combined. The revised survey instrument was then administered electronically via e-mail to the sample of 30 African American undergraduate females who had declared majors in STEM (M_{age} = 21.80 years, SD_{age} = 4.11). Tables 4, 5, 6, and 7 illustrate the specific characteristics of the pilot study sample.

Table 4

Majors of Pilot Study Participants

Major	Frequency	%
Biochemistry	3	10
Biology	4	13.3
Biology with Premedical, Dental, or Veterinary emphasis	5	16.7
Chemistry	2	6.7
Civil Engineering	1	3.3
Civil Engineering Technology	1	3.3
Computer Engineering	2	6.7
Computer Science	1	3.3
Electrical Engineering	3	10
General Engineering Technology	2	6.7
Mathematics – Secondary Education	1	3.3
Mechanical Engineering	2	6.7
Ocean and Earth Science	1	3.3
Physics	2	6.7

Table 5

Age of Pilot Study Participants

Age	Frequency
18	2
19	8
20	7
21	5
23	2
24	1
28	1
29	1
30	1
32	2

Table 6

Academic Class of Pilot Study Participants

Academic Class	Frequency	%
Freshman	9	30
Sophomore	5	16.7
Junior	10	33.3
Senior	6	20

Table 7

Transfer Status of Pilot Study Participants

Transfer Student	Frequency	%
Yes	5	16.7
No	25	83.3

The data were collected and coded prior to performing statistical analysis. The software program, Statistical Package for Social Sciences (SPSS) Version 22, was utilized to analyze the questionnaire responses. Descriptive statistics were used to describe the basic features of the data and the characteristics of the sample. Factor analysis determined what, if any, underlying structure existed for the scale. Prior to the analysis, evaluation of linearity and normality occurred and met conditions. Principal components analysis also occurred using a varimax rotation. The analysis retained eight components (see Table 8), which comprise 84.43% of the total variance explained. The researcher found 68 (20%) nonredundant residuals with absolute values greater than .05. Analysis of the scree plot and residuals also supported the retention of the eight components. The researcher interpreted factor loadings and labeled them as constructs related to confidence, influential people, introduction and aptitude for STEM, outcome and goals, influence of family and friends, high school coursework, high school teacher, and high school STEM experience. Reliability statistics ran on the entire STEM major selections scale resulted in a relatively high reliability with a Cronbach's α of .79.

Table 8

Factor Loadings for Pilot Study

Factor	Constructs
1	Related to confidence
2	Related to influential people
3	Introduction to/aptitude for STEM
4	Related to outcome/goals
5	Related to influence of family/friends
6	Related to high school coursework
7	Related to high school teacher
8	Related to high school STEM experience

Data Analysis

The survey results for the current study were extracted utilizing Qualtrics followed by statistical analysis using SPSS. Descriptive, comparative, and inferential statistical analyses were conducted on the quantitative data collected from the instrument to explore the factors that influenced STEM major selection and success. Responses were analyzed from the open-ended questions utilizing a qualitative approach, as discussed later in this chapter. Table 9 lists each research question and the statistical method used to analyze the data collected.

Table 9

Research Questions and Statistical Analysis

Research Question	Method of Analysis
1. What are the factors, if any, which influence African American female undergraduate students to select STEM majors at a public research university in southeastern Virginia?	Descriptive
2.What are the statistically significant factors, if any, unique to African American female undergraduate students as compared to non-African American female undergraduates, which influence STEM Major selection at a public research university in southeastern Virginia?	Inferential (*t*-Test)
3.What are the factors, if any, which impact the success of African American female undergraduate students in STEM majors at a public research university in southeastern Virginia?	Qualitative

Descriptive Statistics

Descriptive statistics were used to answer Research Question 1: "What are the factors, if any, which influence African American female undergraduate students to select STEM majors at a public research university in southeastern Virginia?" Specifically, frequencies and percentages displayed the demographic characteristics of the sample. The demographic information included current major, intent to become a teacher in secondary education, age, transfer status, and academic class. Additionally, the average influence levels of each of the items, without regard for level of significance, indicated the most influential factors for STEM major selection for African American undergraduate females.

Inferential Statistics

Inferential statistic analyses were used to answer Research Question 2: "What are the statistically significant factors, if any, unique to female undergraduate African American students as compared to non-African American female undergraduates which influence STEM Major selection at a public research university in southeastern Virginia?" Inferential statistics allow researchers to draw conclusions about large populations with relatively small samples (Leedy & Ormrod, 2013, p. 277). An independent samples *t*-test was used to compare the mean scores for undergraduate African American females majoring in STEM and non-African American females majoring in STEM on each influential factor on the survey instrument. The samples sizes for these two groups were not equal, therefore the Levene's test for equality of variances was used to test for the assumption of approximately equal variances. The critical value utilized for the analyses was .05. The Levene's test dictated that if the *p*-value was less than or equal to the alpha level of .05, then the variances were unequal. If the *p*-value was larger than the alpha level of .05, then the variances were equal. Utilizing a two-tailed test, the significance value determined the significance of the relationship between the two groups. A statistically significant relationship was denoted if $p \leq .05$. If $p > .05$, the null hypothesis was not rejected, implying no sufficient evidence existed to denote a statistically significant relationship. The null hypothesis of no statistically significant influential factors was rejected for *p*-values above .05.

Qualitative Analysis

Qualitative analysis was conducted to answer Research Question 3: "What are the factors, if any, which impact the success of African American female undergraduate students in STEM majors at a public research university in southeastern Virginia?" The open-ended questions on the survey instrument explored this research question. A phenomenological approach was used to analyze and code the data. Phenomenology is a research tradition that seeks "to discover and describe the meaning or essence of participants' lived experiences, or knowledge as it appears to consciousness" (Hays & Singh, 2012, p. 50). This approach allowed for an exploration of the factors that impact the success of African American females majoring in STEM fields of study and to describe the phenomenon to find meaning in the experiences of the participants (Hays & Singh, 2012; Patton, 2002). Based on the responses to the open-ended questions, open, axial, and selective coding processes were used. Themes and descriptions based on the coding process were developed.

Ethical Considerations

Several ethical considerations were addressed in this study. Prior to commencing the study, the Human Subjects Review Board within the College of Education approved the use of human subjects in the study (see Appendix A). Participants understood that the process was completely voluntary and that their responses would remain confidential. The researcher was prudent to avoid disclosing information that would lead to identifying participants. Only the researcher maintained access to individual responses to the questionnaire. Data was deidentified upon collection, eliminating the link between individual responses and participants. Data collected (i.e., questionnaire data, demographic information, and informed consent information) were saved on an encrypted, password-protected computer stored in a locked room accessible only to the researcher. The key to the room was stored separately and securely.

Methodological Limitations

The following limitations applied to this study:

1. Convenience sampling was employed due to access to a population at a specific institution in the region. This sampling method may lead to contamination and may affect external validity. This may affect the researcher's ability to generalize results to different populations and settings.
2. There was a risk of nonresponse error during the data collection process. This error could have affected external validity because the sample may not be representative of the defined population.
3. Self-reported data obtained from a survey instrument was obtained, meaning that much of the data collected was based on the participants' memories, perceptions, and inclination towards social desirability.
4. This study did not address significant factors influencing other underrepresented populations, graduate students, former students, or faculty.
5. The population of African American female students majoring in STEM was small. Future researchers may find it necessary to obtain samples from multiple institutions or at different periods of time to support findings.

Summary

Chapter 3 described the methods of investigation used for this study. This chapter highlighted the hypothesis, research design, setting, population and sample, validation of the survey instrument, data analysis, ethical considerations, and limitations of the study. The next chapter details the results and findings of this research.

CHAPTER 4

FINDINGS

Overview

This chapter provides an overview of the quantitative and qualitative findings of this study organized in three sections. The first section provides a detailed report of the descriptive analysis of STEM majors, including the demographic characteristics of the sample (i.e., current major, intent to enter secondary education, age, transfer status, and academic class) as well as frequencies and percentages for the influential factors for the participants. The second section reviews the findings of the inferential statistical analysis on the unique factors influencing African American females compared to non-African American females. Lastly, the third section highlights the findings from the open-ended questions.

Descriptive Analysis

In response to Research Question 1 ("What are the factors, if any, which influence African American female undergraduate students to select STEM majors at a public research university in southeastern Virginia?"), this section details the demographic characteristics of each sample and the reported influential factors for STEM major selection for African American females. A survey of the target population (i.e., undergraduate African American females majoring in STEM) garnered 38 respondents. The comparison group (i.e., undergraduate non-African American females majoring in STEM) garnered 165 respondents.

Demographic Characteristics of Samples

Most respondents reported their current major, intent to enter secondary education as a teacher, age, transfer status, and academic class. In order to gain an understanding of the background characteristics of the sample, Table 10 presents a summary and detailed description of results.

Table 10

Demographic Characteristics of Samples

Demographic Characteristics	African American Females (*n* = 34)		Non-African American Females (*n* = 130)		Difference*
	n	%	*n*	%	%
Current Major					
Sciences	21	61.8	79	60.8	1
Engineering and Technology	13	38.2	51	39.2	-1
Teacher Preparation					
No	31	91.2	111	85.4	5.80
Yes	3	8.8	19	14.6	-5.80
Age					
Under 18	0	0.0	0	0.0	0.00
18-24	21	61.8	88	67.7	-5.90
25-34	13	38.2	32	24.6	13.60
35-44	0	0.0	4	3.1	-3.10
45-54	0	0.0	5	3.9	-3.90
55-64	0	0.0	1	0.8	-0.80
65 and over	0	0.0	0	0.0	0.00
Prefer not to answer	0	0.0	0	0.0	0.00
Transfer Student					
No	18	52.9	71	54.6	-1.70
Yes	16	47.1	59	45.4	1.70
Academic Class					
First Year	1	2.9	1	0.8	2.10
Second Year	5	14.7	12	9.2	5.50
Third Year	10	29.4	25	19.2	10.20
Fourth Year	12	35.3	57	43.9	-8.60
Fifth Year or More	6	17.7	35	26.9	-9.20

Note. * Difference was calculated by subtracting African American females from Non-African American females. A positive percentage indicates a higher percentage for Non-African American females.

