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## A Phenomenological Investigation of the Lived Experiences of Female African American Undergraduate Stem Students at an Elite Predominantly White Institution

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**A PHENOMENOLOGICAL INVESTIGATION OF THE LIVED EXPERIENCES  
OF FEMALE AFRICAN AMERICAN UNDERGRADUATE STEM STUDENTS  
AT AN ELITE PREDOMINANTLY WHITE INSTITUTION**

A Dissertation

Presented to

The Faculty of the School of Education

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Philosophy

By

Reginald O. Johns

August 2018

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Reginald Johns

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Approved August 2018 by

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## Dedication

This dissertation is dedicated to the many members of my community whose example and support encouraged me to value and pursue higher education. While growing up, I remember seeing pictures of parents, uncles, and aunts in graduation regalia that signified academic accomplishment and intellectual prowess. On their graduation day, my father, Harold Oswald Johns, and my mother, Marion Poindexter Johns, posed side-by-side in caps and gowns, holding my brother and me. As I, too, obtained my Master's diploma from Hampton University, my parents emotionally, verbally, and financially supported my pursuit of a doctorate of philosophy. Without their love and support, this accomplishment would not have been possible.

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## Abstract

The purpose of this qualitative study was to gain an understanding of the experiences of being a female, African American STEM undergraduate who is enrolled at an elite Predominantly White Institution and who has a mentoring relationship. A hermeneutic approach to phenomenology was used to gather data through open-ended interviews. Research questions included: What are the lived experiences of female, African American STEM undergraduate students of the STEM community at an elite Predominately White Institution? What are the lived experiences of high achieving female African American STEM undergraduate students with their mentors? Four themes emerged from the interviews: (a) Discouraging Academic Environment, (b) Minority Stress, (c) Positive Persuasions, and (d) Mentoring Support. This study concluded that African American women needed a supportive environment to thrive as an undergraduate STEM major. This support came from African American peers, informal mentoring experiences that provided psychosocial support and affirmed their ability, formal mentoring experiences that provided academic guidance, and positive verbal messages by university professors that women belong in STEM careers.

Keywords: African American, STEM undergraduate, Predominately White Institution, and mentoring

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## **CHAPTER ONE: INTRODUCTION**

The higher education system of the United States has been entrusted to produce an educated workforce that is equipped to meet the occupational and professional needs of the nation. By 2020, the top occupational need for the United States will be for science-related practitioners (Lockard & Wolf, 2012). To meet future occupational needs of the nation, trends indicate that the workforce will need to possess advanced skills in science, technology, engineering, and mathematics (STEM). The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (2000) reported concerns of business leaders regarding a shortage of American STEM workers and the potential threat of this shortage on the ability of American businesses to compete in the global market. Additionally, the Congressional Commission (2000) reported that if the United States failed to prepare citizens from all population groups to participate in STEM occupations, “our nation would risk losing its economic and intellectual preeminence” (p. 11). Policy makers and university leaders took notice.

Colleges and universities must prepare the future STEM workforce today. It is projected that by 2022, American colleges and universities will need to increase enrollment in STEM majors by 33% to fill the one million jobs projected to be in the STEM fields (Gates & Mirkin, 2012). It would be advantageous for university STEM departments to consider one of colleges' fastest-growing ethnic populations to meet this need. Pointedly, in 2011, the college enrollment of female African Americans hit a historic high (Moton, 2015). The National Center for Education Statistics (2017a)

reported that between the academic years of 2003-04 and 2013-14, postsecondary degrees increased by 37% for African American students. In the same time period, White students increased in postsecondary degrees by 30%, whereas Hispanic students increased in postsecondary degree completion by 3%. Across all ethnic groups, women earned a greater share of undergraduate degrees and certificates (National Center for Education Statistics, 2017a). Female graduates earned more bachelor's degrees than males, African American women earned 64% of the degrees, White female graduates earned 56% of the degrees, and Hispanic female graduates earned 60% of the bachelor's degrees in their ethnic group (National Center for Education Statistics, 2017a). Targeting female students of color to meet expected shortages in STEM educated workers is critical.

To meet the future STEM occupational needs of the nation, colleges and universities in the United States need to provide an educational climate that contributes to STEM perseverance of African American women in particular as the largest minority group in the pipeline, as this retention can result in sufficient numbers of well-qualified STEM graduates. According to the National Science Foundation (NSF), although more women were earning baccalaureate degrees than men, they were still under-represented in fields of science and engineering (NSF, 2011). For example, women enter into undergraduate engineering and science programs with a similar level of motivation, ability, and academic preparation as their male classmates, but they do not obtain degrees at the same rate as men (Single, Muller, Cunningham, & Single, 2000). In 2006, White women earned 25% of the total STEM Bachelor of Science degrees (Espinosa, 2011). Women of color earned STEM degrees at even a lower rate. The NSF (2017) reported in

2014 that African American women earned only 4.73% of the bachelor's degrees in biological sciences, 2.83% of the bachelor's degrees in the physical sciences, 2.61% of the bachelor's degrees in computer science, 2.35% of the bachelor's degrees in mathematics and statistics, and 0.99% of the bachelor's degrees in engineering (NSF, 2017).

A problem also exists with the departure from STEM majors by women. The NSF (2011) reported that women leave STEM majors during their first and second years at a higher rate than men. According to the National Action Council on Minorities in Engineering (2012), "African American students entering engineering programs are less likely to complete their degrees, take longer to complete their degrees, and transfer to and complete an associates or certificate program at a higher level" (p. 2). The Congressional Commission (2000) advised that it was necessary to concentrate on the cultivation of the scientific talents of all citizens of the United States to meet the nation's STEM needs of the future.

### **Problem Statement**

The purpose of this study was to learn of the lived experiences of female African American undergraduate STEM students at an elite Predominately White Institution (PWI) and their lived experiences with their mentors. Previous researchers have described the experiences female and minority students have had at a PWI. In addition, researchers have also reported on how women have utilized mentoring in their STEM environments.



**Female and minority students in STEM fields.** Researchers have reported that the educational experiences for women differ from the experiences of their male counterparts. Leaper, Farkas, and Brown (2012) have documented that many female undergraduate students experienced academic sexism in regards to their abilities in science and mathematics through the comments made by their peers and teachers. In their study, they found that the females who perceived sexism felt less competent in math and science than minority females who did not perceive academic sexism. The Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development (2000) reported that “women, because of social pressure resulting from the negative social image of scientists and engineers, and because of lack of encouragement (coupled with active discouragement), become diverted from interest in science, engineering, and technology majors” (p. 2). To meet the future STEM occupational needs of the nation, it would be advantageous—indeed, necessary—for colleges and universities to provide an educational climate that contributed to STEM perseverance for their female students.

In concordance with creating an environment that is supportive for women in STEM education, the unique needs of minority students should also be considered. Although women, minorities, and persons with disabilities comprised more than two-thirds of the United States’ workforce, these groups did not represent an equivalent occupation of STEM jobs (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000). According to the National Action Council on Minorities in Engineering (2012), “African Americans

remained one of the most underrepresented minority groups in engineering related fields. African Americans comprised only 5 percent of all engineering bachelor's degrees achieved, with the same percentage of career holders in the engineering workforce" (p. 1). The under-representation of minorities and women could be due to the overall culture of the STEM community. Researchers Malcolm and Malcolm (2011) reported that STEM fields continued to be overwhelmingly dominated by Whites and men. When researchers Barthelemy, McCormick, and Henderson (2016) interviewed 21 women in graduate physics and astronomy programs to examine their experiences, they reported that the majority of the women experienced microaggressions and subtle insults. Some of the participants from this study experienced hostile sexism, gender role stereotypes, and overt discouragement. In addition to the existence of sexism, STEM students of African American descent may also encounter and be impacted by racism.

Indeed, the Congressional Commission (2000) reported that a problem contributing to the lack of diversity in STEM careers is racism. Racial prejudice, ethnic stereotypes, and gender stereotypes were identified as pervasive elements in the professional lives of women and minorities. Researcher Steele (1999) relayed that stereotype threats existed because individuals are viewed through the lens of a negative stereotype or has fear of doing something that would confirm a negative stereotype. Stereotype threats could affect different populations such as women, minorities, the poor, and the elderly. In a study that examined the effects of group performance anxiety on the attrition of women and minorities from science, math, and engineering majors using the National Longitudinal Survey of Freshmen, researchers Beasley and Fischer (2012)

reported that minorities experience stereotype threats more strongly than Whites, and that stereotype threats have a significant positive effect on the likelihood of women and minorities leaving science, technology, engineering, and math majors. Stereotype threats were reported to contribute to the performance gap that exists between Blacks and Whites in academics as well as contribute to the gaps that exist in academic performance between women and men (Brown, Charnasangaveji, Keough, Newman, & Rentfrow, 2000). A stereotype threat could cause an individual's focus to become shifted from performing a task to worrying that low performance would confirm a negative stereotype about the group to which the individual belongs.

**Mentoring support for STEM students.** What might be done to encourage female African American students to consider STEM fields as undergraduate majors and persist in the chosen majors? One promising option is to provide high-quality mentoring to support the access and success of these students. Mentoring could provide psychosocial, emotional, career, and academic support, leading to increased STEM persistence.

Mentoring was reported to significantly predict the degree to which students become socially and academically integrated into an academic area of study and to have a positive outcome on a student's self-confidence, self-actualization, expectations, future aspirations, and persistence rates (Crisp, 2010). The relationship a student has with a faculty member, inside and outside of the classroom, was often cited as a student's connection with the STEM subject matter and long-term academic goals (Espinosa, 2011). Historically, relational experiences were reported to be very important to

successful women in STEM fields (Zeldin, Britner, & Pajares, 2008). Women in a male-dominated field reported using relational experiences to buttress their confidence so that they could succeed in a male-dominated field (Zeldin et al., 2008). The relational experiences found in mentoring could be key to increasing STEM persistence for female African American undergraduates.

**Summary.** Identifying the experiences of African American women in STEM undergraduate majors at an elite PWI and their experiences with their mentors would provide an understanding of current educational conditions for African American women. Each year, new students enter the college system who represent a variety of backgrounds. Each incoming undergraduate class has a different representation of gender, ethnicity, social economic status, and parental connections to STEM professions.

This phenomenological study investigated a contemporary experience of female, African American STEM undergraduates at an elite PWI. It allowed co-participants to communicate their experiences, perceptions, and beliefs as members of a community that is designed to educate top-performing students with exceptional abilities and merited achievement. A PWI as a research setting would prove beneficial because it mimics the predominately white majority of the STEM profession.

### **Conceptual Framework**

The conceptual framework for this study builds on the role of mentoring in supporting students in academic programs. Ragins and Kram (2007) defined mentoring as “a relationship between an older, more experienced mentor and a younger, less experienced protégé for the purpose of helping and developing the protégé’s career” (p.

4). As Ragins and Kram (2007) noted, “at its best, mentoring can be a life-altering relationship that inspires mutual growth, learning, and development. Its effects could be remarkable, profound, and enduring; mentoring relationships have the capacity to transform individuals, groups, organizations, and communities” (p. 3). Mentoring provides an opportunity for a novice to receive an interpersonal exchange with an experienced person (Blake-Beard, Bayne, Crosby, & Muller, 2011). Career development and growth are the primary foci of the mentoring relationship (Ragins & Kram, 2007).

Mentoring can nurture career development and growth for protégés by providing two functions: career functions and psychosocial functions (Ragins & Kram, 2007). A mentor’s ability to provide career functions to a protégé is dependent upon the mentor’s position and influence in an organization (Ragins & Kram, 2007). Behavior that is associated with the career function of mentoring includes coaching, sponsorship, increasing the protégé’s exposure and visibility, and providing the opportunity to complete challenging assignments (Ragins & Kram, 2007). The psychosocial function that is provided in the mentoring relationship depends on the quality of emotional bonds and psychosocial attachments in the relationship (Ragins & Kram, 2007). Behavior that is associated with the psychosocial function of mentoring includes offering acceptance, confirmation, friendship, and role modeling to the protégé.

### **Purpose of the Study**

The purpose of this study was to learn of the experiences of female African American undergraduate STEM students at a PWI for high achieving students and their lived experiences with their mentors in the STEM arena.

## **Research Questions**

This study sought to answer the following research questions:

1. What are the lived experiences of female African American STEM undergraduate students of the STEM community at an elite PWI?
2. What are the lived experiences of high achieving female African American STEM undergraduate students with their mentors?

## **Significance of the Study**

This phenomenological case study provides an understanding of the lived experiences of being a female African American STEM student. The exploration of the phenomenon of being an African American woman in the STEM undergraduate community provides insight to their experiences that could increase the future retention and graduation rates of minority females who are STEM majors, and understanding of their perceptions of the STEM culture on a university campus that is entrusted to develop future STEM professionals. Insight on the experiences of a mentoring relationship could provide future direction for educational initiatives that could provide social or verbal persuasions that promote a sense of belonging or a stronger connection to the STEM community, promote STEM persistence, and encourage degree completion. University faculty and university leaders should have an understanding of the conditions that African American women find both welcoming and alienating in their STEM major. They should understand the conditions that encourage them to persist or leave a STEM major. Comprehension of these conditions would provide faculty and university leaders with the basis for guidelines to evaluate their practices. This evaluation would contribute to a

school culture that promotes a sense of well-being for African American women and a sense of inclusion for all in the STEM community.

### **Definitions of Terms**

*African American:* The United States Census Bureau (2011) defined African American as:

a person having origins in any Black racial groups of Africa. The Black racial category includes people who identify as Black, African American, or Negro. It also includes respondents who reported themselves as African American; Sub-Saharan African entries, such as Kenyan and Nigerian; and Afro-Caribbean entries, such as Haitian and Jamaican. (p. 2)

*Career function:* Ragins and Kram (2007) defined the career function of mentoring as:

a range of behaviors that helped protégés learn the ropes and prepared them for hierarchical advancement within their organization. These behaviors included coaching protégés, sponsoring their advancement, increasing their positive exposure and visibility, and offering them protection and challenging assignments. (p. 4)

*Mentoring:* Ragins and Kram (2007) defined mentoring as a relationship between an older, more-experienced mentor and a younger, less-experienced protégé for the purpose of helping and developing the protégé's career.

*Psychosocial function:* Ragins and Kram (2007) defined the psychosocial function of mentoring as the building of:

trust, intimacy, and interpersonal bonds in the relationship and include behaviors that enhance the protégé's professional and personal growth, identity, self-worth, and self-efficacy. They include mentoring behaviors such as offering acceptance and confirmation and providing counseling, friendship, and role modeling. (p. 4)

### **Summary**

The co-participants of this study were all chosen to attend the same elite PWI. Each of the co-participants of this study chose to major in STEM and identified a person to be her mentor. This phenomenological study has revealed the essence of their experiences. While research exists that explores the experiences of women in STEM undergraduate programs, research does not exist on experiences at a PWI that is considered an elite institution. Although research on mentoring relationships exists for women in STEM careers, research has not been conducted on the perceptions on mentoring by female, African American STEM undergraduates at an elite PWI.



## **CHAPTER TWO: LITERATURE REVIEW**

In order to meet the career demand for STEM occupations, institutions of higher education will need to concentrate their efforts to improve and increase graduation rates for all students, including female African American students. Female African Americans are enrolling in college at the highest rates of any other ethnicity, male or female (Moton, 2015). Female African Americans are also choosing to major in STEM at a higher rate than other ethnicities of women (Moton, 2015). In contrast to these positive indicators, African American women have left STEM majors at a higher rate than other ethnicities (Single et al., 2000). Unfortunately, many African American women experienced an educational environment that remains unwelcoming and aversive to their STEM persistence. This literature review explores trends in STEM career selection and examines how diversity could help the nation meet future STEM needs.

### **Trends in STEM Career Selection**

STEM was defined by Langdon, McKittrick, Khan, and Doms (2011) to be occupations that involve science, technology, engineering, and mathematics. In 2010, one in 18 workers in the United States was employed in STEM occupations (Langdon, McKittrick, Khan, & Doms, 2011). This represents 7.6 million workers. From 2001 to 2011, STEM jobs experienced a growth that outpaced growth in non-STEM sectors (Langdon et al., 2011 ). These researchers also reported that between the years of 2001 to 2011, STEM jobs increased three times as fast as others in the job market. This trend is expected to continue. The United States Department of Commerce projected that between the years of 2008 to 2018, STEM occupations will grow by 17%, whereas

occupations that are not STEM-related will only increase by 9.8% (Langdon et al., 2011). The U.S. Bureau of Labor Statistics (2017) reported that computer and mathematical occupations would experience faster than average employment growth of 13.5% between 2016 and 2026. For example, healthcare support occupations are expected to experience 23.2% growth, and technical occupations are expected to experience 15.2% growth during this decade (U.S. Bureau of Labor Statistics, 2017). These two fields are expected to contribute to one-fifth of all new jobs by 2026. Given this projected job growth, it is important to understand better the experiences of African American female students to know what best supports their persistence.

**Why is STEM important?** The United States Department of Commerce indicated that STEM workers play an important role in stabilizing the United States economy (in Langdon et al., 2011). It is noted that “STEM workers drive our nation’s innovation and competitiveness by generating new ideas, new companies and new industries” (Langdon et al., 2011, p. 1). STEM professions also provide a stable income for workers that surpass that of non-STEM jobs. The United States Department of Commerce also reported that STEM workers earn 26% more than non-STEM workers, and STEM workers are less likely to experience unemployment than non-STEM workers (in Langdon et al., 2011).

The Committee on Prospering in the Global Economy of the 21st Century is an organization composed of representatives from the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. The Committee on Prospering in the Global Economy of the 21st Century

(2007) reported that “corporate, government, and national scientific and technical leaders have expressed concern that pressures on the science and technology enterprise could seriously erode past success and jeopardize future US prosperity” (p. ix). The movement of U.S. manufacturing, engineering, and research jobs overseas has become a trend that could erode the economic conditions of the nation. A weakening of science and technology fields would contribute to a degrading of the economic and social conditions of the United States and lessen the ability of its citizens to compete for high-quality jobs (Committee on Prospering in the Global Economy, 2007). Therefore, when educational efforts are placed on preparedness to enter into the STEM fields, graduates will enter into a professional realm that will have higher job opportunities, higher salaries, and experience decreased spans of unemployment. What remains unknown is how the experiences of African American women in STEM academic programs influences a desire to stay in the major and in the career track. In addition, understanding their experiences at an elite PWI could provide understanding on what is needed for women and African Americans to thrive in a STEM profession that is highly populated by White men. Exploration of the co-participants’ experiences with their mentors could provide additional understanding of the needs of a minority group that is in the process of developing a STEM identity while acquiring professional skills.

### **Diversity Can Help Fill the STEM Need**

Shifts in college enrollment, the ethnic make-up of the United States, and the rate of enrollment of female African American undergraduates should all be considered as variables that could help meet the future STEM employment needs of the nation.

Specifically, female and ethnic diversity should be given serious consideration and support in order to address the current and anticipated STEM career needs.

**Female enrollment.** By the year 2020, the top occupational group will be science-related (Lockard & Wolf, 2012). The STEM cluster of careers is expected to increase by 6% by 2024. This expansion should provide 71,000 jobs in the Commonwealth of Virginia. A highly educated workforce will be needed to fill science-related jobs. Even though more women are earning baccalaureate degrees, they are under-represented in the fields of science and engineering (NSF, 2011). In 2008, women made up 50.7% of the U.S. population, but only 26% of women were employed as scientists or engineers (NSF, 2011). This study intends to help fill the gap in understanding why minority women are not pursuing STEM degrees.

**United States' ethnic composition.** The 2010 Census reported non-Hispanic Whites increased from 86.9 million to 111.9 million from 2000 to 2010. Over one-third of the U.S. population reported their race and ethnicity as something other than non-Hispanic White. This group had grown by 29% from 2000 to 2010 (U.S. Census Bureau, 2011). At the same time, minority women constituted only 8% of U.S. scientists and engineers (NSF, 2011). If current trends persist, this will prove problematic because a growing percentage of the United States' population will not be prepared to fill the growing number of STEM employment opportunities. The United States Census Bureau (2008) has released population projections that indicate that non-Hispanic Whites will no longer be the majority of the population by 2042. Logically, the role of minority women in the workforce will be increasingly important to fill science occupations that have

traditionally been filled by White men or even White women because of their increasing ethnic minority demographic representation.

Efforts should be made to increase the representation of African American women in STEM majors because of their high representation in college enrollment and underrepresentation in STEM. The National Center for Education Statistics (2017a) reported that African American women earned 64% of the bachelor's degrees earned by African American students. To fill future STEM jobs, it will be necessary to increase the representation of African American females in STEM majors.

**African American STEM representation.** Despite the high representation of African American women in college, there is not a high representation of African American women in STEM majors. The NSF (2017) reported that in every STEM degree category, the percentage of African American women who earned bachelor's degrees in STEM fields decreased from 2000 to 2014 (see Table 1). Between the years of 2000 and 2014, the percentage of African American women earning an engineering bachelor's degree decreased from 1.83% to 0.99%. Of the majors of biological science, computer science, mathematics and statistics, physical science, and engineering, the highest percentage of bachelor's degrees in STEM earned by African American women was in the field of biological science. This STEM field had the lowest percentage of decrease between the years of 2000 and 2014. In the fields of biological sciences, computer sciences, mathematics and statistics, physical science, and engineering, African American women's earning of bachelor's degrees averaged a decrease of 1.06% between 2000 and 2014 (NSF, 2017). Even though representation in college is increasing for African

American women, this data indicates that they are earning fewer STEM degrees than in the year 2000. What are the educational experiences and environments that are contributing to this decreased representation in STEM majors? It would be important to understand what conditions in a major make one more appealing than another for African American women. Why have majors such as biological science been able to obtain a higher degree of graduates than computer science and mathematics when African American women obtained over 4% of these bachelor degrees in 2000? Although all of the majors indicate a decreased percentage of degrees earned by African American women, they vary in the amount each degree declined since 2000. Understanding the experiences African American women have across different STEM degrees could provide understanding of the overall STEM environment that exists. It is possible that one major has practices that are more favorable to African American women than another. It is possible that one major has a higher representation of women in its major than another in the student body representation or in the faculty. This qualitative data should promote further investigation into the conditions that exist across STEM majors for African American women on the undergraduate level.

Table 1

*Percent of Science and Engineering Bachelor's Degrees Earned by Black or African American Women by field: 2000-2014*

Year	Biological Science	Computer Science	Mathematics and Statistics	Physical Science	Engineering
2000	4.36	4.53	4.02	3.60	1.83
2001	4.56	4.65	3.94	3.33	1.74
2002	4.60	4.75	3.84	3.58	1.80
2003	4.73	4.91	3.23	3.20	1.67
2004	4.90	4.63	3.25	3.49	1.70
2005	4.73	4.37	2.96	3.29	1.64
2006	4.73	4.38	2.79	3.22	1.45
2007	4.74	3.81	2.75	3.02	1.41
2008	4.65	3.44	2.52	3.09	1.28
2009	4.59	3.45	2.49	3.08	1.22
2010	4.41	3.23	2.51	2.87	1.08
2011	4.34	3.03	2.29	2.80	1.04
2012	4.32	3.04	2.35	3.26	1.04
2013	4.26	2.89	2.39	2.87	0.99
2014	4.23	2.61	2.35	2.83	0.99

*Note.* Adapted from “Field of degree: Women, men, and racial and ethnic groups,” 2017. Copyright 2017 by the National Science Foundation.

In 2009, African Americans earned only 89 PhDs out of 5,048 in the physical sciences (Washington, 2011). African Americans also had lower representation in the

biological and biomedical sciences. Out of 6,957 PhD degrees that were awarded in 2009, African American men earned 88 of the PhD degrees, and 176 of them were earned by African American women (Washington, 2011).

The National Action Council on Minorities in Engineering (NACME) also reported under-representation of African Americans in earning engineering and engineering-related degrees (NACME, 2012). Using data from 2010 provided by the U.S. Department of Education, the National Center for Education Statistics, and the Integrated Post-secondary Education System (IPEDS), NACME examined the degree attainment of different ethnicities and nationalities. At the Bachelor's, Master's, and PhD levels, Whites earned the highest number of engineering degrees among United States citizens. NACME reported that 62,314 Bachelor's degrees in engineering were earned by Whites, and African Americans earned 4,688. Whites earned 15,424 Master's degrees in engineering; African Americans earned 1,385. White graduate students earned 2,505 PhDs in engineering; African American graduate students earned 163 (NACME, 2012).

NACME (2012) has reported that at the graduate level, foreign students exceeded White students in earning Master's degrees and PhDs. Foreign students earned 16,549 Master's degrees in engineering awarded in 2010. White students earned 15,424 degrees. Foreign students earned 4,314 PhDs in engineering, while White students earned 2,505. When other U.S. ethnicities were added to the number of White engineering graduates, the number of U.S. citizens who were graduates with Master's and PhDs in engineering in 2010 outnumbered the graduates who were classified as foreign students. To maintain the number of U.S. engineering graduates, efforts must be made to increase STEM



graduate representation across all ethnicities and genders. The reliance on non-U.S. citizens to meet the needs for a STEM workforce could become problematic for the U.S. economy if it becomes more difficult for non-U.S. citizens to obtain employment. After foreign students complete their studies, they need to become lawful immigrants or Green Card holders in order to obtain employment in the United States. If the non-U.S. citizen is not able to obtain a Green Card or an F-1 visa, the person will not be able to obtain residence in the United States and employment in STEM fields. Political pressures that impact immigration could impact the future productivity and growth of STEM corporations.