Current major. Of the African American females sampled, 61.8% of respondents reported a current major in the sciences (i.e., biochemistry, biology, chemistry, mathematics and statistics, ocean and earth science, and physics), while 38.2% of respondents reported a current major in engineering and technology (i.e., civil engineering, civil engineering technology, computer engineering, computer science, electrical engineering, electrical engineering technology, general engineering technology, mechanical engineering, mechanical engineering technology, and modeling and simulation engineering). For the comparison group, non-African American undergraduate female students, 60.8% of respondents reported a current major in the sciences, while 39.2% reported a current major in engineering and technology.

Teacher preparation. Regarding whether or not students intended to pursue a STEM secondary education track, 91.2% of African American females responded negatively, while 8.8% of these respondents responded positively. Of non-African American females, 85.4% responded negatively, while 14.6% responded positively.

Age. In terms of age, 61.8% of African American females sampled were between the ages of 18 and 24 and 38.2% were between the ages of 25 and 34. Of non-African American females sampled, 67.7% were between the ages of 18 and 24, 24.6% were between the ages of 25 and 34, 3.1% were between the ages of 35 and 44, 3.9% were between the ages of 45 and 54, and, 0.8% were between the ages of 55 and 64.

Transfer status. Regarding whether students transferred from a community college prior to attending their current institution, of African American females, 52.9% responded negatively, while 47.1% responded positively. Of non-African American females, 54.6% responded negatively, while 45.4% responded positively.

Academic class. Of African American females, 2.9% were in their first year, 14.7% were in their second year, 29.4% were in their third year, 35.4% were in their fourth year, and 17.7% were in their fifth year or more. Of non-African American females, 0.8% were in their first year, 9.2% were in their second year, 19.2% were in their third year, 43.9% were in their fourth year, and 26.9% were in their fifth year or more.

Summary of demographic characteristics

1. The majority of undergraduate African American females majoring in STEM (61.8%) and undergraduate non-African American females majoring in STEM (60.8%) declared majors in the sciences.
2. Only a small percentage of African American females (8.8%) and non-African American females (14.6%) intended to pursue secondary education.
3. The largest percentage of African American females (61.8%) and non-African American females (67.7%) were between the ages of 18 and 24.
4. A substantial number of both African American females (47.1%) and non-African American females (45.4%) transferred from a community college prior to attending their current institution.
5. Many African American females (35.3%) and non-African American females (43.9%) were in their fourth year at their current institution.

Influential Factors

Respondents rated factors influencing their selection of a STEM major by a list of 27 items grouped into five categories: interests and skills, career goals, personal interactions, coursework and activities, and confidence. In response to Research Question 1, the following presents detailed descriptions of the findings for the influential factors for African American females majoring in STEM.

Interests and skills. Table 11 reports the influential factors in selecting a STEM major related to interests and skills: specific interest in subject, aptitude test, career inventory, and the reputation of the university, college, or department. The majority (78.95%) of African American females majoring in STEM indicated they were "very influenced" by specific interest in the subject, with a smaller percentage (15.79%) indicating they were "somewhat influenced." As it relates to whether an aptitude test served as an influential factor, the majority of respondents (57.89%) indicated they were "not at all" influenced by this item. Only 7.89% of respondents indicated they were "very influenced" by aptitude tests. Concerning career inventories, 31.58% of the sample was "very influenced," while 36.84% were "somewhat influenced." Lastly, an equal percentage of respondents (28.95%) were either "somewhat influenced" or "not at all" influenced by the reputation of the university, college, or department.

Table 11

Influential Factors Related to Interests and Skills

Influential Factors: Interests and Skills	African American Females (*n* = 38)	
	n	%
Specific interest in subject		
Not at all	0	0.00
Slightly influenced	2	5.26
Somewhat influenced	6	15.79
Very influenced	30	78.95
Does not apply to me	0	0.00
Aptitude test (e.g., PSAT, SAT, ACT)		
Not at all	22	57.89
Slightly influenced	4	10.53
Somewhat influenced	5	13.16
Very influenced	3	7.89
Does not apply to me	4	10.53
Career inventory		
Not at all	9	23.68
Slightly influenced	2	5.26
Somewhat influenced	14	36.84
Very influenced	12	31.58
Does not apply to me	1	2.63
Reputation of university/college/department		
Not at all	11	28.95
Slightly influenced	6	15.79
Somewhat influenced	11	28.95
Very influenced	10	26.32
Does not apply to me	0	0.00

Career goals. Table 12 presents the influential factors in selecting a STEM major related to career goals: availability of career or job opportunities after graduation, high level of compensation (pay) in the field, future leadership potential, and type of work. The vast majority of undergraduate African American females majoring in STEM (68.42%) were “very influenced” by the availability of career or job opportunities after graduation, with only a small percentage (5.26%) indicating “not at all.” For prestige in field, 50% of respondents were “very influenced” by this factor, while 26.32% were “somewhat influenced.” Regarding the high level of compensation in the field, 60.53% of respondents were “very influenced” by this factor. Regarding future leadership potential, 55.26% of respondents were “very influenced,” and the vast majority of respondents (76.32%) were also “very influenced” by the type of work, with only a small percentage (5.26%) “not at all” influenced.

Table 12

Influential Factors Related to Career Goals

Influential Factors: Career Goals	African American Females (*n* = 38)	
	n	%
Availability of career/job opportunities after graduation		
Not at all	2	5.26
Slightly influenced	4	10.53
Somewhat influenced	6	15.79
Very influenced	26	68.42
Does not apply to me	0	0.00
Job status (prestige of field)		
Not at all	5	13.16
Slightly influenced	4	10.53
Somewhat influenced	10	26.32
Very influenced	19	50.00
Does not apply to me	0	0.00
High level of compensation (pay) in this field		
Not at all	1	2.63
Slightly influenced	3	7.89
Somewhat influenced	11	28.95
Very influenced	23	60.53
Does not apply to me	0	0.00
Future leadership potential		
Not at all	6	15.79
Slightly influenced	5	13.16
Somewhat influenced	6	15.79
Very influenced	21	55.26
Does not apply to me	0	0.00
Type of work		
Not at all	2	5.26
Slightly influenced	0	0.00
Somewhat influenced	7	18.42
Very influenced	29	76.32
Does not apply to me	0	0.00

Personal Interactions. Table 13 reports the influential factors in selecting a STEM major related to personal interactions: parents/guardians, family members (not parent/guardian), friends/peers, religious leaders, high school teachers, high school guidance counselors, college academic advisors, and college instructors/professors. Only 26.32% of African American females reported being “very influenced” by a parent or guardian, with the majority of respondents (39.47%) indicating they were “not at all” influenced by a parent or guardian. The vast majority of respondents also indicated they were “not at all” influenced by family members (55.26%), friends or peers (57.89%), religious leaders (81.58%), high school teachers (60.53%), high school guidance counselors (78.95%), college academic advisors (63.16%), and college instructors or professors (52.63%).

Coursework and activities. Table 14 reports the influential factors in selecting a STEM major related to coursework and activities, which are precollege (high school) coursework in mathematics, science, and technology, precollege STEM experience (e.g., field trip, activities, event), STEM-related club or organization in high school, and introductory college courses. Of African American females, 35.14% indicated they were “very influenced” by precollege coursework in mathematics, while 27.03% were “not at all” influenced. Regarding precollege coursework in science, the majority of students (59.46%) indicated they were “very influenced” by this factor. An equal percentage of students (35.14%) were either “very influenced” or “not at all” influenced by precollege coursework in technology. Many students (45.95%) were “very influenced” by a precollege STEM experience and 40.54% were “very influenced” by a STEM-related club or organization in high school. Regarding introductory college courses, 43.24% of respondents were “very influenced” by this factor, while 37.84% were not at all influenced.

Table 13

Influential Factors Related to Personal Interactions

Influential Factors: Personal Interactions	African American Females (*n* = 38)	
	n	%
Parent/guardian		
Not at all	15	39.47
Slightly influenced	9	23.68
Somewhat influenced	4	10.53
Very influenced	10	26.32
Does not apply to me	0	0.00
Family members (not parent/guardian)		
Not at all	21	55.26
Slightly influenced	6	15.79
Somewhat influenced	4	10.53
Very influenced	7	18.42
Does not apply to me	0	0.00
Friends/peers		
Not at all	22	57.89
Slightly influenced	8	21.05
Somewhat influenced	4	10.53
Very influenced	4	10.53
Does not apply to me	0	0.00
Religious leader (minister, priest, pastor)		
Not at all	31	81.58
Slightly influenced	4	10.53
Somewhat influenced	1	2.63
Very influenced	1	2.63
Does not apply to me	1	2.63
High school teacher		
Not at all	23	60.53
Slightly influenced	5	13.16
Somewhat influenced	4	10.53
Very influenced	6	15.79
Does not apply to me	0	0.00
High school guidance counselor		
Not at all	30	78.95
Slightly influenced	3	7.89
Somewhat influenced	4	10.53
Very influenced	1	2.63
Does not apply to me	0	0.00
College academic advisor		
Not at all	24	63.16
Slightly influenced	5	13.16
Somewhat influenced	5	13.16
Very influenced	4	10.53
Does not apply to me	0	0.00
College instruction/professor		
Not at all	20	52.63
Slightly influenced	6	15.79
Somewhat influenced	4	10.53
Very influenced	8	21.05
Does not apply to me	0	0.00

Table 14

Influential Factors Related to Coursework and Activities

Influential Factors: Coursework and Activities	African American Females (*n* = 38)	
	n	%
Precollege (high school) coursework in mathematics		
Not at all	10	27.03
Slightly influenced	6	16.22
Somewhat influenced	7	18.92
Very influenced	13	35.14
Does not apply to me	1	2.70
Precollege (high school) coursework in science		
Not at all	7	18.92
Slightly influenced	0	0.00
Somewhat influenced	8	21.62
Very influenced	22	59.46
Does not apply to me	0	0.00
Precollege (high school) coursework in technology		
Not at all	13	35.14
Slightly influenced	5	13.51
Somewhat influenced	4	10.81
Very influenced	13	35.14
Does not apply to me	2	5.41
Precollege (high school) science, technology, engineering, or mathematics (STEM) experience (e.g., field trip, activities, event)		
Not at all	10	27.03
Slightly influenced	2	5.41
Somewhat influenced	6	16.22
Very influenced	17	45.95
Does not apply to me	2	5.41
STEM-related club or organization in high school		
Not at all	12	32.43
Slightly influenced	2	5.41
Somewhat influenced	3	8.11
Very influenced	15	40.54
Does not apply to me	5	13.51
Introductory college courses		
Not at all	14	37.84
Slightly influenced	3	8.11
Somewhat influenced	4	10.81
Very influenced	16	43.24
Does not apply to me	0	0.00

Confidence. Table 15 presents the influential factors related to confidence: mathematics ability, confidence in ability to be successful in mathematics in college, confidence in science ability, and confidence in ability to be successful in science coursework in college. The majority of undergraduate African American female students (43.25%) were “very influenced” by their confidence in their mathematics ability, while 21.62% were "not at all" influenced by this factor. The majority of respondents (40.54%) were also "very influenced" by their confidence in their ability to be successful in mathematics in college. The majority of students were "very influenced" by their confidence in their science ability and 62.16% were "very influenced" by their confidence in their ability to be successful in science coursework in college.