NACME (2012) reported that from 2006 to 2010, more men obtained engineering degrees than women. Between 2006 and 2010, men earning Bachelor's degrees in engineering outnumbered women by 58,937. Between 2006 and 2010, men earning Master's degrees in engineering outnumbered women by 21,696. Between 2006 and 2010, men earning doctoral degrees outnumbered women by 4,197. Within these data, African American women exhibited a different trend in regards to educational attainment and their gender. According to NACME (2012),

Across all levels of degree attainment in engineering, African American women's representation continues to grow. African American women are increasing their achievement in engineering related graduate degrees at a rate comparable to their male peers, increasing at least 1 percentage point on a yearly basis. (p. 2)

Understanding of the essence of an experience from a collection of experiences could provide understanding of the STEM environment on a deeper level. Exploration of

the components of the experiences of female African American STEM undergraduates that were both beneficial and discouraging, can provide a basis for future exploration and evaluation of current STEM conditions at different universities that contribute to and erode STEM identities in African American women.

### **Ethnicity in STEM**

A person's ethnicity may play a role in degree completion and a sense of belonging to the STEM community. Representation of one's ethnicity could be a contributing factor in STEM degree completion. Different ethnicities complete STEM degrees at different rates. A student's ethnicity could also impact their sense of belonging.

**Ethnicity and degree completion.** NACME examined the retention and graduation rates among the 2003 first-year class majoring in computer science, engineering, and engineering technology using the National Center for Education Statistics in 2011. Whites had a graduation rate of 63.7% while Blacks had a graduation rate of 31.2%. Whites had the smallest percentage, 9.9%, of all the ethnicities that left the major without receiving credentials. African Americans had the largest percentage of students, 31%, who left the major without receiving credentials. Overall, "compared with other student groups, African American students entering engineering programs were less likely to complete their degrees, took longer to complete their degrees, and transferred to and completed an associates or certificate program at a higher level" (NACME, 2012, p.

2). What remains unknown is how their experiences in college and STEM programs influenced these outcomes.

**Ethnicity's impact on sense of belonging.** In a qualitative study, researchers Solorzano, Ceja, and Yosso (2000) examined the experiences of 34 African American students who were attending three predominately White, Research I, universities. They reported that participants felt racial microaggressions within academic spaces in the form of stereotype threats and racial discrimination (Solorzano et al., 2000). Participants in this study reported feeling invisible in the classroom setting and feeling that the faculty had low expectations for their performance in the classroom (Solorzano et al., 2000). They also reported being accused of cheating when they had done well on exams, and being left out of groups because of their ethnicity. Additionally, the research team reported:

Several of the students we interviewed indicated that beyond feeling like a numerical minority, they also felt personally diminished by nonverbal microaggressions perpetrated by their White counterparts. Other students agreed that merely looking like a person of color could draw negative assumptions. They further recognized that being stereotyped carries very real consequences beyond feeling bad about oneself. Some indicated feeling “drained” by intense scrutiny of their everyday actions received in the context of negative preconceived notions about African Americans. (p. 67)

Steele (1999) observed that stereotype threats existed because the person was viewed through the lens of a negative stereotype or fears doing something that would

confirm a negative stereotype. Stereotype threats could affect different populations, such as women, minorities, the poor, and the elderly. Steele and Aronson (1995) tested how stereotype threats impacted African American college students on standardized cognitive tests. They sought to determine if stereotype threats would depress their performance to a statistically reliable degree. In their experiment, African American and White students were individually given a 30-minute verbal test. Steele and Aronson (1995) hypothesized that because of the negative stereotype; African American students would interpret their performance as a poor indicator of their own ability and their race. Even if this belief was not fully conscious, it could impair their best thinking. Steele and Aronson (1995) found support for their hypothesis. Even though groups were statistically matched in ability level, the African American students performed dramatically less well than the White students (Steele & Aronson, 1995). To follow up, students were retested to determine if stereotype threats had indeed impaired the students' performance. In the second test, the students were told that the task did not measure a person's intellectual ability and that the task was going to be used to study how problems were solved. This time, the students' performance on the test rose to match equally the scores of the Whites (Steele & Aronson, 1995).

Stereotype threat was also demonstrated to impact women's mathematical performance. Spencer, Steele, and Quinn (1989) selected 28 men and 28 women from the University of Michigan. All of the participants had scored above the 85th percentile on the math section of the Scholastic Aptitude Test (SAT), had at least one semester of calculus, and had received a grade of B or better. Each of the students had also

participated in a survey where they ranked themselves as good in math. The first time the students were tested, they were told that the University was developing new evaluations for students and that they were going to take a math test. On this test, women did worse or underperformed in comparison to the men. In the second study, a group of participants was told that the test had previously shown gender differences at another test administration; the other group was told that the test had never shown gender differences.

When participants were explicitly told that the test yielded gender differences, women greatly underperformed in relation to men. But when told the test was purposed not to yield gender differences, women performed at the same level, as equally as men. (Spencer et al., 1999, p. 12)

These results supported the researchers' assumptions that:

when a stereotype about one's group indicted an important ability, one's performance in situations where that ability could be judged comes under an extra pressure—that possibility of being judged by or self-fulfilling the stereotype—was an extra pressure that may interfere with performance. (Spencer et al., 1999, p. 6)

Steele (1999) proposed that minority students with strong academic skills were exposed to a higher pressure of stereotype threat.

They may have long seen themselves as good students—better than most. But led into the domain by their strengths, they pay an extra tax on their investment—vigilant worry that their future will be compromised by society's perception and treatment of their group. (Steele, 1999, p. 6)

This research indicated that students of similar abilities have diverse needs. Even though students may have similar academic achievements, they may experience educational environments differently because of their ethnicity. A difference in ethnicity from the majority population may impact minority students' psychological sense of well-being and academic performance.

**Gender identity's impact on sense of belonging.** Gender stereotypes can cause people to make false inferences about their abilities or skills in a profession:

Gender stereotypes are widely shared assumptions about traits, behaviors, and roles of women and men. They typically include the assumption that men and women are different from one another, with each group being “naturally good” at some things and “naturally bad” at others. (Dasgupta, 2016, p. 87)

Stereotypes of gender differences in STEM ability were reported to be experienced most by undergraduate women (Robnett, 2016). In study of Asian American, European American, and Latina high school, undergraduate, and graduate students, 61% of the girls and women reported experiencing forms of gender bias, 70% of the undergraduate female math majors reported experiencing gender bias from male peers. Female students perceived they had to work harder than male students to be taken seriously, or reported hearing negative comments about the STEM abilities of women and girls. Participants in a math intensive field reported higher rates of gender bias than participants in the life sciences (Robnett, 2016). Participants in undergraduate programs reported higher rates of gender bias than participants in graduate school or high school. Male peers were reported to be a more common source of gender bias than teachers, professors, mentors,

or female peers. Robnett (2016) proposed that negative interaction with peers contributed to the eroding of women's sense of belonging in their major. The negative interaction the women had with their male peers in school may help to explain why women in STEM careers continue to perceive the STEM environment as hostile (NSF, 2011).

O'Brien, Adams, Blodorn, and Garcia (2015) researched how ethnicity impacted how White and African American college women experienced the STEM stereotype of male dominance. These researchers used an intersectional approach to support their hypotheses that African American women participated in STEM majors at higher rates than White European American college women; that African American women experienced weaker implicit gender STEM stereotypes than European women; and that ethnic differences in implicit gender-STEM stereotypes partially mediated ethnic differences in STEM participation. Tharp-Taylor and Nelson-Le Gall (2005) theorized that in the African American family, there was less gender role differentiation. African American boys and girls had similar family experiences. Black females and males were socialized to be assertive and independent, especially since, historically, African American women have worked and headed families (Andersen, 1997).

O'Brien et al. (2015) designed a study to examine African American and European American college women's gender-STEM stereotypes and the role gender-STEM stereotypes had in predicting ethnic differences in STEM participation. They proposed that participation in college in STEM majors would vary between African Americans and European Americans because of different constructions of gender due to ethnic variation. The researchers proposed that there would be a weaker association with

STEM and maleness because African Americans valued common STEM traits like independence for both men and women. To conduct their study, the researchers used 1,772,133 participants who had completed the annual Cooperative Institute Research Program (CIRP) Freshman Survey between 1990 and 1999; 55.8% were women and 7.6% were African American. The research team found that African American women held weaker implicit gender STEM stereotypes than European American women. They also reported that both African American women and European women had similar perceptions of the gendered nature of STEM fields and considered STEM to be a more masculine field than liberal arts. African American women were also more likely to indicate they were majoring in a STEM field than European women. Over half, 55% of the African American women reported that they were STEM majors; 17% of the European American women indicated that they were STEM majors. A test of mediation was used to determine whether ethnic differences in implicit gender STEM stereotypes could account for the ethnic differences in the tendency to choose a STEM major. The researchers found the total effect of ethnicity on the tendency to major in STEM to be significant. There was a direct effect of ethnicity on the tendency to major in STEM. The researchers concluded that implicit STEM stereotypes partially mediated the effect of ethnicity on the tendency to major in STEM (O'Brien et al., 2015).

### **Social Persuasions**

Social persuasions are the messages participants receive from others about the ability to perform or complete a task. Social persuasions may be presented verbally or nonverbally. The climate of the university or STEM department may present a message



to its students that is either welcoming or exclusionary. Further research is needed to understand the current messages that African American women are receiving about their belonging to the STEM community.

**Perceptions of STEM culture by undergraduates.** The climate of STEM undergraduate culture may contribute to the lack of retention of undergraduate students. Researchers Malcolm and Malcolm (2011) reported that “STEM fields continued to be overwhelmingly dominated by Whites and men, although laws banning discrimination on the basis of race and/or sex reduced the overt practices that shaped the university and workforce cohorts of previous years” (p. 162). Researchers Seymour and Hewitt (1997) conducted a qualitative study by interviewing 355 students at seven four-year institutions of higher education to examine the factors that contributed to the decision of undergraduates to switch from a STEM major to a non-STEM discipline. The climate of the STEM culture was seen to be problematic even for students who had similar abilities as those who persisted in STEM majors. Seymour and Hewitt (1997) discovered that women who switched to a non-STEM discipline had higher average GPA scores than men who did not leave STEM majors. The loss of interest in the discipline, poor teaching by the STEM faculty, and a feeling of being overwhelmed by the pace and the load of the course demands were three of the four highest factors that contributed to the switching of majors for both men and women. Researchers Seymour and Hewitt (1997) reported that all four of the most highly ranked factors to switching majors were related to teaching in some respect. Both students who changed majors and non-STEM switchers voiced concern about the pedagogy and the STEM climate. Students often described the faculty

as being unapproachable or unavailable for help; the STEM culture was described as a competitive environment that undermined a sense of belonging and a sense of collaboration for women; the classes were described as being too large to connect with the faculty member; and the foundational classes were suspected as being over-packed for the purpose of weeding-out students. Understanding the emotional and academic needs of the student body may help students persist in STEM majors.

In another qualitative study that examined the experiences of women of color who were studying undergraduate science, the culture of the department at the predominately White research university was not viewed as welcoming (Johnson, 2007). At a university where 15% of the students were identified as non-white, 19 participants who had come to college with an interest in majoring in science were selected. Through the use of interviews and classroom observations, Johnson (2007) identified three practices of science departments that the women found to be discouraging: large lecture classes, asking questions in class, and engaging in research. Johnson relayed that the participants in her study felt that the large lecture classes that seated several hundred students made them feel like the audience of a play and not a student in class. The participants expressed that the large lecture classes prevented them from getting to know their professors. One participant, an African American biology major, expressed that she felt alienated in class. When she asked a question after class, her professor did not even recognize that she was a student of his. She recounted:

Alexis was in cell biology with us that year. And towards the last exam, Alexis and I went to go talk to the professor who was teaching—he's a really good

teacher. He said, “strange, I don’t recognize you guys from my class. Do you sit in the back?” And in retrospect, I was like, “Dang! How could he miss us? Me, Alexis and Deratu were the only Black people in the whole class!” I was like, “do you not look up?” (Johnson, 2007, p. 811)

In class, Alexis also recounted that she felt like a spectator. She did not feel like she was a part of the learning process and spent her time more or less watching in the class versus actively participating (Johnson, 2007). When Johnson (2007) observed classroom lectures, she saw very few women answer questions. She reported, “despite the fact that women were in the majority of the science classrooms, I saw few women answer questions posed by the professors; this was the realm of White male students” (p. 812). She continued, “I never saw a woman of color either ask or answer a question, with the notable exception of Mariah, an Asian American biochemistry major who would shout out questions frequently in her organic chemistry class” (p. 812). Johnson learned that her participants already felt conspicuous or anomalous; she concluded that asking a question in class would draw unwanted attention. Johnson (2007) reported that one African American biology major, Alethia, described herself as being on the outside:

Like the classes were, you know, there’s a select few over-achievers who laugh at all the jokes, who ask questions, who ask the “challenge the professor” questions, who probably clone genes at home. I don’t know—it’s like those selected few and the professor, and everybody else is just either asleep or just scribing every word they can get. And that’s just what I felt like—the class is just following along, and I’m just sort of like along for the ride. (Johnson, 2007, p. 813)

Alethia did not feel as if she belonged. Johnson (2007) attributed this lack of engagement to a feature of women's socialization. Johnson theorized that women are socialized not to draw attention to themselves. Refraining from asking questions permits the women to maintain a social norm.

In the atmosphere of a research lab, the participants of Johnson's study had mixed experiences. Several of Johnson's participants had excellent experiences as undergraduate research assistants, while others did not. A Latina kinesiology major felt ignored by her mentor. She recounted:

I did research my freshman year in an environmental biology lab and it was so boring to me. I was looking into a microscope 3-4 hours a day looking at fungi. How fun is that? I would go to the professor in charge of the lab with intent of getting course advice or help as far as what else my biology degree would get me. I was expecting a mentor, but that didn't happen. He was too busy for little ol' me. (Johnson, 2007, p. 814)

The participant in the Johnson study that had a positive research experience felt drawn to her current major because of a research experience. Johnson (2007) reported "for students who participated in research as undergraduates, it emerged as the most important factor, either positive or negative, in their pursuing careers in science" (p. 814). Experience in the STEM discipline contributed to the participants' decision to pursue a STEM career. Although some participants wanted a mentoring relationship, opportunities to conduct research proved to benefit STEM students as well.

**Self-doubt in STEM.** LaMont Toliver is the director of the University of Maryland Baltimore County's Meyerhoff Scholars Program. This program is designed to increase diversity in participation in the University's STEM majors. When questioned about the low participation of minority students in STEM majors, Toliver indicated that he saw a problem with what he called "self-doubt" (as cited in Washington, 2011). Toliver indicated that there is a need for mentoring and a supportive community to improve the self-efficacy of students in STEM majors.

A case study by researchers Perna et al. (2009) examined how a Historically Black College or University (HBCU) prepared women students for STEM careers. A common theme of faculty encouragement and involvement evolved in this study. The faculty that participated in the focus group sessions voiced one example that demonstrated this. The faculty indicated that their introductory STEM courses had to be reconceptualized to promote success. The researchers reported:

Faculty members are working to ensure that a STEM curriculum encourages rather than discourages academic attainment. For example, with the support of external grants for time to focus on curriculum development (e.g., the National Aeronautics and Space Administration (NASA) Models of Excellence (MOE) Program), faculty members have reorganized introductory STEM courses to serve not as mechanisms to "weed out" poorly performing students, but as "gateways" to more advanced STEM coursework. (Perna et al., 2009, p. 13)

Even though a high interest or ability in STEM contributed to why African American women chose a STEM major, students might abandon STEM majors if they find

themselves unsuccessful in college courses (McPherson, 2013). In a multiple case study conducted by McPherson (2013), each of the 16 participants indicated that a high individual interest in science or math contributed to their desire to become a STEM major, but once in college, some of the participants chose to leave a STEM major because of academic difficulty in a STEM class. McPherson (2013) reported:

When African American women faced adversity in science or math classrooms in college, their engagement and commitment to math or science curriculum and/or interests in STEM decreased. For instance, some health science majors and social science majors changed their undergraduate curricular programs after they faced adversity in hard science classes. (p. 93)

It was proposed that teachers could contribute to the retention of African American women in STEM majors because they could provide support and encouragement to African American women as they pursued science majors (Borum & Walker, 2012). What remains unknown is how African American men are influenced by adversity in the classroom.

**Perceptions of African Americans at PWIs.** Research showed that African Americans who attended a PWI reported a lower degree of support from faculty and mentors than African Americans who attended a HBCU (Gallup-USA Funds, 2015). In a 2015 study conducted by Gallup and USA Funds, over 50,000 graduates who had received bachelor's degrees between 1940 and 2015 were surveyed about their college experiences to understand the differences in engagement experienced by former students, their college experiences, and their present sense of well being. The results based on the

data collected in 2014 and 2015 by Gallup have indicated that minority students who attended HBCUs and minority students who attended PWIs differed in their college experiences and perceptions of the university. The Black graduates from the HBCUs reported that they experienced support at a higher rate than Black graduates from a non-HBCU. In this study, support was defined as having at least one professor who made them excited about learning, or having a professor "who cared about them as people," or having a mentor who encouraged them to pursue their goals and dreams. In this study, "Black graduates of HBCUs were more than twice likely as Black graduates of non-HBCUs to recall experiencing all three support measures" (Gallup-USA Funds, 2015, p. 7). Moreover, "the gap between HBCU and non-HBCU Black graduates was the widest when recalling having professors who cared about them as people" (Gallup-USA Funds, 2015, p. 18). More than half of the Black graduates from HBCUs, 58%, reported having professors who cared about them in such a manner, and less than half of the Black graduates from non-HBCUs, 25%, reported having professors who cared about them as people. A higher percentage of the Black graduates, 42% who attended an HBCU also reported having a mentor who encouraged their pursuit of their goals and dreams. Only 23% of the Black graduates from a non-HBCU reported having this type of support. Gallup reported that support was strongly related to the graduates' feeling of preparedness for life outside of college, workplace engagement, and a sense of well-being of the college graduates. Gallup – USA Funds (2015) reported:

For these graduates, two experiences at HBCUs differentiate such universities from their counterparts: having at least one professor who made the graduates

excited about learning and a mentor who encouraged them to pursue their goals and dreams. Strongly agreeing with these two items raised the odds of thriving in all five areas of well-being and being engaged in work, indicated that perhaps the depth and influence of these relationships may be profound at HBCUs. (p. 20)

The researchers reported that when the Black graduates attended a non-HBCU, they were two times more likely to identify their well-being, after graduation, as thriving if they reported that a mentor had encouraged them to pursue their goals and dreams.

In a case study of 19 female students who were all STEM majors at an HBCU women's college, Spelman, three faculty members and five administrators, researchers reported that there was a concerted effort of the faculty to encourage and promote the students' success (Perna et al., 2009). The researchers identified faculty encouragement as a theme that contributed to the African American women's preparedness for STEM careers. The faculty members of Spelman College encouraged the students' academic success by assuming that all the students could achieve their educational goals, and the faculty members worked to ensure that students also believed they could achieve their educational goals by helping them overcome negative stereotypes about women's abilities in STEM. These faculty members worked to encourage academic attainment rather than discourage it and worked to encourage academic attainment by being accessible to students. The findings of Perna and colleagues' research (2009) indicated that the students who participated in their study reported that they benefitted when the faculty members "go well beyond to support them and to make sure they understand the material" (Perna et al., p. 13), and students also benefitted from faculty members that



intentionally reinforced their aspirations and encouraged their consideration for post-graduate programs. The relationships the faculty members developed with students may have positively contributed to the students' identities as STEM professionals, and to their persistence in their STEM majors.

The overall culture of the university could impact a student's perceptions of their experiences at the institution. Some universities do not utilize an academic approach that seeks to build upon a student's academic strengths. Instead, institutions use an approach that weeds students out of programs. At Mount St. Mary University in Maryland, its president, Simon Newman, acknowledged that he devised a strategy to push out low-achieving students. In an email that addressed the incoming freshman class, Newman indicated that he had a goal for 20-25 students to leave the university by the 25th of September in an effort to improve the retention statistics for the University (Schisler & Golden, 2016). Unlike the culture at Mount St. Mary University, culture at the university featured in this phenomenological study may provide a supportive academic climate to all of its students. The participants may be influenced by the culture of the university more than the culture of the STEM community. This influence of university culture might impact the participants' perceptions of their experiences within the STEM community.

Researcher Walter Allen (1992) reported that African American students did not fare as well as White Students at PWIs in overall psychosocial adjustments as they did at HBCUs. In this study, Black students were found to have more favorable psychosocial adjustments reflected in positive self-images, strong racial pride, and high aspirations at HBCUs. At PWIs, African American students reported feelings of alienation, sensed

hostility, racial discrimination, and lack of integration (Allen, 1992). Although universities may recruit students with similar backgrounds, abilities, and achievements, consideration needs to be made of the educational setting where the students will learn to master the skills needed to succeed in the profession of their choice.

### **Mentoring**

Mentoring provides an opportunity for a novice to receive an interpersonal exchange with an experienced person (Blake-Beard et al., 2011). Mentoring can have a career function and a psychosocial function for the student. When the exchange between the mentor and the student provides an understanding of the discipline or major, it fulfills a career function. When the exchange provides an opportunity for the student to receive confirmation, acceptance, friendship, and counseling from the mentor, it fulfills a psychosocial function (Blake-Beard et al., 2011). In addition, mentoring can provide role modeling for the student by providing guidance for shaping his or her own values, behaviors, and attitudes. As stated by Ragins and Kram (2007), “At its best, mentoring can be a life-altering relationship that inspires mutual growth, learning, and development” (p. 3).

In a longitudinal study of 94 Westinghouse Science Talent Search winners, mentoring played a role in STEM persistence (Subotnik, Duschel, & Selmon, 1993). The Westinghouse Science Talent Search award was given to high school seniors for the design and completion of original science or science-related research. As a group, these students were recognized to be a prospective pool of future scientists, mathematicians, and engineers. The 94 winners of this talent search were invited to participate in the study

as high school students and were surveyed and interviewed for 10 years. The study was constructed to investigate longitudinally the variables that characterized individuals who follow a path of superior achievement and high creativity in science, using questionnaires and follow-up interviews. Fifty-seven of the participants in this study were men, and 37 were women. The researchers did not share the ethnicity of the participants. Mentoring was mentioned as a factor that was different between the students who stayed and the students who departed STEM majors. By 1988, 5-years into the 10-year study, 41% of the females had dropped out of science-related fields, and only 12% of the males had dropped out. It was reported that students who stayed in a STEM major and entered into a STEM career or graduate STEM studies, experienced a more supportive environment than students who chose not to pursue a STEM career or finish a STEM major (Subotnik et al., 1993).

Once in college, the students' experiences differed in the level of tacit knowledge they received from mentors to succeed in research (Subotnik et al., 1993). Tacit knowledge was categorized as being information that was more informal than formal, and this information was more practical than academic. The tacit knowledge obtained by the students was reported to be important to survival in STEM. Subotnik and colleagues (1993) observed that the talented students who lacked tacit knowledge or mentoring guidance needed to compete in scientific research, opted out of science. The researchers also observed that the students who stayed in science were more likely to have enthusiastic professors who encouraged their students to participate in science competitions.

Subotnik and colleagues (1993) reported that those who remained in the science track were more likely than those who dropped out to have been supported in efforts to carry out research projects. They were given resources to engage in research and were provided mentoring at a level equal to what the participants experienced in high school. They also had exposure to knowledge needed to succeed in the world of scientific research (Subotnik et al., 1993). When one participant who opted out of the STEM pipeline was asked to comment on the lack of support she had received in college, she replied:

I think it's very discouraging because I do have a deep interest and deep love for science. No matter what I do, inevitably I come back to that. I want to have a career that relates to science, and I'm sorry that there wasn't someone there who would have recognized that. (p. 70)

For this student, it appeared that a relationship with a member of the STEM community was needed to help her connect to a STEM career. Unfortunately, this type of relationship was not evident for many of the participants. When the study began, 37 women had a passion for STEM and had been awarded for their own scientific research (Subotnik et al., 1993). When the study ended, only 22 of these women stayed in the STEM field (Subotnik et al., 1993).

When the students who stayed in a STEM pathway were questioned, all but one had a faculty research advisor or mentor. Their advisors were reported not to have provided much emotional support, but they provided support in other ways. The advisors or mentors who were categorized as the most helpful provided general advice, suggested

research topics, provided access to equipment and facilities, and introduced the students to professionals in the field (Subotnik et al., 1993). The type of assistance provided by the advisor or mentor may have been a contributing factor to a higher level of retention by the male participants. By the end of the study, only 12% of the male participants dropped out of the STEM pipeline (Subotnik et al., 1993). Perhaps the students, who did not choose to remain in STEM majors or pursue STEM occupations, did not receive the type of mentoring they needed.

Mentors can provide psychological and emotional support, degree and career support, and academic support (Burke, McKeen, & McKenna, 1993). In a study that examined the type of mentoring women received, mentors reported female mentees received more psychosocial mentoring than males; males received more career-related mentoring (Burke et al., 1993). Liang (2002) reported that mentoring relationships that matched the needs of the population buffered the effects of stress due to school transition and adjustment. Liang (2002) proposed that college-aged women might be better served by a reciprocal type of mentoring that recognizes their psychological needs and fosters growth instead of the unidirectional relationship that passes down advice. Liang's research revealed that women with high levels of relational mentoring had higher levels of self-esteem and sense of connection. The presence of relational qualities in mentoring was reported to contribute to efficacy in the lives of women (Liang, 2002).

In a comparison study that examined the self-efficacy of men and women in successful STEM careers, gender differences arose. Men and women reported different contributing factors to their self-efficacy (Zeldin et al., 2008). The analysis of narratives

revealed that the self-efficacy beliefs of the men were based on mastery experiences. The analysis of Zeldin and colleagues (2008) relayed that the female participants relied on “relational episodes in their lives to create and buttress the confidence that they can succeed in male-dominated domains” (Zeldin et al., 2008, p. 1036). The women in the study reported that relationships with family, academic members, and peers nurtured their self-efficacy and helped them develop persistence and maintain efforts to overcome personal, social, and academic obstacles. Zeldin and colleagues (2008) reported:

Women consistently recalled experiences that involved an influential person, often during a critical time, which helped them, develop their beliefs about their capabilities while they also developed their competencies. The vicarious experiences influenced both their ideas regarding STEM careers and their philosophies about women in male-dominated fields. Although these women recalled obstacles such as negative social messages about themselves and about their careers or academic pursuits, their experiences with positive messages and models proved more influential in their pursuit of STEM careers. (p. 1039)

In this study, the male participants' self-efficacy in STEM was based on their achievements and success in the field instead of relational support. Their self-efficacy was not tied to their perceptions of relationships with people in STEM.