Table 15

Influential Factors Related to Confidence

Influential Factors: Confidence	African American Females (*n* = 38)	
	n	%
Confidence in mathematics ability		
Not at all	8	21.62
Slightly influenced	6	16.22
Somewhat influenced	7	18.92
Very influenced	16	43.24
Does not apply to me	0	0.00
Confidence in ability to be successful in mathematics in college		
Not at all	8	21.62
Slightly influenced	6	16.22
Somewhat influenced	8	21.62
Very influenced	15	40.54
Does not apply to me	0	0.00
Confidence in science ability		
Not at all	1	2.70
Slightly influenced	6	16.22
Somewhat influenced	8	21.62
Very influenced	22	59.46
Does not apply to me	0	0.00
Confidence in ability to be successful in science coursework in college		
Not at all	2	5.41
Slightly influenced	6	16.22
Somewhat influenced	6	16.22
Very influenced	23	62.16
Does not apply to me	0	0.00

Summary of Influential Factors

1. The majority of undergraduate African American female students surveyed were "very influenced" to select a STEM major by specific interest in the subject and "not at all" influenced to select a STEM major by aptitude tests.

2. Career goals highly influenced respondents to select a STEM major, particularly the type of work that would be pursued and the expectation of availability of career opportunities after graduation.
3. Overwhelmingly, African American females were not influenced to select a STEM major by personal interactions with the exception of parents or guardians.
4. Precollege coursework in science and introductory college courses highly influenced students to select a STEM major.
5. Each of the confidence factors highly influenced the majority of respondents to select a STEM major. The confidence factors were confidence in mathematics ability, confidence in ability to be successful in mathematics in college, confidence in science ability, and confidence in ability to be successful in science coursework in college.

Inferential Statistical Analysis

To respond to Research Question 2 ("What are the statistically significant factors, if any, unique to female undergraduate African American students as compared to non-African American female undergraduates which influence STEM Major selection at a public research university in southeastern Virginia?"), the researcher conducted inferential statistics. The researcher used an independent samples *t*-test to compare the mean scores of the two groups (race/ethnicity) on the statistically significant factors unique to female undergraduate African American students as compared to non-African American female undergraduates. The grouping variable (race/ethnicity) was 1 = African American females and 2 = non-African American females. The section of the survey instrument addressing Research Question 2 contained 27 items or influential factors grouped into five categories. The scale for this section was a 4-point Likert scale ranging from "not at all" to "very influenced," with an option of "does not apply."

Table 16 presents the means of the independent samples *t*-test of influences on STEM major selection by race and/or ethnicity. Appendix D shows the full details of the *t*-tests. A detailed description of results by category is provided below.

Table 16

Means, Standard Deviations, and T-Test Results for Influences on STEM Major Selection

Factor	African American Female		Non-African American Female		*t*	*df*	*p*	Confidence Interval	
	M	*SD*	*M*	*SD*				Lower	Upper
Specific interest in subject	3.74	0.55	3.74	0.65	-0.03	198.00	0.97	-0.23	0.22
Aptitude tests (e.g. PSAT, SAT, ACT)	1.50	1.11	1.36	0.87	0.74	48.16	0.46	-0.25	0.53
Career inventory	2.71	1.23	2.46	1.28	1.11	198.00	0.27	-0.20	0.70
Reputation of university/college/department	2.53	1.18	2.12	1.04	2.09	198.00	0.04*	0.02	0.78
Availability of career/job opportunities after graduation	3.47	0.89	3.32	0.91	0.93	194.00	0.36	-0.17	0.47
Job status (prestige of field)	3.13	1.07	2.97	1.07	0.85	194.00	0.40	-0.22	0.54
High level of compensation (pay) in field	3.47	0.76	2.94	1.08	2.91	194.00	0.00*	0.17	0.90
Future leadership potential	3.11	1.16	2.70	1.09	2.02	194.00	0.05	0.01	0.80
Type of work	3.66	0.75	3.65	0.65	0.10	194.00	0.92	-0.23	0.25
Parent/guardian	2.24	1.24	2.25	1.25	-0.06	192.00	0.95	-0.46	0.43
Family members (not parent/guardian)	1.92	1.19	1.85	1.06	0.35	192.00	0.73	-0.32	0.46
Friends/peers	1.74	1.03	1.85	1.00	-0.60	192.00	0.55	-0.47	0.25
Religious leader (minister, priest, pastor)	1.21	0.66	0.99	0.57	2.10	192.00	0.04*	0.01	0.43
High school teacher	1.82	1.16	1.78	1.06	0.21	192.00	0.84	-0.35	0.43
High school guidance counselor	1.37	0.79	1.18	0.72	1.42	192.00	0.16	-0.07	0.45
College academic advisor	1.71	1.06	1.42	0.81	1.56	48.02	0.13	-0.08	0.66
College instructor/professor	2.00	1.23	2.08	1.18	-0.39	192.00	0.70	-0.51	0.34
Precollege (high school) coursework in mathematics	2.57	1.30	2.67	1.19	-0.47	184.00	0.64	-0.54	0.34
Precollege (high school) coursework in science	3.22	1.16	2.77	1.18	2.09	184.00	0.04*	0.03	0.88
Precollege (high school) coursework in technology	2.35	1.42	3.23	1.02	-3.54	45.67	0.00*	-1.38	-0.38
Precollege (high school) science, technology, engineering, or mathematics (STEM) experience (e.g., field trip, activities, event)	2.70	1.43	3.23	1.02	-2.13	45.40	0.04*	-1.04	-0.03
STEM-related club or organization in high school	2.30	1.60	2.25	1.15	0.15	45.44	0.88	-0.52	0.60
Introductory college courses	2.59	1.38	2.90	1.15	-1.25	48.61	0.22	-0.80	0.19
Confidence in mathematics ability	2.84	1.21	1.90	1.22	4.22	188.00	0.00*	0.50	1.38
Confidence in ability to be successful in mathematics in college	2.81	1.20	2.32	1.36	2.01	188.00	0.05*	0.01	0.97
Confidence in science ability	3.38	0.86	1.61	1.32	9.94	82.49	0.00*	1.41	2.12
Confidence in ability to be successful in science in college	3.35	0.95	2.05	1.25	7.00	69.34	0.00*	0.93	1.67

Note. $^*p \leq .05$.

Interests and Skills

Specific interest in subject mean scores were the same for African American and non-African American females (*M* = 3.74, *SD* = .065), which was statistically nonsignificant (*t*[198] = -0.03, *p* = 0.97, two-tailed). Aptitude tests mean scores for African American (*M* = 1.50, *SD* = 1.11) and non-African American females (*M* = 1.36, *SD* = 0.87) resulted in a difference of 0.14, which was statistically nonsignificant (*t*[48.16] = 0.74, *p* = 0.46, two-tailed). Career inventory mean scores for African American females (*M* = 2.71, *SD* = 1.23) and non-African American females (*M* = 2.46, *SD* = 1.28) resulted in a difference of 0.25, which was statistically nonsignificant (*t*[198] = 1.11, *p* = 0.27, two-tailed). Reputation of university, college, or department mean scores for African American (*M* = 2.53, *SD* = 1.18) and non-African American females (*M* = 2.12, *SD* = 1.04) resulted in a difference of 0.41, which was statistically significant (*t*[198] = 2.09, *p* = .04, two-tailed). This suggests that African American females were slightly more influenced by the reputation of the university, college, or department than non-African American females.

Career Goals

Availability of job or career opportunities after graduation mean scores for African American (*M* = 3.47, *SD* = 0.89) and non-African American females (*M* = 3.32, *SD* = 0.91) resulted in a difference of 0.15, which was statistically nonsignificant (*t*[194] = 0.93, *p* = 0.36, two-tailed). Job status (prestige of field) mean scores for African American (*M* = 3.13, *SD* = 1.07) and non-African American females (*M* = 2.97, *SD* = 1.07) resulted in a difference of 0.16, which was statistically nonsignificant (*t*[194] = 0.85, *p* = 0.40, two-tailed). High level of compensation (pay) in field mean scores for African American (*M* = 3.47, *SD* = 0.76) and non-African American females (*M* = 2.94, *SD* = 1.08) resulted in a difference of 0.53, which was statistically significant between the groups (t[194] = 2.91, p = 0.00, two-tailed). This suggests that African American females were more influenced by compensation than non-African American females. Future leadership potential mean scores for African American (M = 3.11, SD = 1.16) and non-African American females (M = 2.70, SD = 1.09) resulted in a difference of 0.41, which was statistically nonsignificant (t[194] = 2.02, p = 0.05, two-tailed). Finally, type of work mean scores for African American (M = 3.66, SD = 0.75) and non-African American females (M = 3.65, SD = 0.65) resulted in a difference of 0.01, which was statistically nonsignificant (t[194] = 0.10, p = 0.92, two-tailed).