In a study that examined how to decrease the barriers undergraduate women experience as STEM majors, mentoring was referenced as a tool to facilitate success. Campbell and Skoog (2004) examined the experiences of 57 undergraduate women who had participated in a biological science program. Campbell and Skoog (2004) reported

that the women benefitted from mentoring relationships, which provided support, encouragement, and expertise for the students. When combined with undergraduate research opportunities, mentoring positively affected the women. The women in Campbell and Skoog's study (2008) reported that mentoring provided them with critical support, positively affected their career decisions, and stimulated their consideration for graduate school, and continued participation in scientific research.

Mentoring has also been used to improve the social adjustment and academic performance of college students. In a study of 320 community college students, mentoring significantly predicted the degree to which students became socially and academically integrated. Mentoring was found to have a positive outcome on student self-confidence, self-actualization, expectations, future aspirations, and persistence rates (Crisp, 2010).

Researchers de Janasz and Sullivan (2004) proposed that having one mentor in college is unlikely due to demands on faculty. Faculty often leave an institution to obtain a tenured track position. Colleges can also have a high representation of non-tenured faculty who may teach there for short periods of time. De Janasz and Sullivan (2004) proposed that a collection of mentors would be needed to provide career guidance in addition to psychosocial or emotional support. They argued that developing multiple relationships with people who can assist in different aspects of a career would be more beneficial than a traditional mentoring relationship with only one person. De Janasz and Sullivan (2001) advised that different members of faculty could be targeted who could assist in developing a specific skill and competencies, providing emotional support, and

offering career advice. Since this approach was advised for faculty members who were seeking to establish themselves in academia, a multiple mentoring approach may also be beneficial for undergraduate students in higher education as well.

### **Summary**

The literature has revealed that there will be an increased need for STEM professionals (U.S. Bureau of Labor Statistics, 2017). Even though women made up 50.7% of the U.S. population, they represented only 26% of the STEM workforce (NSF, 2011). Because African American women constitute a growing representation of the college population, it would be beneficial to examine their experiences in STEM programs to increase their representation in STEM careers. Research has indicated that African American women were less impacted by gender stereotype threats (O'Brien et al., 2015) and African American women were more likely to indicate they were majoring in STEM fields than European women. Even though representation of African American women in STEM-degree completion is decreasing, mentoring has played a role in STEM persistence (Subotnik et al., 1993).

Presently, there exists a gap in the research that examines the experiences of African American women from the beginning to the end of a STEM undergraduate program at an elite PWI. This research study fills in this gap through a qualitative study that investigates this lived experience.



## **CHAPTER THREE: METHODS**

This chapter describes the research design, research strategy, sampling method, instrumentation, data generation and collection, data analysis, ethical considerations, and limitations for this study. Previous literature has reported the trends of degree completion and majors of undergraduate students. However, these numerical reporting do not provide sufficient information to understand the multiple factors that affect STEM persistence for an undergraduate student who is classified as a double minority: African American and female. We must explore the lived experiences of these students to grasp an understanding of the lived reality of connecting to an academic community that does not exhibit a large representation of the African American ethnicity or the female gender. The purpose of this study was to explore the experiences of female African American students in a mentoring relationship to understand how informal relationships can impact their sense of belonging to the STEM community.

### **Research Questions**

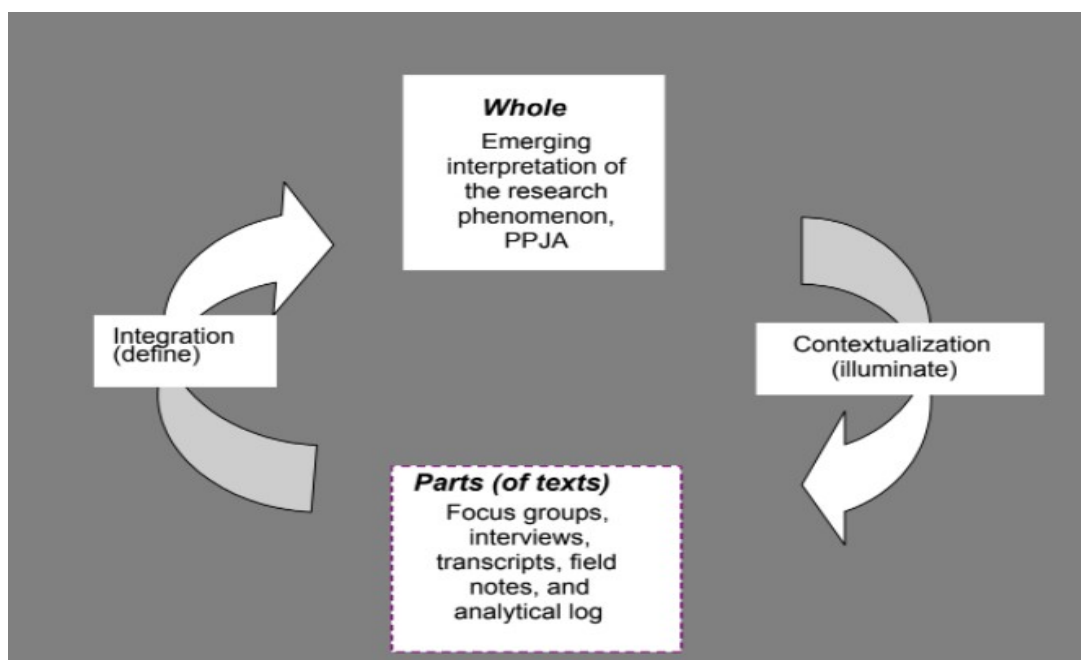
The following research questions guided this study.

1. What are the lived experiences of female African American STEM undergraduate students of the STEM community at an elite PWI?
2. What are the lived experiences of female African American STEM undergraduate students with their mentors?

## **Phenomenological Case Study**

The intention of a phenomenological study is to gain an understanding of the essence of an experience (Creswell, 2013). It permits the voice of people who have experienced a phenomenon to communicate it. This research method is well-suited to examine the phenomenon of being a double minority in the STEM community, namely a woman and an African American. The study explored the experiences that minority female undergraduates have had with their mentors and the STEM community at the university. The aim of the phenomenological approach is “to determine what an experience means for the persons who have had the experience and are able to provide a comprehensive description of it. From the individual descriptions general or universal meanings are derived” (Moustakas, 1994, p. 13). Knowing more about the experiences of African American women in their STEM relationships and the STEM culture on a university campus might provide insight to the components that are needed to promote retention in STEM majors and increase entry into STEM careers after graduation.

**Hermeneutic circle.** The hermeneutic circle from Heidegger’s framework of phenomenology permits the researcher to look for meaning in the data through a lens of pre-understanding (Figure 1). In this process of analysis, the understanding for the researcher changes as the text is examined in whole, in part, and in whole. Each examination impacts how the whole and the parts of the phenomenon are interpreted.



*Figure 1.* Adapted from “Using Hermeneutics as a Qualitative Research Approach in Professional Practice,” by M. Paterson and J. Higgs, 2005, *The Qualitative Report*, 10(2), p. 345. Copyright 2005 by Nova Southeastern University.

A traditional approach of phenomenological analysis utilizes bracketing to suspend the judgment of the researcher to remove their own beliefs about the phenomena in order to see it clearly (Lavery, 2003). Hermeneutic phenomenology instead uses a process of co-construction of the data by the researcher and the co-participant (Lavery, 2003). I used this approach to follow the steps of Moustakas’s (1994) modification of the Stevick-Colaizzi-Keen method of analysis.

This process did not require me to bracket myself out of the experiences of the co-participant because of a shared experience in the culture or environment of the study (Lavery, 2003). Because of my experiences of being an ethnic minority at an elite Predominately White College for 12 years of combined undergraduate and graduate studies, I believe a hermeneutic approach to analysis provided a more credible approach

to data analysis. Heidegger (1962) stressed that every encounter people have in the world involves an interpretation that is influenced by an individual's background. The Hermeneutic circle permitted me to utilize pre-understandings of the environment or world in the interpretation of the lived experiences of others. According to Munhall (1989) "Pre-understanding is not something a person can step outside of or put aside, as it is understood as already being with us in the world" (p. 28).

Researcher Gadamer (2004) explained that this approach is different from a formal approach to qualitative analysis:

The circle, then, is not formal in nature. It is neither subjective nor objective, but describes understanding as the interplay of the movement of tradition and the movement of the interpreter. The anticipation of meaning that governs our understanding of a text is not an act of subjectivity, but proceeds from the commonality that binds us to the tradition. (Gadamer, 2004, p. 293)

Using this approach, I developed an understanding of the co-participants' experiences in a new way through their individual responses to open-ended questions about their experiences as a STEM student and as a mentee.

As a researcher, I valued the perspective of the co-participant, but I understand that my belonging to the African American community and also being a student with undergraduate and graduate experiences at elite PWIs impacted my interpretation of the experiences of the co-participants. Indeed, a person's view of the world and the people in the world are related to cultural, historical, and social contexts (Laverty, 2003).

Heidegger relayed that all understanding inevitably involves some prejudice and that “prejudice certainly does not necessarily mean false judgment” (Gadamer, 2004, p. 273). I shared the same ethnicity as my co-participants and the experiences of being an ethnic minority at a high achieving PWI. I understand how this connection with the experiences and ethnicity of the co-participants impacts how I interpreted their experiences. The Heidegger approach to analysis provides a strategy to understand how my own biases impact my understanding of the experiences of others. In Gadamer’s review of the analysis of the Heidegger approach, he stated,

.A person trying to understand a text is prepared for it to tell him something. The important thing is to be aware of one’s own bias, so that the text can present itself in all its otherness and thus assert its own truth against one’s own fore-meanings. (Gadamer, 2004, pp. 271-272)

Gadamer conveyed that the researcher always has some connection to the research that should be acknowledged:

Research in the human sciences cannot regard itself as in an absolute antithesis to the way in which we, as historical beings, relate to the past. At any rate, our usual relationship to the past is not characterized by distancing and freeing ourselves from tradition. Rather, we are always situated within tradition, and this is no objectifying process—i.e., we do not conceive of what tradition says as something other, something alien. (Gadamer, 2004, p. 283)

In Gadamer’s examination of the Heidegger framework, he explained:

A person who is trying to understand a text is always projecting. He projects a meaning for the text as a whole as soon as some initial meaning emerges in the text. Again, the initial meaning emerges only because he is reading the text with particular expectations in regard to a certain meaning. Working out this fore-projection, which is constantly revised in terms of what emerges as he penetrates into the meaning and understanding what is there. (Gadamer, 2004, p. 269)

As a researcher, I sought to understand the experiences of the female African American STEM undergraduate in a southeastern state. After the co-participants shared their experiences, I sought to identify the larger meanings and themes in the experiences shared by using an approach that examined the collective experiences as a whole and the individual experiences in part. Then, I divided the whole experience into different parts to identify the themes from the experiences. These themes were synthesized and put back together so that the whole experience could be reexamined in light of the newly acquired understanding of the parts of the experience.

The process that Heidegger described is that every revision of that fore-projection is capable of projecting before itself a new projection of meaning; rival projects can emerge side-by-side until it becomes clearer what the unity of meaning is. Interpretation begins with fore-conceptions that are replaced by more suitable ones. This constant process of new projection constitutes the movement of understanding and interpretation (Gadamer, 2004, p. 269).

This approach to research incorporates a circular movement of understanding called the Hermeneutic circle. This approach places emphasis on the act of inquiry. It

permits the researcher to go back and forth between personal reflection and the larger concept being explored. As the researcher, I identified the characteristics of being an African American who attends an elite PWI in a southeastern state and found meaning in the experiences of the co-participants through examining the individual experiences and the collective experiences as a whole. I revised my understanding of the phenomenon of being a female African American, STEM undergraduate major at an elite PWI as I found meaning in the individual parts of the text. As I read the transcripts of individual experiences, I made revisions of my understanding of the collective experience. There was a movement back and forth from the text that was being understood to the personal understanding I received from the reported phenomenon. In that regard, “the circular movement of understanding runs backward and forward along the text, and ceases when the text is perfectly understood” (Gadamer, 2004, p. 294). Gadamer (2004) further stated that,

Understanding means, primarily, to understand the content of what is said, and only secondarily to isolate and understand. Understanding is not, in fact, understanding better, either in the sense of superior knowledge of the subject because of clearer ideas or in the sense of fundamental superiority of conscious over unconscious production. It is enough to say that we understand in a different way, if we understand at all. (p. 296)

Analysis based on the Heidegger’s hermeneutic circle permitted the researcher to understand the essence of the experiences of African American women in their STEM undergraduate majors and their experiences with their mentors.