Personal Interactions

Parent or guardian mean scores for African American (M = 2.24, SD = 1.24) and non-African American females (M = 2.25, SD = 1.25) resulted in a difference of -0.01, which was statistically nonsignificant (t[192] = -0.06, p = 0.95, two-tailed). Family members (not parent or guardian) mean scores for African American (M = 1.92, SD = 1.19) and non-African American females (M = 1.85, SD = 1.06) resulted in a difference of 0.07, which was statistically nonsignificant (t[192] = 0.35, p = 0.73, two-tailed). Friends or peers mean scores for African American (M = 1.74, SD = 1.03) and non-African American females (M = 1.85, SD = 1.00) resulted in a difference of -0.11, which was statistically nonsignificant (t[192] = -0.60, p = 0.55, two-tailed). Religious leader (minister, priest, pastor) mean scores for African American (M = 1.21, SD = 0.66) and non-African American females (M = 0.99, SD = 0.57) resulted in a difference of 0.22, which was statistically significant (t[192] = 2.10, p = 0.04, two-tailed). This suggests that African American females were more influenced by religious leaders than non-African American females. High school teacher mean scores for African American (M = 1.82, SD = 1.16) and non-African American females (M = 1.78, SD = 1.06) resulted in a difference of

0.04, which was statistically nonsignificant (*t*[192] = 0.21, *p* = 0.84, two-tailed). High school guidance counselor mean scores for African American (*M* = 1.37, *SD* = 0.79) and non-African American females (*M* = 1.18, *SD* = 0.72) resulted in a difference of 0.19, which was statistically nonsignificant (*t*[192] = 1.42, *p* = 0.16, two-tailed). College academic advisor mean scores for African American (*M* = 1.71, *SD* = 1.06) and non-African American females (*M* = 1.42, *SD* = 0.81) resulted in a difference of 0.29, which was statistically nonsignificant (*t*[48.02] = 1.56, *p* = 0.13, two-tailed). Finally, college instructor or professor mean scores for African American (*M* = 2.00, *SD* = 1.23) and non-African American females (*M* = 2.08, *SD* = 1.18) resulted in a difference of -0.08, which was statistically nonsignificant (*t*[192] = -0.39, *p* = 0.70, two-tailed).

Coursework and Activities

Precollege (high school) coursework in mathematics mean scores for African American (*M* = 2.57, *SD* = 1.30) and non-African American females (*M* = 2.67, *SD* = 1.19) resulted in a difference of -0.10, which was statistically nonsignificant (*t*[184] = -0.47, *p* = 0.64, two-tailed). Precollege (high school) coursework in science mean scores for African American (*M* = 3.22, *SD* = 1.16) and non-African American females (*M* = 2.77, *SD* = 1.18) resulted in a difference of 0.45, which was statistically significant (*t*[184] = 2.09, *p* = 0.04, two-tailed). This suggests that African American females were more influenced by precollege coursework in science than non-African American females. Precollege (high school) coursework in technology mean scores for African American (*M* = 2.35, *SD* = 1.42) and non-African American females (*M* = 3.23, *SD* = 1.02) resulted in a difference of -0.88, which was statistically nonsignificant (*t*[45.67] = -3.54, *p* = 0.00, two-tailed). This indicates that non-African American females were more influenced by precollege coursework in technology than African American females. Precollege (high school) STEM experience mean scores for African American (*M* = 2.70, *SD* = 1.43) and non-African

American females (*M* = 3.23, *SD* = 1.02) resulted in a difference of -0.53, which was statistically significant (*t*[45.40] = -2.13, *p* = 0.04, two-tailed). This indicates that non-African American females were more influenced by a precollege STEM experience than African American females. The STEM-related club or organization in high school mean scores for African American (*M* = 2.30, *SD* = 1.60) and non-African American females (*M* = 2.25, *SD* = 1.15) resulted in a difference of 0.05, which was statistically nonsignificant (*t*[45.44] = 0.15, *p* = 0.88, two-tailed). Introductory college courses mean scores for African American (*M* = 2.59, *SD* = 1.38) and non-African American females (*M* = 2.90, *SD* = 1.15) resulted in a difference of -0.31, which was statistically nonsignificant (*t*[48.61] = -1.25, *p* = 0.22, two-tailed).

Confidence

Confidence in mathematics ability mean scores for African American (*M* = 2.84, *SD* = 1.21) and non-African American females (*M* = 1.90, *SD* = 1.22) resulted in a difference of 0.94, which was statistically significant (*t*[188] = 4.22, *p* = 0.00, two-tailed). This suggests that African American females were more influenced by confidence in mathematics ability than non-African American females. Confidence in ability to be successful in mathematics in college mean scores for African American (*M* = 2.81, *SD* = 1.20) and non-African American females (*M* = 2.32, *SD* = 1.36) resulted in a difference of 0.49, which was statistically significant (*t*[188] = 2.01, *p* = 0.05, two-tailed). This suggests that African American females were more influenced by confidence in ability to be successful in mathematics in college than non-African American females. Confidence in science ability mean scores for African American (*M* = 3.38, *SD* = 0.86) and non-African American females (*M* = 1.61, *SD* = 1.32) resulted in a difference of 1.77, which was statistically significant (*t*[82.49] = 9.94, *p* = 0.00, two-tailed). This suggests that African American females were more influenced by confidence in science ability than non-African

American females. Finally, confidence in ability to be successful in science in college mean scores for African American (M = 3.35, SD = 0.95) and non-African American females (M = 2.05, SD = 1.25) resulted in a difference of 1.30, which was statistically significant (t[69.34] = 7.00, p = 0.00, two-tailed). This suggests that African American females were more influenced by confidence in ability to be successful in science in college than non-African American females.

Summary of Unique Influential Factors

1. Reputation of the university, college, or department influenced African American females slightly more than non-African American females.
2. High level of compensation in the field influenced African American females more than non-African American females.
3. Religious leaders influenced African American females more than non-African American females.
4. Precollege coursework in science influenced African American females more than non-African American females.
5. Precollege coursework in technology influenced non-African American females more than African American females.
6. A precollege STEM experience influenced non-African American females more than African American females.
7. Confidence in mathematics ability influenced African American females more than non-African American females.
8. Confidence in ability to be successful in mathematics in college influenced African American females more than non-African American females.

9. Confidence in science ability influenced African American females more than non-African American females.
10. Confidence in ability to be successful in science in college influenced African American females more than non-African American females.

Qualitative Analysis

The survey instrument included two open-ended questions in order address Research Question 3: "What are the factors, if any, which impact the success of African American female undergraduate students in STEM majors at a public research university in southeastern Virginia?" The first open-ended question asked students, "Based on the items that may have influenced your major choice displayed in the previous section, please list the top three that had the most influence on your success in your current major and explain why." The second open-ended question asked, "Based on the items that may have influenced your major choice displayed in the previous section, list the top three that had the least influence on your success in your current major and explain why." For each question, themes emerged regarding the factors that had most and least influenced participants' success in STEM.

Responses to Open-Ended Question 1

Four themes emerged regarding the items most influenced success in African American females' STEM majors: (a) high level of compensation in the field, (b) parents/legal guardians and family members, (c) specific interest in the subject, and (d) confidence in science and math ability.

High level of compensation in field. The majority of students highlighted that the high level of compensation in the field most influenced their success in STEM:

- "My parents wanted me to go into a field that had a high salary and great job market."

- "Education is a very expensive investment. I wanted a major that would reap me the best outcome after graduation."
- "I want a career field where I can help others, make money and live a comfortable life."

Parent/legal guardians and family members. In addition to the high level of compensation in the field, African American females reported that personal interactions with parents, guardians, and other family members were essential to success in their current major. Students reported that these individuals provided encouragement, motivation, and opportunities to engage in STEM activities:

- "My mother, grandmother, and myself—because they didn't finish school—and when I get discouraged, I think of them and push through."
- "My parents got me started [and] interested in my field of study choice because they were the ones who bought me toys in STEM-related fields."
- "My [parents] had the most influence on my success, since they are engineers and I was exposed at and early age."

Specific interest in subject. Many respondents stated that their success in their STEM major could be attributed to their specific interest in their subject:

- "Personal interest because it's something that I love."
- "I chose computer engineering, because I love programming."
- "I'm not going to waste years of my life learning about something that doesn't get my blood pumping."
- "I like building things."

Confidence in science and math ability. African American female respondents believed that confidence in their ability to perform in science math contributed greatly to their success:

- "Success in math is paramount. Most don't make it if their math skills aren't up to par."
- "My ability to learn the information made it easier for me to build confidence in my major."
- "The decision to choose my major was more based on the fact that I did really well [in] science courses and knew I could continue that trend [in college]."

Responses to Open-Ended Question 2

Overwhelmingly, one theme emerged concerning what least influenced success in African American females' STEM majors: the personal interactions of individuals excluding family members. Respondents noted that guidance counselors, religious leaders, academic advisors, and peers did not impact their success in STEM:

- "I go to a mega church, so I don't really know too many of my church leaders personally."
- "High school guidance counselors didn't offer for me to complete harder classes while in high schools, therefore I wasn't open to join clubs and organizations that would have best fit me."
- "They didn't influence me. My mind was already made and nothing is going to stop me from reaching my goals."
- "I base my decisions off of my own preferences, not those around me."
- "I have always had an independent mindset with what I wanted to do with my life."
- "No one ever told me I should do this before I decided I should."

Summary of Responses to Open-Ended Questions

1. High level of compensation in the field, parents/legal guardians and family members, specific interest in the subject, and confidence in science and math ability emerged as themes for the factors that most influenced African American females' success in STEM majors.
2. One theme, personal interactions excluding family members, emerged as the least influential factor for African American females majoring in STEM.

Summary

Chapter 4 detailed the quantitative and qualitative findings of this study. This included the descriptive analysis, which contained the demographics characteristics of the sample, the inferential statistical analysis, and the responses to the open-ended questions of the survey instrument. The next chapter provides a summary of the study, findings related to the literature, and conclusions.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

Because the traditional groups that typically enter STEM fields may be unable to support workforce demand, it is essential to build the STEM workforce in the United States utilizing underrepresented populations. This study served as a preliminary investigation to explore how undergraduate students who are traditionally underrepresented in STEM fields decide to entire the pipeline. This chapter discusses the descriptive, inferential, and qualitative results and overall findings of the study. This chapter is divided into three sections: (a) a summary of the study, (b) a discussion of the major findings related to the literature, and (c) a presentation of conclusions including implications for application and recommendations for future research.

Summary of the Study

This dissertation presented an introduction and background of the research, a literature review for context, the research methodology, and the results and findings of the study. The following sections provide a summary of the study, including an overview of the problem, purpose statement, research questions, a review of the methodology, and major findings for the study.