## **Sampling**

All of the participants in the study were enrolled in the same elite PWI in a southeastern state. This permitted me to understand the participants' perspectives on interacting with the same STEM community at the same university. I was able to obtain a comprehensive understanding of the experiences of being a female African American STEM undergraduate by solely focusing the investigation on one university in a southeastern state. Participants in this study have experienced the STEM culture on the same campus. It is possible that they have shared the same classroom spaces and interacted with the same faculty.

A participant range from 3 to 10 is suitable to investigate a phenomenon using qualitative case study research methods (Creswell, 2013). A co-participant is defined as a joint contributor and investigator of the research project (Given, 2008). I used a purposeful convenience sampling to select eight co-participants. A participant sample size of eight permitted me to collect multiple perspectives of the STEM community at the elite PWI in a southeastern state. This number also afforded me the opportunity to analyze the data if any co-participants decide not to complete the study. In order to participate in this study, the co-participant needed to be an African American, undergraduate or recently graduated woman who was over 18 years old and majoring in science, technology, engineering, or mathematics. The co-participant also needed to be involved in a mentoring relationship with someone who was connected to the STEM field.



This university was classified in the Carnegie Classification of Institutions of Higher Education as 4-year, medium-sized, highly residential, public university. It was also identified as a doctoral university with higher research activity, a high undergraduate enrollment profile, and a lower transfer-in rate. The majority of the undergraduate students were full time.

This university was also selected for its location within a southeastern state of the United States. Historically, efforts were made to resist the integration of African Americans into the public school system (Virginia Historical Society, 2017). In 1954, Senator Harry F. Byrd, Sr. promoted the practice of Massive Resistance. Senator Byrd's Massive Resistance promoted the adoption of a group of laws that were intended to prevent the integration of schools. These laws permitted state funds to be cut off and schools to be closed that attempted to integrate. It also provided tuition waivers to students who did not want to integrate and changed the placement of students to prevent integration. Conducting this study at a college in a southeastern state provided insight to the current experiences African Americans are having in public educational institutions today.

The co-participants were selected from a PWI that is considered an elite educational institution. This university is an elite institution because of these highly selective admission criteria. An elite institution represents 70 schools with the most restrictive admissions criteria ("The Elite Schools," 2010).

These schools generally accept fewer than 30% of all applicants and have a highly selective reputation. Students who attend these universities most likely have a

high grade point average, high-test scores, superior writing ability, and exemplary extracurricular achievement.

This university was chosen because it provided access to a large sampling of high achieving students. As a doctoral candidate with a concentration in gifted administration, I am interested in the experiences gifted students have past the doors of a high school. Multiple efforts are made to funnel high achieving students into the pursuit of STEM degrees, such as the promotion of advanced high school diplomas with high concentrations of advanced coursework in mathematics and science. Examining the experiences of high achieving students at a high achieving PWI would provide guidance to help prepare future students to enter STEM majors.

I used a combination of emails and flyers (see Appendix A), and personal solicitation to find participants for the study. A request was made to the director of an undergraduate program designed to increase minority participation in research, to send my contact information, participation criteria, and a description of the research focus to prospective participating students. Co-participants were solicited from a student organization, Scope, established to provide academic and social networking opportunities for minority STEM majors at the university identified for the study. Representatives of traditional African American sororities were also contacted to find potential co-participants. I sought participants through snowballing, which is defined as the selection of participants for a study by asking a person who is a suitable participant to recommend someone else who is suitable for the study of the phenomenon of interest (Gall, Gall, & Borg, 2007).

## **Instrumentation**

In the spring of 2018, I designed a data collection instrument (see Table 2) to gain an understanding of the experiences of co-participants who are a double minority in a STEM major and in a mentoring relationship. In phenomenological research, it is important to examine how individuals describe the phenomenon they have experienced (Moustakas, 1994). These co-participants would be considered a double minority because of the minority status of women in the STEM undergraduate major and the minority representation of African Americans in STEM majors.

**Data sources.** Prior to the interview, co-participants received a letter of consent (Appendix B). The letter of consent described the scope of the study and the co-participant's role. Contact information of the chair of the dissertation committee was provided in this letter for co-participants to use to discuss irregularities or concerns in the conduction of this research.

I utilized an open-ended protocol (Appendices C and D) with questions to explore the STEM and mentoring experiences of African American females who are a double minority in their field of undergraduate studies because of their ethnicity and gender. The interview protocol (see Appendix E ) required the co-participant to examine and relay her experiences in the STEM community using her perspective as a STEM student, an African American, and a woman. Each interview question was followed by probing questions to provide descriptions of the lived experiences of the participants. The relation each protocol has to each research question was identified. A post interview checklist

(Appendix F) was used to standardize the ending of the interview and provide an opportunity for the researcher to reflect on the process.

**Icebreakers.** The first questions of the protocol (see Appendix E) were preliminary questions that were used as icebreakers. They were used to help build rapport with the co-participants by having them communicate the positive experiences that ignited their passion for STEM and selection of a STEM major, and to reflect on a person or experience that sparked their interest in STEM. There was a need for me as the interviewer to form a bond with the co-participants and make them feel comfortable and trusting (Creswell, 2013). In addition, icebreakers were used to collect background information on the co-participant to contribute to their description as co-participants.

**STEM culture.** To explore the experiences of the co-participants in the STEM culture, the next set of questions and their follow-up questions (see Appendix E) were constructed to have the co-participants discuss their experiences within the STEM community while considering their identities as an undergraduate student, an African American, and a woman.

**Mentoring.** The last set of questions (see Appendix E) were designed to explore the experiences of the co-participants in their mentoring relationships. These questions explored their lived experiences and what they were aware of at the time in the STEM field with persons they considered to be their mentors.

## **Data Collection**

I collected data by conducting interviews with 8 female African American undergraduate STEM majors who attended a PWI in the South. They were conducted during the spring semester of 2018 following the approval of the Educational Internal Review Committee, EDIRC, at the College of William and Mary (see Appendix G). As previously described, the interview questions were broad and open-ended, enabling the participants to construct meaning from their experiences (Creswell, 2013). The interview was comprised of open-ended questions, which allowed participants to share their experiences on campus and their mentoring experiences. Individual interviews were conducted in person, or by phone if an in-person interview was not possible. At any time, co-participants could choose not to answer a question or to end the interview. Interviews took up to 60 minutes and were transcribed for the co-participants' review. The co-participants were given a \$10 gift card for their participation in the study.

The co-participants could clarify their responses or opt to remove responses at any time during the research process. In the process of examining the co-participants' responses in the whole, data was classified with codes that described the experience of the co-participant by the researcher (Appendix H). Next, the data was examined in part by the researcher by dividing the responses into different categories: experiences from the lens of a STEM undergraduate student, the experiences from the lens of an African American, experiences from the lens of a woman, and the mentoring experience (see Appendices J, K, and L).

## **Data Analysis**

To analyze the data collected from the interviews, Moustakas's (1994) modification of the Stevick-Colaizzi-Keen method of analysis of phenomenological data was used. The first step in this analysis was to obtain a full description of the participants' experiences of the phenomenon. Following this step, I identified the significance of the description from each verbatim transcript. Next, I recorded all of the relevant statements and listed the non-repetitive and non-overlapping statements to identify the invariant horizons or meaning units of the experiences to identify codes. After this step, I clustered these meaning units into themes to develop a description of the textures of experiences through synthesis. This description included verbatim examples that illustrate the emergent themes from the interviews. Following this step, I reflected on these descriptions and constructed a description of the structures of the experiences and constructed a composite of textural-structural descriptions that described the essence of the experiences. This produced a universal description of the experiences by representing the experiences of the group as a whole.

The intersection of academic achievement, race, and relationships interested me as an educator and a researcher. I desired to investigate the experiences of African American female STEM undergraduates and their mentor relationships. Like me, the co-participants in this study were experiencing an educational institution as an African American.

## **Researcher as Instrument**

As a 48-year-old African American male from a two-parent, middle-class family of professional educators who share an African American descent, I understand that my previous experiences could impact my understanding of the experiences of others. Each one of these factors directly influences my perspective and point of view as a researcher. I am a man who was born at the end of 1960s. I have attended desegregated and integrated schools for the duration of my educational career. I also understand that the acceptance of African Americans into an educational institution can be met with resistance. This resistance can be displayed overtly or in discreet manners. In 1956, public schools were closed in Virginia to resist the integration of schools. In 1960, parents rioted and protested the entry of African American student Ruby Bridges into schools in Louisiana.

At an early age, I learned that the culture of a school environment could impact the experiences of African American students. As a resident of a Black neighborhood, I went to a neighborhood school that was filled with African American children. It was also filled with African American administrators and teachers. Achieving in school was praised above all things in my community. This educational environment bred security and confidence in me. As a primary student in elementary school, I felt that cultural pride and academic achievement went hand-in-hand. I felt a strong sense of belonging.

In middle school, I entered into a new educational environment. In this school setting, my ethnicity was a minority in the student and teaching population. It was in this setting that I had my first encounter with minority stress as one of the few Blacks in a

predominately White school. The lack of African American presence was even more pronounced in my advanced classes. It was in this setting that I discovered there were not a lot of people who looked like me in educational settings designed for advanced learners. I was the only Black student in my social studies class when we discussed the role of slavery in America. I was called upon, not only to give input as a student who possessed knowledge about the subject matter, but also I felt responsible to relay to the class the cultural perspectives of the African American viewpoint. I felt that I was responsible for representing an entire race of people to people who did not share my ethnicity. My words and viewpoint became more than the viewpoint of a teenager and student; I felt like my viewpoint should reflect the voice of a race.

At Bethel High School, at the University of Virginia, at Old Dominion University, and at the College of William and Mary, I would continue to be a minority. Within each institution, I found professionals who provided encouragement and direction. I used the vicarious experiences of my African American professors and teachers to build my own self-efficacy as a student and a scholar. I was directed into leadership opportunities and experiences because of the guidance of these educators. I began to understand that relationships were as equally important as academic ability.

### **Limitations, Delimitations, and Assumptions**

To provide understanding of the scope of this research, I will discuss in the following section the limitations, delimitations, and assumptions of this research study.

**Limitations.** There are limitations that may arise from this study because of participant selection and retention. The method of data analysis selected for this study



required the co-participants to take the role of co-researcher. To participate fully, they committed to an interview and needed to review the units, themes, and textual descriptions that arose from the analysis of the data. It is possible that participation as a co-researcher at the beginning of the semester was more feasible due to the lightness in workload experienced by undergraduate students at the beginning of the semester. It is also possible that by the end of the semester, duties associated with coursework may have limited the availability and role of the student as a co-participant and co-researcher.

A second limitation was the selection of participants through the process of volunteering and snowballing. Participants who volunteered may have strong opinions in favor of, or in opposition to the STEM community at the university or their mentoring relationship. A co-participant who has a very negative relationship with her mentor or university may have been unwilling to share how mentoring was impacting her experiences.

**Delimitations.** This study only focused on the experiences of African American undergraduate women at one elite PWI in a southeastern state. The conclusions were based solely on the experiences the co-participants were willing to share. It is possible that co-participants were unwilling to share some experiences that may exemplify alienation, isolation, racism, prejudice, sexism, or discrimination because of embarrassment or lack of trust with the researcher. To address this concern, efforts were made to meet each participant in person prior to the first interview. This helped participants become familiar with me and become comfortable enough to share their experiences.

**Assumptions.** It is an assumption that responses given in the interview were answered as honestly and as directly as possible. Since the participants in this study were volunteers, it was assumed that they shared their experiences to the best of their ability. Specific details of shared events were considered accurate unless there was a contradiction that was observed from the responses given. When a contradiction in responses was noticed, co-participants were asked to provide clarity orally or through email. The identity of the co-participants were masked for reporting purposes. The names and majors of the co-participants were not reported to protect their identity.

### **Trustworthiness**

In a qualitative study, credibility, dependability, and transferability must be considered to determine the trustworthiness of the findings that are reported. Several features help assure trustworthiness. Trustworthiness is important to evaluate the worth of research (Lincoln & Guba, 1985). Credibility provides confidence in the findings; dependability shows the findings could be repeated; and transferability shows that the findings have application in other contexts (Lincoln & Guba, 1985).

**Credibility.** Credibility is defined as the congruence between the findings and reality (Shenton, 2004). To improve the credibility of my reporting on this phenomenon, I sampled people from a range of majors. Each of the participants had a different STEM major and had attended the same university. This time spent at the university permitted them to give an interpretation of the STEM climate and their perception of a mentoring relationship.

Member checking was used to improve the credibility and trustworthiness of the responses. After the interview was conducted, I transcribed the co-participant's responses word for word. These transcripts were emailed to the participants and returned with edits from the participants. All co-participants had the opportunity to edit for content and meaning. If the participant felt uncomfortable with how a response was given, co-participants could change their replies or offer further elaboration. I also used member checking to permit the co-participant to match their words to what she actually intended to say (Shenton, 2004). If the participants wanted to delete a response entirely, they could. In an effort to promote honesty in the participants, co-participants were permitted to refuse to answer particular questions or a group of questions (Shenton, 2004). In addition, co-participants were able to provide input on the codes and themes that were identified by the researcher. Co-participants received a copy of the codes and themes that emerged and had an opportunity to provide input on the analysis of the researcher as he engaged with the rich textual descriptions.

**Dependability.** Dependability permits the researcher to infer if the research was repeated, in the same context, and if the same methods and participants were used, similar results would happen (Shenton, 2004). Dependability, in qualitative research, can be achieved through the description of the research design (Shenton, 2004). Future researchers should be able to duplicate my procedures because of the detail that I provided of the study design. When studying a phenomenon, the exact results may not occur when studied across different samples of a population (Shenton, 2004). The study may prove to be dependable if the themes that emerge from the interviews were similar to

the themes from other studies that examined the experiences of African American women in STEM undergraduate programs at elite, Predominately White Institutions.

Dependability can also be increased through the reflective appraisal of the project (Shenton, 2004). By evaluating the effectiveness of the inquiry process, the reader of the research can determine how dependable the results were from the study. The descriptive phenomenological investigation captures the invariant structures of the experience (Sousa, 2014). The invariant structure identifies the typified knowledge of the experience but doesn't imply the experience is true for all situations. This makes the essence that emerges from the common experiences to be general experiences but not universal experiences. Even experiences that are not universal provide value because variations in experiences can be significant.

**Transferability.** Transferability discusses the broader generalization of the results of this qualitative study. If a researcher could provide sufficient contextual information, a reader should be able to determine if the results are transferable or applicable to his or her own context (Shenton, 2004). The organization where the study takes place, the number of participants, and the type of co-participants who contributed to the data should all be considered to determine the transferability of a study (Shenton, 2004). These components contribute to the transferability of a study.

Transferability concerns of this study stem from the small number of co-participants, the general ethnic classification used of African American, and the co-participants' backgrounds. Since these findings are based on the responses of self-selected participants, it is impossible to demonstrate that the conclusions can be applied

to other situations or populations. The responses of the students might vary if participants had not volunteered and were selected by random selection. Some students may have a negative relationship with their mentor and ended the mentoring relationship prior to my solicitation for participation in the study. It is possible that experiences may vary based on the student's status as a first-year, second-year, third-year, fourth-year student or graduate of the university. When a study is examined in the context of an environment of similar studies, a broader understanding of a phenomenon can be gained (Shenton, 2004).

Co-participants could also differ in their experience as African Americans. Although all of the participants self-selected their identity to be African Americans or Black, their responses may present problems in being generalized to represent the opinions and experiences of all African American women. If the person considered herself African American because of Jamaican or West Indian or Haitian descent, their perceptions may be different than those of someone who is identified as African American because of ancestry stemming from the practice of slavery in the United States. I also failed to identify other factors that could impact the perceptions of an African American. The background questions did not gather information regarding socio-economic status, family background, and an urban, suburban, or rural residency. Perceptions of the African American participants could also vary due to their previous experiences with racism or experiences while in an integrated classroom.

It is also important to consider the training and expertise of the co-participants involved in fieldwork (Shenton, 2004). In preparation for the study, I participated in 10 hours of training and earned a certificate from the Collaborative Institutional Training

Initiative (CITI). This certification is required by the College of William and Mary for candidates to receive approval to begin a research study involving human subjects.

### **Ethical Considerations**

Steps were taken to protect the welfare of the co-participants of this study. First, I applied for and obtained approval from the Institutional Review Board (IRB) of the affiliated university, the Education Internal Review Committee (EDIRC). The EDIRC evaluated the methods proposed for research and determined their suitability for human study. After receiving approval from the EDIRC, the researcher solicited co-participants by providing to potential co-participants an explanation of the purpose of the study and the criteria that was used to select co-participants. Co-participants discussed the interview process with the researcher and received contact information of the dissertation chair to report questionable practices, and to sign an EDIRC-approved consent form (see Appendix B) during the time of the interview. If the interview was conducted by phone, the consent form was emailed and electronically signed prior to the interview. Phone interviews were conducted for STEM students who graduated in 2017.

I provided a letter of consent (Appendix B) to all co-participants who agreed to take part in the study. This letter of consent informed each co-participant that her participation in the study would not affect her relationship with the STEM department with which she was affiliated. It would also not affect her relationship with her mentor. She was also informed that she had the right to refuse to answer any part of an interview question, a group of questions, or any particular question for any reason. She was informed that she could cease participation in the study at any time, and was given the

contact information of the dissertation chair to communicate any practice she deemed inappropriate or unprofessional.

Prior to conducting the interview, I used the Pre-Interview Protocol (see Appendix C) to review with the co-participant the purpose of the interview, to relay that the interview would be recorded and transcribed, and to inform the co-participant that she would not be addressed by name during the interview. To protect the identity of the co-participants, their names, majors, and university affiliation were masked for reporting purposes. This masking was used because the low number of students who shared characteristics in one major could make it possible for the identity of the co-participants to be revealed if only names were masked.

As an expression of gratitude, co-participants were given a \$10 gift card for their participation by the researcher. This was distributed as the researcher followed the Post-Interview Checklist (see Appendix F). This checklist also guided the interviewer to thank the co-participant for her time, provide contact information, and guided the researcher in reflection of the interview process (see Appendix F).

## **CHAPTER FOUR: FINDINGS**

The purpose of this research was to learn of the experiences of female African American undergraduate STEM students at an elite PWI and their lived experiences with their mentors. This study used phenomenology as a research method, which focuses on consciousness and experiences of people who have experienced a common event (Moustakas, 1994). The researcher seeks to capture the essence of the experiences through investigating text and the context of the experiences. The understanding of the researcher stems from the descriptions of the experiences and the culture where the experiences occurred (Moustakas, 1994). Researcher Moustakas proposed that “history adds to the meaning of experience by reflecting on political and economic activities, settlements, and wars” (Moustakas, 1994, p. 9). Thus, the backdrop of being a STEM major at an elite PWI influenced the experiences of my participants, as did the external culture of being Black in the United States.

Eight co-participants were interviewed about their experiences as a female, African American STEM undergraduate at an elite PWI. Text from these interviews was used to provide the description of the conscious experiences (Moustakas, 1994). Analysis of this text was based on reflective interpretation. This involved the acknowledgement of prejudgment, an adjustment of beliefs based on interaction with the text, the acquisition of new understanding, and a repetition of the process. This study sought to provide understanding of what it is like to be a STEM undergraduate who attends an elite PWI, who is a woman, who is an African American, and who has a mentor.



This phenomenological study was guided by two research questions: (1) What are the lived experiences of female, African-American STEM undergraduate students of the STEM community at an elite Predominately White Institution? and (2) What are the lived experiences of female, African-American STEM undergraduate students with their mentors?

The purpose of this study was to learn of the experiences of female African American undergraduate STEM students at an elite PWI and their lived experiences with their mentors. The voices of the eight co-participants added to the use of a hermeneutical circle. The co-participants represented a variety of STEM majors and were in various stages of their STEM degree programs: first-year, second-year, third-year, fourth-year, and graduate. Each co-participant was assigned a pseudonym to mask her identity. Because of the low reported number of African American women in their majors, the names of the majors and university were omitted. This omission sought to further protect the identity of the co-participants.

### **Researcher's Pre-Understanding**

“Hermeneutic phenomenology is concerned with the life world or human experience as it is lived” (Lavery, 2003, p. 24). The researcher who is identified as the creator of hermeneutic phenomenology, Martin Heidegger, is referenced to propose that a person’s view of the world and the people in the world are related to cultural, historical, and social contexts (Lavery, 2003).

As a college student, I became personally aware of the world in which I lived and injustices that were found in society. As a college student at the University of Virginia,

this awareness impacted my experiences on campus. As a second-year undergraduate student, I participated in rallies at the University of Virginia to encourage the Board of Visitors to divest of their investments in South African companies that practiced apartheid. This experience mirrored the educational traditions of my family. As an undergraduate college student at Virginia Union University, my mother participated in sit-ins at Woolworth lunch counters to protest practices of Jim Crow. Because of these experiences, I believe that world events impact how students develop and engage in college.

This school year (2018), there were several events that brought issues of race to the forefront. In the future, they may be viewed as historical events that impacted my understanding and my interpretation of the responses of the co-participants. The following are some events that I believe have influenced my pre-understanding as a researcher.

This year, the President of the United States referred to African nations as “shit holes.” An online publication by NBC News reported:

It came as senators huddled in the Oval Office with the president to discuss a path forward on an immigration deal. Trump questioned why the United States would want people from nations such as Haiti while being briefed on changes to the visa lottery system. According to the aid, when the group came to discussing immigration from Africa, Trump asked why America would want immigrants from “all these shithole countries” and that the U.S. should have more people coming in from places like Norway. (Vitali, Hunt, & Thorp, 2018)

This event made me feel that African Americans were still not valued as contributing citizens of the American fabric. Even though the former United States President, Barack Obama's father was from an African nation, people who are African immigrants were categorized negatively. This comment made me feel that, despite the contributions African Americans make to this country, people of African descent are not welcomed as much as those who are from European countries.

In the academic year 2017-2018, a rally called "Unite the Right" was held in Charlottesville. On the skirt of the campus where I attended as an undergraduate student, the University of Virginia, several hundred White Supremacists congregated and chanted, "White lives matter!" (Heim, 2017, para. 10) and "You will not replace us!" (Heim, 2017, para. 12). *The Washington Post* conveyed in its online publication:

The chants echoed as the group marched past the iconic halls of the university founded by Thomas Jefferson, paraded down the middle of the hallowed Lawn, climbed to the Rotunda and converged on a statue of Jefferson himself. There they met their enemy. A group of about 30 UVA students—students of color and white students—had locked arms around the base of the statue to face down the hundreds of torchbearers. The marchers circled the statue. Some made monkey noises at the Black counter protests. Then they began chanting, "White lives matter!" (Heim, 2017, para. 9 & 10)

This event underscored for me that people from diverse backgrounds were unwelcomed and unsafe at college. I am unsure why this location was chosen to communicate racism. I am sure that the presence of this group on campus negatively impacted the African

American students who attend the University of Virginia, my alma mater. As a member of the African American community, I feel like I was one of those students who was targeted.

In April of 2018, Syracuse University suspended an engineering fraternity for racist, anti-Semitic, and homophobic chants and slurs (Schmidt, 2018). Verbally, members and pledges of this engineering fraternity made oaths using curse words in a video to affirm hatred for African Americans and others from diverse backgrounds. This video was another negative social persuasion that conveyed to me that African Americans are not valued or welcomed in higher education settings.

Some could try to discount these occurrences as isolated incidents. Regardless of their proximity to the institution where this study was conducted, I believe these incidents can have a compounded impact on African American students who are learning in an institution where they are different because of race, country of origin, gender, socio-economic status, and educational legacy. Several of the co-participants came from families whose parents were first-generation immigrants from Africa. As they recounted their experiences and perceptions of the STEM community, I understand how their perceptions of their experiences could be associated with acts of racism in other elite PWIs, across the state, and by national leaders.

The Congressional Commission (2000) reported that a problem contributing to the lack of diversity in STEM careers is racism. Racial prejudice, ethnic stereotypes, and gender stereotypes were identified as pervasive elements in the professional lives of women and minorities. Because of this research and the current events that are

happening in my nation, state, and school, it is my pre-understanding that elements of racism and sexism exist. I believe that the co-participants could perceive and experience a level of difficulty in the STEM community because of their gender and race.

### **African American, Female, STEM Co-Participants**

Eight women who had mentors and self-identified as African American STEM undergraduates at the same elite PWI participated in this study. The group was comprised of six undergraduates and two students who graduated from undergraduate programs at the college in 2017. Of the six students who were undergraduates, two co-participants identified themselves as freshmen, one identified herself as a sophomore, one identified herself as a junior, and two identified themselves as seniors. Two co-participants identified themselves as 2017 STEM graduates of the same institution. Each of the co-participants reported that they had a mentoring relationship. Three of the co-participants indicated that they had a formal mentoring relationship, and five of them had an informal mentoring relationship. In Table 2, a summary of participants is presented with regard to their class year and type of mentoring relationship.

Co-participants also differed in background. They differed in their legacy in college, legacy in STEM, and legacy in the United States. Co-participants differed in their status of being a first-generation college student. Co-participants also differed in their legacy in STEM. Three co-participants had parents who had earned STEM degrees. Students also differed in their family's longevity in the United States. Three co-participants indicated that one or both parents were first-generation immigrants from

Africa. In Table 3, a summary of participants is presented to indicate their family's background in college education, STEM education, and immigration.