Overview of the Problem

Participation in STEM is at a record low in the United States, affecting the available workforce (Charleston, 2012). Declines in STEM participation have disproportionately affected underrepresented populations including African American females (Espinosa, 2011). Compared to all races and ethnicities, undergraduate African American females are the least likely to complete a STEM major (Moakler & Kim, 2014). Traditionally, the White male population has served as the pipeline for talent (Ong et al., 2011). Due to the demographic shift occurring in the United States, encouraging diversity in STEM is essential to increasing the talent pool of individuals educated in STEM (Ong et al., 2011; Tsui, 2007). Scientific advancement and innovation, stimulated by an educated workforce, can strengthen the United States socially, technologically, and economically (Ong et al., 2011). As such, identifying factors that influence African American females' decision to pursue STEM fields can contribute to building a viable STEM workforce.

Purpose Statement and Research Questions

The purpose of this study was to investigate the significant factors influencing STEM major selection by African American females. The research questions that guided this investigation were:

1. What are the factors, if any, which influence African American female undergraduate students to select STEM majors at a public research university in southeastern Virginia?
2. What are the statistically significant factors, if any, unique to female undergraduate African American students as compared to non-African American female undergraduates which influence STEM major selection at a public research university in southeastern Virginia?
3. What are the factors, if any, which impact the success of African American female undergraduate students in STEM majors at a public research university in southeastern Virginia?

Review of Methodology

The SCCCM was used as the conceptual framework to study the factors that influence African American female undergraduate students to select STEM majors. The researcher employed a quantitative research design with a qualitative component. The researcher conducted survey research utilizing an online questionnaire to collect data from participants at a public, coeducational research university located in southeast Virginia. African American undergraduate females that had declared a major in STEM comprised the target population for the study. The instrument included quantitative items, influential factors rated on a 5-point Likert scale, and two open-ended questions related to the factors that contributed most and least to the students' success in STEM disciplines. Additionally, the questionnaire included five demographic items related to the participants' current major, age, transfer status, intent to pursue secondary education, and academic class. Prior to the data collection, the researcher conducted a pilot study to test the initial reliability and validity of the survey instrument.

The researcher utilized different methods of analysis for each research question. First, the researcher used descriptive statistics to answer Research Question 1. Frequencies and percentages illustrated the demographic characteristics of the sample, which included current major, intent to enter secondary education, age, transfer status, and academic class. Additionally, the researcher reported the average influence levels of each factor, without regard for level of significance. The researcher then used inferential statistic to answer Research Question 2, including an independent samples *t*-test to compare the mean scores for African American versus non-African American females on each influential factor on the survey instrument. Finally, the researcher conducted qualitative analysis of the open-ended survey questions to answer Research Question 3, including open, axial, and selective coding processes.

Major Findings

In order to get a better sense of the demographic characteristics of the samples (African American vs. non African American females), the researcher collected information regarding current major, intent to enter secondary education, age, transfer status, and academic class. Both African American and non-African American females most frequently declared majors in the sciences. Only a relatively small percentage of African American and non-African American females intended to pursue secondary education. The majority of the samples were between the ages of 18 and 24 and in their fourth year at the institution. The quantitative and qualitative findings of this study are briefly summarized below as they relate to the three research questions.

Research Question 1. The respondents rated the extent to which they were influenced to select a STEM major on a list of 27 items grouped into five categories: interests and skills, career goals, personal interactions, coursework and activities, and confidence. African American female respondents were very influenced by the specific interest in the subject, type of work, availability of career opportunities after graduation, parent/guardian, precollege coursework in science, and introductory college courses items. In addition, the majority of respondents were very influenced by each of the confidence factors. Aptitude tests did not influence African American females.

Research Question 2. African American females were more influenced than their non-African American female counterparts for the following factors: reputation of the university, college or department, high level of compensation in fields, religious leaders, precollege coursework in mathematics, confidence in mathematics ability, confidence in ability to be successful in mathematics in college, confidence in science ability, and confidence in ability to be successful in science in college. Non-African American females were more influenced than

African American females by precollege coursework in technology and a precollege STEM experience.

Research Question 3. Four themes emerged regarding the items that most influenced success in African American females' STEM majors: high level of compensation in the field, parents/legal guardians and family members, specific interest in the subject, and confidence in science and math ability. One theme emerged regarding the items that least influenced success in African American females' STEM majors: personal interactions of individuals excluding family members.

Findings Related to the Literature

Qualified STEM majors are of national importance, crucial to the nation's competiveness and innovation (Shapiro & Sax, 2011). As the demand for graduates in STEM fields continues to grow, representation from underrepresented groups is imperative (Wang & Degol, 2013). Nationwide, women comprise nearly 57% of undergraduate students, but this has not translated to representation in STEM disciplines (Shapiro & Sax, 2011). While many gender disparities exist, women have made some progress in STEM fields, especially in the biological sciences (Shapiro & Sax, 2011). Specifically for underrepresented women, leaks in the STEM pipeline can occur at major selection (Malcom & Malcom, 2011).

The findings of this study supported the dimensions of the SCCCM. The SCCCM centers on personal, environmental, and behavioral factors that influence academic and career interests (Lent et al., 2008). These factors include personal experiences, background, learning experiences, self-efficacy, and outcome expectations (Lent et al., 1994). The findings from the descriptive, quantitative, and qualitative analyses suggest that confidence or self-efficacy in mathematics and/or science are major factors influencing STEM major selection and success in these disciplines. According to Bandura (1977), academic ability is the most influential source of self-efficacy information, as it is based on personal mastery. This, in turn, affects personal and scholastic achievement (Lent et al., 1994). Unfortunately, according to previous studies, women consistently express lower levels of confidence in their academic and mathematical abilities than their male counterparts, even when women's actual abilities are comparable (Shapiro & Sax, 2011).

The high level of compensation in the field also emerged as an influential factor in the inferential and qualitative analysis. In the literature, the financial aspects of a future career in STEM have a strong effect on major selection (Beggs et al., 2008). Since choice of a college major is a significant determinant of subsequent career success, students may be motivated by the possibility of earning higher incomes (Montmarquette et al., 2002). Despite the desire for higher earnings, the highest paying positions in the United States are overwhelming held by White males, while African Americans fill only 3% of these positions (Charleston, 2012).

During this research, specific interest in the subject emerged as an influential factor from the descriptive and qualitative analysis. Respondents indicated that they "loved" their selected field or they enjoyed the work it entailed. According to a study conducted by Adams, Pryor, and Adams (1994), respondents indicated that genuine interest in the field was strongly influential in academic major selection. Career development researchers have indicated that interest is a personal variable with significant impacts on career decision-making (Duffy & Sedlacek, 2010).

Role models can have a significant influence on major selection and retention. It follows, then, that an influential factor that emerged from the analysis was interaction with parents or guardians. Respondents indicated the encouragement and motivation received from parents or guardians were instrumental in their college major selection and their subsequent success in the field. Many studies have concluded that parental influence has a strong impact on major choice (Beggs et al., 2008). Parents can serve as role models for interested students. If one or both parents work in these fields, students are more likely to pursue a career in STEM (Shapiro & Sax, 2011).

Conclusions

The findings of this study may inform current practices and research on African American females in STEM. Because much of the research obscures the racial and ethnic compositions of its samples, it is important to explore the unique experiences of groups to further STEM research and policy development (Johnson, 2011).

Implications for Application

Building self-efficacy. Confidence in ability and future success emerged overwhelmingly as an important factor for African American females. Students cited their comfort with mathematics and science coursework as a key reason for selecting a STEM major. Respondents also understood that they needed to have confidence in their ability to be successful in these disciplines at the college-level. Accordingly, building confidence or self-efficacy in this population is essential to encourage African American females to enter the STEM pipeline. Allowing African American females to master academic experiences through coursework or activities can foster this self-efficacy. It is suggested in the research that stereotype threat must be acknowledged when attempting to build self-efficacy, as perceptions can often dictate future success despite the actual ability of the individual (Shapiro & Williams, 2012).

Generating interest in STEM. Another important implication of this research is the importance of generating interest in STEM fields. Understandably, this is one of the most important determinants of STEM major selection (Adams, Pryor, & Adams, 1994). In the present study, African American females indicated that an influential factor in their decision to select STEM and their subsequent success was related to their interest in the majors they pursued. Primary and secondary school leaders play an essential role in spawning interest in these fields. This interest could be generated by offering precollege coursework in STEM or other experiences and activities in primary and secondary schools. Many students cited exposure to STEM activities or organizations as effective means of generating interest.

Parents as role models and motivators. Parents and guardians play a fundamental role in guiding and motivating their students to enter STEM disciplines. Accordingly, parents and guardians are necessary participants in STEM education. These individuals should be included early on, and informed about STEM programs, courses, and activities. Furthermore, tools should be provided to parents and guardians that will allow them to learn how to nurture enthusiasm for STEM fields.

Promoting earnings potential. Students placed a high value on potential earnings. They identified the high level of compensation in the field as an opportunity to live a comfortable life and recuperate the investment made in their education. With this in mind, the implication for practice is highlighting the earning potential of STEM careers to prospective STEM majors. This would allow students to recognize their ability for strong career opportunities, as well as their value in a workforce that contributes greatly to the sustainability of the United States via science and technology.

Diversifying the STEM ranks. College and university recruitment officers and administrators, STEM faculty, and industry officials have a duty to explore avenues to diversify their incoming classes and hiring practices, respectively. College recruiters can pay particular attention to students participating in STEM programs at the secondary level. Industry officials may consider developing programs to create a pipeline for underrepresented STEM graduates to their organizations. In this way, more diverse candidates can be considered for collegiate programs and coveted positions in the STEM industry.

Promoting STEM education policy. It is important that education researchers and government policymakers also understand the importance of encouraging entry into the STEM pipeline, increasing the STEM workforce by generating interest, and influencing the decision-making process early on. This can occur through the integration of STEM curriculum in primary and secondary schools, exposure to STEM experiences, and promotion of access to communities and schools that are traditionally underserved and underfunded. The importance of diversity in the STEM workforce cannot be overlooked in primary and secondary education, if that diversity is expected to carry through to a college education.

Recommendations for Future Research

This served as a preliminary investigation of the factors that influence African American females to select STEM majors. The main goal was to explore the influential factors that may emerge at a public research university in southeastern Virginia. Because of the relatively small scope of this study, there are several opportunities to extend this research into further studies, in order to understand more fully why African American females select STEM majors.

The most apparent extension of this study is to expand the research to different types of higher education institutions. Researchers may find that exploring the influential factors of students at public versus private, small versus large, predominately White versus historically Black institutions may lead to different implications. Factors could also vary by state or region. Such inquiry would allow the body of research to reflect more STEM majors and detect any differences among different institution types. Additionally, one of the limitations of this study is the relatively small sample size. Since the main premise of this research is that African American females majoring in STEM comprise a relatively small number in individual college and university campuses, future researchers may find it prudent to garner a larger sample by expanding to additional institutions and comparing these sample populations.

While not a primary focus of this research, the importance of community colleges in the STEM pipeline is noteworthy. Over 50% of African American female respondents in the current study indicated that they transferred from a community college. Further research could explore the importance of the community college for STEM major selection. By engaging African American female community college students, further exploration can be completed to determine whether attendance at a community college is a significant determinant of STEM major selection.

In order to collect information about the unique influences to the STEM major selection process by undergraduate African American females, information was also collected for undergraduate non-African American females. It may also be of interest to future researchers to compare the influential factors of African American females with other groups, to include African American males, White females, or White males. This will allow researchers to gain a better understanding of how these groups differ in terms of the factors that influence STEM major selection.

Studies should also be conducted that take into account the inherent differences between individuals pursuing different STEM disciplines. STEM major selection and the prospect of future success may vary by discipline and it is important to explore where this variability may exist among these majors. Further, future research can explore the reasons why African American females chose one major over another.

Further research could also engage in additional qualitative inquiry in the form of interviews or focus groups. This could allow researchers to add the experiences and voices of African American females to the current body of research and to understand better how students interpret these influential factors. It may also be noteworthy to consider the role of race, ethnicity, and gender in major selection and success. The experiences within the African American female population may differ and further inquiry can provide implications pertinent to students of specific backgrounds.

Lastly, this study employed the specific approach of exploring why students select STEM majors. Future researchers may want to take the deficit approach and determine why students chose to select a non-STEM major. This could provide further insights into the barriers and challenges facing African American females considering STEM majors.

Concluding Remarks

The economic vitality of the nation is inextricably tied to building and diversifying the STEM workforce (Perna et al., 2009). Populations that have traditionally comprised the STEM workforce will no longer be able to support workforce demands as the demographics of the United States shift (Ong et al., 2011). Since African American females are underrepresented in STEM disciplines, this population serves as an important opportunity increase the number of qualified individuals in the workforce while boosting diversity. To this end, it is important to expand the body of literature to reflect the factors that influence STEM major selection. Through more thorough understanding of these factors, undergraduate STEM disciplines programs will be able to promote greater participation among African American females.

REFERENCES

Adams, S. J., Pryor, L. J., & Adams, S. L. (1994). Attraction and retention of high-aptitude students in accounting: An exploratory longitudinal study. *Issues in Accounting Education, 9*(1), 45.

Bandura, A. (1977). Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Beggs, J. M., Bantham, J. H., & Taylor, S. (2008). Distinguishing the factors influencing college students' choice of major. *College Student Journal, 42*(2), 381.

Borum, V., & Walker, E. (2012). What makes the difference? Black women's undergraduate and graduate experiences in mathematics. *Journal of Negro Education, 81*(4), 366–378.

Charleston, L. J. (2012). A qualitative investigation of African Americans' decision to pursue computing science degrees: Implications for cultivating career choice and aspiration. *Journal of Diversity in Higher Education, 5*(4), 222–243.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Duffy, R. D., & Dik, B. J. (2009). Beyond the self: External influences in the career development process. *The Career Development Quarterly, 58*(1), 29–43.

Duffy, R. D., & Sedlacek, W. E. (2010). The salience of a career calling among college students: Exploring group differences and links to religiousness, life meaning, and life satisfaction. *The Career Development Quarterly, 59*(1), 27–41.

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209–241.

Haun-Frank, J. (2011). Narratives of identity in everyday spaces: An examination of African American students' science career trajectories. *Science Education International, 22*(4), 239–254.

Hays, D. G., & Singh, A. A. (2012). *Qualitative inquiry in clinical and educational settings*. New York, NY: Guilford Press.

Hernandez, P. R., Schultz, P. W., Estrada, M., Woodcock, A., & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89–107.

Inda, M., Rodríguez, C., & Peña, J. V. (2013). Gender differences in applying social cognitive career theory in engineering students. *Journal of Vocational Behavior*, *83*(3), 346–355.

Jackson, D. (2013). A balancing act: Impacting and initiating the success of African American female community college transfer students in STEM into the HBCU environment. *Journal of Negro Education, 82*(3), 255–271.

Johnson, D. R. (2011). Women of color in science, technology, engineering, and mathematics (STEM). *New Directions for Institutional Research, 152*, 75–85. doi:10.1002/ir.410

Kiran, D., & Sungur, S. (2012). Middle school students' science self-efficacy and its sources: Examination of gender difference. *Journal of Science Education & Technology, 21*(5), 619–630. doi:10.1007/s10956-011-9351-y

Lee, H. S., Flores, L. Y., Navarro, R. R., & Kanagui-Muñoz, M. (2015). A longitudinal test of social cognitive career theory's academic persistence model among Latino/a and White men and women engineering students. *Journal of Vocational Behavior, 88*, 95–103.

Leedy, P. D., & Ormrod, J. E. (2013). *Practical research: Planning and design*. Boston, MA: Pearson.

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior, 45*(1), 79–122.

Lent, R. W., Lopez, A. M., Lopez, F. G., & Sheu, H. B. (2008). Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines. *Journal of Vocational Behavior, 73*(1), 52–62.

Lent, R. W., Lopez, F. G., Sheu, H. B., & Lopez, A. M. (2011). Social cognitive predictors of the interests and choices of computing majors: Applicability to underrepresented students. *Journal of Vocational Behavior, 78*(2), 184–192.

Lent, R. W., Sheu, H. B., Gloster, C. S., & Wilkins, G. (2010). Longitudinal test of the social cognitive model of choice in engineering students at historically Black universities. *Journal of Vocational Behavior, 76*(3), 387–394.

Lichtenberger, E., & George-Jackson, C. (2013). Predicting high school students' interest in majoring in a STEM field: Insight into high school students' postsecondary plans.

MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. *Analyses of Social Issues & Public Policy, 13*(1), 347–369. doi:10.1111/asap.12033

Malcom, L. E., & Malcom, S. M. (2011). The double bind: The next generation. *Harvard Educational Review, 81*(2), 162–171.

Malcom, S. M., Hall, P. Q., & Brown, J. W. (1976, April). *The double bind: The price of being a minority woman in science.* Washington, DC: American Association for the Advancement of Science.

Malgwi, C. A., Howe, M. A., & Burnaby, P. A. (2005). Influences on students' choice of college major. *Journal of Education for Business, 80*(5), 275–282.

Moakler, M. W., & Kim, M. M. (2014). College major choice in STEM: Revisiting confidence and demographic factors. *Career Development Quarterly, 62*(2), 128–142. doi:10.1002/j.2161-0045.2014.00075.x

Montmarquette, C., Cannings, K., & Mahseredjian, S. (2002). How do young people choose college majors? *Economics of Education Review, 21*(6), 543–556.

National Science Board. (2014). *Science and engineering indicators* (Vol. 1). Author.

National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering: 2011*. Arlington, VA: Author. Retrieved http://www.nsf.gov /statistics/wmpd/start.cfm

Old Dominion University. (2016a). About ODU. Retrieved from https://www.odu.edu/about

Old Dominion University. (2016b). Factbook 2014–2015. Retrieved from http://ww2.odu.edu /ao/ira/factbook/degconf/dc1415.html

Ong, M., Wright, C., Espinosa, L. L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review, 81*(2), 172–208.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage.

Perna, L., Lundy-Wagner, V., Drezner, N. D., Gasman, M., Yoon, S., Bose, E., & Gary, S. (2009). The contribution of HBCUS to the preparation of African American women for STEM careers: A case study. *Research in Higher Education, 50*(1), 1–23. doi:10.1007/s11162-008-9110-y

Scheuermann, T. S., Tokar, D. M., & Hall, R. J. (2014). An investigation of African-American women's prestige domain interests and choice goals using social cognitive career theory. *Journal of Vocational Behavior, 84*(3), 273–282.

Scott, T. P., & Tolson, H. T. (2009). Predicting retention of mathematics and science majors at a research one institution and suggested advising tools. *Journal of College Admission, 204*, 20–24.

Shapiro, C. A., & Sax, L. J. (2011). Major selection and persistence for women in STEM. *New Directions for Institutional Research*, *152*, 5–18.

Shapiro, J., & Williams, A. (2012). The role of stereotype threats in undermining girls' and women's performance and interest in STEM fields. *Sex Roles, 66*(3/4), 175–183. doi:10.1007/s11199-011-0051-0

Smith, J. L. (2006). The interplay among stereotypes, performance-avoidance goals, and women's math performance expectations. *Sex Roles, 54*(3/4), 287–296. doi:10.1007/s11199-006-9345-z

Soria, K. M., & Stebleton, M. (2013). Major decisions: Motivations for selecting a major, satisfaction, and belonging. *NACADA Journal*, *33*(2), 29–43.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality & Social Psychology, 69*(5), 797.

Stolle-McAllister, K., St. Domingo, M., & Carrillo, A. (2011). The Meyerhoff way: How the Meyerhoff scholarship program helps Black students succeed in the sciences. *Journal of Science Education & Technology*, *20*(1), 5–16. doi:10.1007/s10956-010-9228-5

Thompson, M. N., & Dahling, J. J. (2012). Perceived social status and learning experiences in social cognitive career theory. *Journal of Vocational Behavior, 80*(2), 351–361.

Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *Journal of Negro Education, 76*(4), 555–581.

Waller, B. (2006). Math interest and choice intentions of non-traditional African-American college students. *Journal of Vocational Behavior,* 68, 538–547. doi:10.1016/j.jvb.2005.12.002

Wang, M., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review,* 33, 304–340. doi:10.1016/j.dr.2013.08.001

Zafar, B. (2013). College major choice and the gender gap. *Journal of Human Resources, 48*(3), 545-595.

Zeldin, A., Britner, S., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching, 45*(9), 1036–1058.

APPENDIX A

HUMAN SUBJECTS APPROVAL

OLD DOMINION UNIVERSITY

OFFICE OF THE VICE PRESIDENT FOR RESEARCH

aaalac INTERNATIONAL
PROUDLY, AN AAALAC ACCREDITED PROGRAM

Physical Address
4111 Monarch Way, Suite 203
Norfolk, Virginia 23508
Mailing Address
Office of Research
1 Old Dominion University
Norfolk, Virginia 23529
Phone(757) 683-3460
Fax(757) 683-5902

DATE:	April 5, 2016
TO:	Dana Burnett
FROM:	Old Dominion University Education Human Subjects Review Committee
PROJECT TITLE:	[863519-1] Factors Influencing STEM Major Selection by African American Females Dissertation Research Study
REFERENCE #:	
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	April 5, 2016
REVIEW CATEGORY:	Exemption category # *[6.1]*

Thank you for your submission of New Project materials for this project. The Old Dominion University Education Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Petros Katsioloudis at (757) 683-5323 or pkatsiol@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Education Human Subjects Review Committee's records.

APPENDIX B

E-MAIL SOLICITATION FOR STEM MAJORS

SUBJECT: Brief Undergraduate Academic Major Survey

Greetings!

My name is Tiffany Ray and I am a Ph.D. Student in the Higher Education Program at Old Dominion University. I am conducting a research study to determine the factors that influenced students to select their undergraduate academic majors. I am writing to request your participation in a short questionnaire. The survey is very brief and will take **less than 10 minutes** to complete.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}
Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Your participation in this study is completely **voluntary** and all of your responses will be kept **confidential**.

Thank you very much for your cooperation. Have a great day!

Sincerely,

Tiffany M. Ray
Ph.D. Student in Higher Education
Old Dominion University

Follow the link to opt out of future emails: ${l://OptOutLink?d=Click here to unsubscribe}

APPENDIX C

SURVEY INSTRUMENT

Influences on Choice of Academic Major Questionnaire

Thank you for choosing to participate in this questionnaire. The purpose of this questionnaire is to identify what influenced your academic major choices. Please complete and submit only once. The questionnaire should take less than 10 minutes to complete. Your participation is completely voluntary and your responses will remain confidential.

When selecting your current major, to what extent were you influenced by the following items? Please evaluate each item on its level of influence leading you to select your current major. Use a scale of 1 to 4, where: 1 = Not at All and 4 = Very Influenced. Select "Does Not Apply to Me," or "0," if you the factor does not apply to you or it did not influence the choice of your major.

1 (Not at All) **2** (Slightly Influenced) **3** (Somewhat Influenced)
4 (Very Influenced) **0** (Does Not Apply to Me)

Questionnaire

Interests and Skills
The following relate to your interests and skills.

1. Specific interest in subject	1	2	3	4	0
2. Aptitude test (e.g. PSAT, SAT, ACT)	1	2	3	4	0
3. Career inventory	1	2	3	4	0
4. Reputation of university/college/department	1	2	3	4	0

Career Goals
The following relate to your career goals and future expectations.

5. Availability of career/job opportunities after graduation	1	2	3	4	0
6. Job status (Prestige of field)	1	2	3	4	0
7. High level of compensation (pay) in this field	1	2	3	4	0
8. Future leadership potential	1	2	3	4	0
9. Type of work	1	2	3	4	0

Personal Interactions
The following relate to personal interactions with various individuals.

10. Parent/guardian	1	2	3	4	0
11. Family members (not parent/guardian)	1	2	3	4	0

12. Friends/peers	1	2	3	4	0
13. Religious leader (Minister, Priest, Pastor)	1	2	3	4	0
14. High school teacher	1	2	3	4	0
15. High school guidance counselor	1	2	3	4	0
16. College academic advisor	1	2	3	4	0
17. College instructor/professor	1	2	3	4	0

Coursework and Activities
The following relate to previous coursework and activities.

18. Pre-college (high school) coursework in mathematics	1	2	3	4	0
19. Pre-college (high school) coursework in science	1	2	3	4	0
20. Pre-college (high school) coursework in technology	1	2	3	4	0
21. Pre-college (high school) science, technology, engineering, or mathematics (STEM) experience (field trip, activities, event)	1	2	3	4	0
22. STEM-related club or organization in high school	1	2	3	4	0
23. Introductory college courses	1	2	3	4	0

Confidence
The following relate to your confidence that you would do well in certain academic subjects.

24. Confidence in mathematics ability	1	2	3	4	0
25. Confidence in ability to be successful in mathematics in college	1	2	3	4	0
26. Confidence in science ability	1	2	3	4	0
27. Confidence in ability to be successful in science coursework in college	1	2	3	4	0

Open-Ended Questions
For the following questions, please respond openly using the text boxes below.

28. Based on the items that may have influenced your major choice displayed in the previous section, please list the top three that had the most influence on your success in your current major and explain why.

29. Based on the items that may have influenced your major choice displayed in the previous section, list the top three that had the least influence on your success in your current major and explain why.

30. Please select your current major:

SCIENCES (Biochemistry, Biology, Chemistry, Mathematics and Statistics, Ocean and Earth Science, Physics)

ENGINEERING & TECHNOLOGY (Civil Engineering, Civil Engineering Technology, Computer Engineering, Computer Science, Electrical Engineering, Electrical Engineering Technology, General Engineering Technology, Mechanical Engineering, Mechanical Engineering Technology, Modeling & Simulation Engineering)

31. Are you preparing to become a teacher (secondary education)?
No
Yes

32. Age:

Under 18
18–24
25–34
35–44
45–54
55–64
65 and over
Prefer Not to Answer

33. Prior to enrolling at this institution, did you attend a community college?

No
Yes

34. Indicate your current academic status/class:

First Year
Second Year
Third Year
Fourth Year
Fifth Year or More

Adapted with permission from:

Malawi, C. A., Howe, M. A., & Burnaby, P. A. (2005). Influences on students' choice of college major. *Journal of Education for Business, 80*(5), 275–282.

APPENDIX D

T-TEST OUTPUT

```
T-TEST GROUPS=V2(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=Q5_1SpecificInterestinSubject Q5_2AptitudeTeste.g.PSATSATACT
Q5_3CareerInventory
    Q5_4ReputationofUniversityCollegeDepartment
    Q12_1AvailabilityofCareerJobOpportunitiesAfterGraduation
Q12_2JobStatusPrestigeofField
    Q12_3Highlevelofcompensationpayinthisfield Q12_4FutureLeadershipPotential
Q12_5Typeofwork
    Q13_1ParentGuardian Q13_2FamilyMembersnotparentguardian Q13_3FriendsPeers
    Q13_4ReligiousLeaderMinisterPriestPastor Q13_5HighSchoolTeacher
Q13_6HighSchoolGuidanceCounselor
    Q13_7CollegeAcademicAdvisor Q13_8CollegeInstructorProfessor
    Q14_1Precollegehighschoolcourseworkinmathematics
Q14_2Precollegehighschoolcourseworkinscience
    Q14_3Precollegehighschoolcourseworkintechnology
    Q14_4Precollegehighschoolsciencetechnologyengineeringormathemati
    Q14_5STEMrelatedclubororganizationinhighschool
Q14_6Introductorycollegecourses
    Q15_1Confidenceinmathematicsability
Q15_2Confidenceinabilitytobesuccessfulinmathematicsincollege
    Q15_3Confidenceinscienceability
Q15_4Confidenceinabilitytobesuccessfulinsciencecourseworkincolle
  /CRITERIA=CI(.95).
```

***T*-Test Notes**

Output Created		12-SEP-2016 01:12:16
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	216
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=V2(1 2) /MISSING=ANALYSIS /VARIABLES=Q5_1SpecificInterestinSubject Q5_2AptitudeTeste.g.PSATSATACT Q5_3CareerInventory Q5_4ReputationofUniversityCollegeDepartment Q12_1AvailabilityofCareerJobOpportunitiesAfterGraduation Q12_2JobStatusPrestigeofField Q12_3Highlevelofcompensationpayinthisfield Q12_4FutureLeadershipPotential Q12_5Typeofwork Q13_1ParentGuardian Q13_2FamilyMembersnotparentguardian Q13_3FriendsPeers Q13_4ReligiousLeaderMinisterPriestPastor Q13_5HighSchoolTeacher Q13_6HighSchoolGuidanceCounselor Q13_7CollegeAcademicAdvisor Q13_8CollegeInstructorProfessor Q14_1Precollegehighschoolcourseworkinmathematics Q14_2Precollegehighschoolcourseworkinscience Q14_3Precollegehighschoolcourseworkintechnology Q14_4Precollegehighschoolsciencetechnologyengineeringormathemati Q14_5STEMrelatedcluborganizationinhighschool Q14_6Introductorycollegecourses Q15_1Confidenceinmathematicsability Q15_2Confidenceinabilitytobesuccessfulinmathematicsincollege Q15_3Confidenceinscienceability Q15_4Confidenceinabilitytobesuccessfulinsciencecourseworkincolle /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.00

Group Statistics

Race		*N*	Mean	*SD*	*SE* Mean
Q5_1 - Specific Interest in Subject	1	38	3.74	.554	.090
	2	162	3.74	.646	.051
Q5_2 - Aptitude Test (e.g. PSAT, SAT, ACT)	1	38	1.50	1.109	.180
	2	162	1.36	.868	.068
Q5_3 - Career Inventory	1	38	2.71	1.228	.199
	2	162	2.46	1.276	.100
Q5_4 - Reputation of University/College/Department	1	38	2.53	1.179	.191
	2	162	2.12	1.044	.082
Q12_1 - Availability of Career/Job Opportunities After Graduation	1	38	3.47	.893	.145
	2	158	3.32	.905	.072
Q12_2 - Job Status (Prestige of Field)	1	38	3.13	1.070	.174
	2	158	2.97	1.067	.085
Q12_3 - High level of compensation (pay) in this field	1	38	3.47	.762	.124
	2	158	2.94	1.075	.086
Q12_4 - Future Leadership Potential	1	38	3.11	1.158	.188
	2	158	2.70	1.091	.087
Q12_5 - Type of work	1	38	3.66	.745	.121
	2	158	3.65	.649	.052
Q13_1 - Parent/Guardian	1	38	2.24	1.240	.201
	2	156	2.25	1.248	.100
Q13_2 - Family Members (not parent/guardian)	1	38	1.92	1.194	.194
	2	156	1.85	1.058	.085
Q13_3 - Friends/Peers	1	38	1.74	1.032	.167
	2	156	1.85	.998	.080
Q13_4 - Religious Leader (Minister, Priest, Pastor)	1	38	1.21	.664	.108
	2	156	.99	.568	.045
Q13_5 - High School Teacher	1	38	1.82	1.159	.188
	2	156	1.78	1.063	.085
Q13_6 - High School Guidance Counselor	1	38	1.37	.786	.127
	2	156	1.18	.723	.058
Q13_7 - College Academic Advisor	1	38	1.71	1.063	.172
	2	156	1.42	.812	.065
Q13_8 - College Instructor/Professor	1	38	2.00	1.230	.200
	2	156	2.08	1.175	.094
Q14_1 - Pre-college (high school) coursework in mathematics	1	37	2.57	1.303	.214
	2	149	2.67	1.188	.097
Q14_2 - Pre-college (high school) coursework in science	1	37	3.22	1.158	.190
	2	149	2.77	1.176	.096
Q14_3 - Pre-college (high school) coursework in technology	1	37	2.35	1.418	.233
	2	149	3.23	1.021	.084
Q14_4 - Pre-college (high school) science, technology, engineering or	1	37	2.70	1.431	.235
mathematics (...	2	149	3.23	1.016	.083
Q14_5 - STEM-related club or organization in high school	1	37	2.30	1.596	.262
	2	153	2.25	1.150	.093
Q14_6 - Introductory college courses	1	37	2.59	1.384	.227
	2	153	2.90	1.146	.093
Q15_1 - Confidence in mathematics ability	1	37	2.84	1.214	.200
	2	153	1.90	1.220	.099
Q15_2 - Confidence in ability to be successful in mathematics in college	1	37	2.81	1.198	.197
	2	153	2.32	1.360	.110
Q15_3 - Confidence in science ability	1	37	3.38	.861	.142

Race		*N*	Mean	*SD*	*SE* Mean
	2	153	1.61	1.323	.107
Q15_4 - Confidence in ability to be successful in science coursework in college	1	37	3.35	.949	.156
	2	153	2.05	1.245	.101

Independent Samples Test

Item		Levene's Test for Equality of Variances		*t*-Test for Equality of Means						
		F	*Sig.*	*t*	*df*	Sig. (two-tailed)	Mean Diff	*SE* Diff	95% CI of Diff Lower	95% CI of Diff Upper
Q5_1 - Specific interest in subject	Equal variances assumed	.015	.903	-.034	198	.973	-.004	.113	-.228	.220
	Equal variances not assumed			-.038	62.834	.970	-.004	.103	-.210	.202
Q5_2 - Aptitude Test (e.g., PSAT, SAT, ACT)	Equal variances assumed	4.848	.029	.858	198	.392	.142	.165	-.184	.468
	Equal variances not assumed			.738	48.164	.464	.142	.192	-.245	.529
Q5_3 - Career inventory	Equal variances assumed	.614	.434	1.111	198	.268	.254	.228	-.197	.704
	Equal variances not assumed			1.138	57.268	.260	.254	.223	-.193	.700
Q5_4 - Reputation of university/college/department	Equal variances assumed	2.521	.114	2.087	198	.038	.403	.193	.022	.783
	Equal variances not assumed			1.935	51.454	.058	.403	.208	-.015	.821
Q12_1 - Availability of career/job opportunities after graduation	Equal variances assumed	.033	.857	.925	194	.356	.151	.163	-.171	.473
	Equal variances not assumed			.933	56.736	.355	.151	.162	-.173	.475
Q12_2 - Job status (prestige of field)	Equal variances assumed	.000	.989	.846	194	.399	.163	.193	-.217	.544
	Equal variances not assumed			.845	56.079	.402	.163	.193	-.224	.550
Q12_3 - High level of compensation (pay) in this field	Equal variances assumed	3.677	.057	2.906	194	.004	.537	.185	.173	.901

Item		Levene's Test for Equality of Variances		*t*-Test for Equality of Means						
		F	*Sig.*	*t*	*df*	Sig. (two-tailed)	Mean Diff	*SE* Diff	95% CI of Diff Lower	Upper
	Equal variances not assumed			3.573	76.759	.001	.537	.150	.238	.836
Q12_4 - Future leadership potential	Equal variances assumed	.368	.545	2.018	194	.045	.403	.200	.009	.796
	Equal variances not assumed			1.947	53.932	.057	.403	.207	-.012	.818
Q12_5 - Type of work	Equal variances assumed	.001	.982	.102	194	.919	.012	.121	-.226	.251
	Equal variances not assumed			.094	51.329	.926	.012	.131	-.252	.276
Q13_1 - Parent/ guardian	Equal variances assumed	.371	.543	-.058	192	.954	-.013	.225	-.458	.431
	Equal variances not assumed			-.059	56.682	.953	-.013	.225	-.463	.437
Q13_2 - Family members (not parent/ guardian)	Equal variances assumed	.858	.355	.349	192	.728	.068	.196	-.319	.456
	Equal variances not assumed			.324	52.058	.747	.068	.211	-.356	.493
Q13_3 - Friends/peers	Equal variances assumed	.005	.942	-.602	192	.548	-.109	.182	-.468	.249
	Equal variances not assumed			-.590	55.104	.558	-.109	.185	-.481	.262
Q13_4 - Religious leader (minister, priest, pastor)	Equal variances assumed	3.638	.058	2.101	192	.037	.223	.106	.014	.433
	Equal variances not assumed			1.910	50.967	.062	.223	.117	-.011	.458
Q13_5 - High school teacher	Equal variances assumed	.522	.471	.205	192	.838	.040	.196	-.346	.426

Item		Levene's Test for Equality of Variances		*t*-Test for Equality of Means						
		F	*Sig.*	*t*	*df*	Sig. (two-tailed)	Mean Diff	*SE* Diff	95% CI of Diff Lower	Upper
	Equal variances not assumed			.195	53.181	.847	.040	.206	-.374	.454
Q13_6 - High school guidance counselor	Equal variances assumed	2.326	.129	1.420	192	.157	.189	.133	-.073	.451
	Equal variances not assumed			1.350	53.285	.183	.189	.140	-.092	.470
Q13_7 - College academic advisor	Equal variances assumed	7.434	.007	1.835	192	.068	.287	.157	-.021	.596
	Equal variances not assumed			1.560	48.018	.125	.287	.184	-.083	.658
Q13_8 - College instructor/ professor	Equal variances assumed	.023	.880	-.389	192	.698	-.083	.214	-.506	.340
	Equal variances not assumed			-.378	54.619	.707	-.083	.221	-.526	.359
Q14_1 - Pre-college (high school) coursework in mathematics	Equal variances assumed	1.142	.287	-.466	184	.642	-.104	.222	-.543	.335
	Equal variances not assumed			-.440	51.870	.662	-.104	.235	-.576	.368
Q14_2 - Precollege (high school) coursework in science	Equal variances assumed	1.215	.272	2.094	184	.038	.451	.215	.026	.876
	Equal variances not assumed			2.114	55.921	.039	.451	.213	.024	.879
Q14_3 - Precollege (high school) coursework in technology	Equal variances assumed	19.455	.000	-4.301	184	.000	-.877	.204	-1.279	-.475
	Equal variances not assumed			-3.539	45.673	.001	-.877	.248	-1.376	-.378
Q14_4 - Precollege (high school) science,	Equal variances assumed	18.436	.000	-2.611	184	.010	-.532	.204	-.934	-.130

Item		Levene's Test for Equality of Variances		*t*-Test for Equality of Means						
		F	*Sig.*	*t*	*df*	Sig. (two-tailed)	Mean Diff	*SE* Diff	95% CI of Diff Lower	Upper
technology, engineering or mathematics (...	Equal variances not assumed			-2.133	45.403	.038	-.532	.250	-1.035	-.030
Q14_5 - STEM-related club or organization in high school	Equal variances assumed	26.241	.000	.185	188	.853	.042	.229	-.409	.493
	Equal variances not assumed			.152	45.437	.880	.042	.278	-.518	.603
Q14_6 - Introductory college courses	Equal variances assumed	10.396	.001	-1.404	188	.162	-.307	.219	-.739	.124
	Equal variances not assumed			-1.251	48.612	.217	-.307	.246	-.801	.186
Q15_1 - Confidence in mathematics ability	Equal variances assumed	.071	.791	4.220	188	.000	.942	.223	.502	1.383
	Equal variances not assumed			4.234	54.974	.000	.942	.223	.496	1.388
Q15_2 - Confidence in ability to be successful in mathematics in college	Equal variances assumed	2.050	.154	2.012	188	.046	.491	.244	.010	.972
	Equal variances not assumed			2.174	60.554	.034	.491	.226	.039	.942
Q15_3 - Confidence in science ability	Equal variances assumed	10.433	.001	7.713	188	.000	1.764	.229	1.313	2.215
	Equal variances not assumed			9.940	82.488	.000	1.764	.177	1.411	2.117
Q15_4 - Confidence in ability to be successful in science coursework in college	Equal variances assumed	5.617	.019	5.939	188	.000	1.299	.219	.868	1.731
	Equal variances not assumed			6.996	69.343	.000	1.299	.186	.929	1.669

Note. Diff = difference.

VITA

TIFFANY MONIQUE RAY

Old Dominion University
Darden College of Education
Educational Foundations and Leadership
Norfolk, VA 23529

EDUCATION

Ph.D., Higher Education, Old Dominion University, 2016
M.B.A, Business Administration, Old Dominion University, 2009
B.S., Business Administration, Old Dominion University, 2007

ADMINISTRATIVE AND TEACHING POSITIONS

Thomas Nelson Community College, Hampton, VA
Interim Dean of Enrollment Management (Present)
Director of Admissions and Registrar (2014–2016)
Manager of Enrollment Services (2012–2014)
Adjunct Instructor, Administrative Support Technology (2013–Present)

Virginia Polytechnic Institute and State University, National Capital Region, Falls Church, VA
Assistant Director, Executive MBA Program (2012)

The College of William and Mary, Williamsburg, VA
Assistant Director, Executive MBA Program (2010–2012)

Old Dominion University, Norfolk, VA
Merit Scholarship and Special Event Coordinator & Admissions Counselor (2008–2010)

PUBLICATIONS

Barr, J. E., & Ray, T. M. (2014). Risk management and crisis planning on college campuses. *Campus Safety & Student Development*, *16*(1), 3–23.

PRESENTATIONS

Leading With Student Development Theory, October 2015, National Council on Student Development.