Table 2

*Summary of Participants*

Participant Pseudonym	Class Year	Type of Mentoring Relationship
Amy	Fourth	Informal
Jeanine	First	Formal
Joan	Third	Informal
Karen	Second	Formal
Laura	2017 Graduate	Informal
Lydia	First	Formal
Stephanie	Fourth	Informal
Yvonne	2017 Graduate	Informal

Table 3

*Summary of Participants' Demographics*

Participant Pseudonym	First Generation College Student	Parent(s) Earned A STEM Degree	Parent(s) are Immigrants from Africa
Amy	No	No	Yes
Jeanine	No	No	No
Joan	No	Yes (Dad)	No
Karen	No	No	Yes
Laura	No	No	No
Lydia	No	Yes (both)	Yes
Stephanie	No	Yes (both)	No
Yvonne	Yes	No	No

Interviews were conducted with the co-participants in March of 2018. Interviews with the undergraduate students were conducted in person in a study room in the library of their campus. Interviews with the recent graduates were conducted by phone. Interviews lasted 35-60 minutes. The responses of the co-participants were recorded using Apple Photobooth. The camera only recorded the image of the researcher and the verbal conversation of the co-participant and interviewer. After the interviews, all of the co-participants received transcripts of their interview and three provided edits to the document. Following, they were emailed biographical questions about their backgrounds. These questions were developed because of the responses of some co-participants in their elaborations. Afterwards codes and themes that had been identified by the researcher

were shared by email to permit the co-participants to provide feedback on the understanding that was emerging from the data. All of the co-participants had the opportunity to provide input on the analysis of the researcher and modify or delete responses that had been given. None of the co-participants requested a change to the coding or theme identification that was made by the researcher. The following sections provide further details on the backgrounds of the co-participants.

**Amy.** Amy is a senior who will graduate with a STEM degree in May 2018. Her interest in STEM emerged as her mother underwent treatment for a variety of illnesses. As her mother interacted with different members of the health profession, Amy's interest was peaked to become educated in a field that would produce healing for others. Amy selected her school because of the counsel of her mother's friend. At first, the academic reputation of the university was intimidating to Amy. Her mother's friend was an alumna of the university and encouraged her to apply. On her campus visit, Amy remembers a peaceful and intense campus atmosphere. As a self-described intense person, Amy thought the university would be a perfect fit for her.

Amy has an informal mentoring relationship. She chose her mentor because she was an alumna of Amy's university. Amy values her mentoring relationship because she shares a similar background to Amy. Both Amy and her mentor are from families in which the parents are first-generation immigrants from Sierra Leone. Amy describes her parents' educational undergraduate experiences as nontraditional. Neither of her parents holds a STEM degree. Having a mentor who attended the same university as Amy provides her with the psychosocial support of empathy. The source of this emotional



support is validated because it comes from someone who is familiar with the student experiences at her university.

**Jeanine.** Jeanine is a first-year STEM student. She made the choice to major in STEM after a discussion with her father. She originally wanted to major in political science but he did not support this choice because of possible difficulties for employment after graduation. Jeanine believes her current STEM major will easily connect her to employment because of the integration of technology into multiple fields. In congruence with her father's persuasion, Jeanine was encouraged by the message that STEM was now open to women. She believes there is now an emphasis for more women to enter into male-dominated fields.

Jeanine is in a formal mentoring relationship. Jeanine met her mentor over the summer while attending a university-sponsored program. Her mentor has given her studying tips, strategies to improve her retention, and connected her with resources she could use to get additional help. In the second semester of her first year, Jeanine believes she will reach out more to her mentor for emotional support. She feels strong academically as a student but complains that she is sacrificing her mental health just to do better in class. Jeanine's mentor provides her with a positive verbal persuasion by saying, "You're doing great!"

**Joan.** Joan is a third-year STEM major who has her sights on going to medical school. Joan relayed that there are not a lot of people who understand what she is going through as a female, African American, STEM major. In her opinion, students in the humanities do not understand what it is like to be in a 3-hour-long lab. In her opinion,

this makes it hard to talk to everyone about her experiences. As a woman, she indicated that men would not always understand her point of view or would be receptive to her perspective. She believes there is also a disconnect when discussing with other cultures about her experiences as an African American. She relayed that sometimes people questioned how she earned her scholarship and assumed it was because she was African American. She believed this assumption was insulting because it errantly omitted the fact that she was smart.

Joan was not part of a formal mentoring program. She has an informal mentor that she chose herself after going to a workshop in a university program that is designed to encourage minority students to become researchers. After this faculty made a presentation at a sponsored event, Joan approached him to initiate the mentoring relationship. His research on Alzheimer's spoke to her, and she declared her major in his field the week following his presentation. Joan values her mentor's knowledge about this area and about medical school. As a former pre-med advisor, Joan believes his understanding of the process will help her attain her ultimate goal of becoming a doctor.

**Karen.** Karen is a second-year STEM student who chose to attend this elite PWI because of the financial aid and scholarship offered by the school. Both of her parents are college graduates but do not possess a STEM degree. Her father is from Kenya. She indicated that her father really encouraged her in her choice of major and her interests in STEM. He encouraged her to go after STEM opportunities in high school. This relationship led to her participation in a STEM summer program at Massachusetts Institute of Technology. This reinforced that STEM was the perfect major for her.

Karen has a formal mentoring relationship with a person who was assigned to her. Karen's mentor is her academic advisor. He provides academic advice and verbally affirms the inclusion and promotion of women in Karen's major. Karen indicated that her mentor is one contributor to her confidence. Talking with her mentor gave her an extra spark. She said,

It makes me feel like I can do this, or I am shooting for something that is bigger than this. Taking time with him gave me a lot of confidence in the things I could do and what I was able to achieve.

**Laura.** Laura graduated with a STEM degree in May 2017. She chose to attend this university because of the scholarship that was offered to encourage her enrollment. She describes herself as a person who just loves science. When she described her intense passion for science, she said, "Whenever I learned anything STEM related, it was like I saw color. My world was exciting and interesting, and I wanted to learn more."

Laura has an informal mentoring relationship with a university professor. He was recommended to her after she communicated her frustration with her academic performance with an instructing professor. This referral turned into a mentoring relationship that provided academic support and empathy. She learned how to study more efficiently, how to schedule her classes to balance a challenging course load, and provided a listening presence to process frustrations and provide meaningful guidance.

**Lydia.** Lydia is a first-year STEM student. Lydia stated that her passion for STEM comes from her parents. Both of her parents earned STEM degrees and are first-generation immigrants from Africa. Lydia says, "As I went through life, I couldn't see

myself in another field.” She chose to attend this university because of its great reputation and the financial support it provided her through a scholarship.

Lydia has a mentoring relationship that is formal. She identifies her freshman advisor as her mentor. Lydia believes she was paired with this mentor because of the responses she turned in on a survey she completed. Lydia uses her African American peers for emotional support and her mentor for academic advice. She believes her mentor makes the task of earning a degree less daunting. Lydia relays that going to talk with her mentor eases her fears and lets her know that she is on track.

**Stephanie.** Stephanie is a fourth-year STEM major who will graduate in May 2018. Both of her parents earned STEM degrees and played a role in developing Stephanie’s science identity. She boasted that her father also attended an elite PWI and that her mother earned a medical degree. Stephanie saw her parents as trailblazers and wanted to be a trailblazer herself. As a teacher assistant in a research lab, Stephanie believes her presence inspires other African American students to persevere in STEM courses.

Stephanie’s mentoring relationship was informal. She was mentored by her youth pastor who earned a degree in engineering. Her mentor provided verbal encouragement in Stephanie’s participation in STEM studies and a safe space to be affirmed in scientific pursuits. Her mentor provided an environment for Stephanie to be her authentic self and not diminish the scientific side of her self.

**Yvonne.** Yvonne became a first-generation college graduate upon the receipt of her STEM degree in 2017. She stated that this status was a source of frustration at the

university. Aspects of normal university protocol such as meeting professors during office hours understanding how to utilize a teaching assistant, and navigating through coursework were like a series of roadblocks she had to navigate over.

Yvonne had an informal mentoring relationship with the head of a program designed to increase minority participation in research at the university. Yvonne interacted with this person to receive academic counsel and advice. Although her mentor was available for her when she needed help, provided responses to emails, and provided contacts to additional resources, Yvonne relayed that she felt like one of the crowd in her relationship with her mentor. Yvonne's mentor was primarily a source for academic support.

### **Theme Identification**

Following the acknowledgment of my pre-understanding, the Hermeneutic circle was used to understand the whole of the phenomenon. This process provides immersion in the text by examining the whole of the text, examining the text in parts, then examining the whole of the text again. This process was done by reading all of the transcripts of the co-participants, looking at the research in parts as it was relayed as the co-participant considered her STEM identity, African American identity, and identity as a woman, as presented in Appendices H, I, J, and K. Then, I looked at the responses of the co-participants as a whole again and interpreted them by classifying the responses to the open-ended questions by codes. These codes were then grouped into themes to generalize the experiences and perceptions of the co-participants.

The disaggregation of the data caused the following four themes to emerge: (a) discouraging academic environment, (b) minority stress, (c) positive persuasions, and (d) mentoring support (see Table 4). The frequency table in Appendix G indicates the co-participants that referred to experiences that exemplify the labeled code. Direct quotes are used to provide examples of the participants' voices. Sections of these direct quotes are italicized to indicate the confirmation of the theme identified through the code.

Table 4

*Summary of Codes and Themes*

<b>Codes</b>	<b>Theme</b>
Introductory classes are too big	Discouraging Academic Environment
Introductory classes are weed-out classes	
STEM department is too small and insufficient	
STEM is hard	
Low African American representation	
Decreasing African American representation	
Adjusting to major takes time	
Lacking role models on campus	Minority Stress
Low female representation	
Gender stereotype threat	
Racial stereotype threat	
Negative verbal persuasions	
Imposter phenomenon	
Microaggressions due to lack of understanding	
Participants see themselves as smart	Positive Persuasions
African American peer support	
Positive female social persuasion	
Positive verbal persuasion	
Female faculty provide vicarious experiences	
Participant provides vicarious experiences for others	
Parents provide vicarious experiences	
Defines mentor in relation to goals	Mentoring support
Defines mentor in relation to psychosocial support	
Mentoring definition combines academic goals and psychosocial support	
Mentor provides academic advice	
Mentor provides mental health support	
Mentor provides empathy	
Mentor provides vicarious experiences	

**Discouraging academic environment.** When asked to relay their experiences in the STEM community at their elite Predominately White Institution, the co-participants revealed several factors that did not promote their academic achievement. Co-participants conveyed that their introductory classes were too big; that these classes were considered weed-out classes; that the STEM department is too small and insufficient; that STEM was a hard major with a low African American representation; that there was a decreasing African American representation in their classes, that adjusting to the major takes time; and that there was a lack of role models on campus.

Karen, a second-year STEM major, commented on the impact that large introductory STEM classes had on her. She perceived that larger introductory classes negatively impacted the foundation a STEM undergraduate was trying to establish:

I guess it was a bit overwhelming at first. The bigger it is, the less personal it is in terms of your relationship with the professor. I think with the amount of work and the amount of people in the class, it is hard for them to give us individual feedback we would need. I think that was a problem with a bigger class and trying to give us a good foundation in the field. (Karen, March 17, 2018)

Karen also thought that the small size of the department limited the number of students who could take the class because of the limited numbers of professors who could teach it. This gave the impression that the STEM department was too small and too inefficient:

It's a good program, but it is much smaller (than I expected). I don't think it is as organized as it could be. I don't think it is run efficiently. The first semester I

came here, there were two intro classes. There were a lot of people needing to take this class. That is a huge downside. I think if it was bigger, you would have more professors to teach the intro level classes, which are the biggest classes.

(Karen, March 17, 2018)

Several students had the impression that the introductory classes were designed to be weed-out classes. This gave them the impression that the classes were not structured to nurture students and help them succeed in the discipline but to remove students from the STEM major. Joan, a third-year STEM undergraduate, reflected:

Everyone above me told me it was a weed-out class. It is not designed for people who want to think outside the box. They wanted very specific answers to their questions, and if you strayed a little away from that then you were no good anymore. They always emphasized, if you don't do well in this class, you will not be admitted. The grade in that class was usually not good. (Joan, March 23, 2018)

As Joan matriculated in her STEM major at the school, she noticed a decline in the number of students who continued to major in a particular STEM major or track:

At this school, a lot of students start out in science or biology, and a lot of students drop off. The number steadily decreases. I think it is kind of sad. I originally wanted to be a bio major, but the intro bio class is such a weed-out class, and I just didn't like the department. (Joan, March 23, 2018)



As a result of these weed-out classes, Joan had a decreased number of friends in her major. It is possible that the decrease from the starting population of STEM majors impacted the level of social support Joan felt was available to her:

There were a lot of people who dropped out of STEM. I had a friend who was in my bio class and now she is international relations major. There are still some of the same people I began with, but the classes get smaller and smaller. (Joan, March 23, 2018)

Stephanie, a fourth-year senior, also reflected on the loss of social support as a result of her peers leaving STEM majors:

In freshman year, you had those larger classes of intro for the major, intro bio classes. There are a lot of people there. Everyone who takes those classes is like pre-med or biology majors. Sophomore year and above, you tend to get smaller classes. Then, I realized that a lot of friends that I had who were (X) majors are not here anymore. (Stephanie, March 18, 2018)

When Stephanie described the STEM experience at the university, she reflected on the lack of African American representation:

Within those lectures, based on race, there are mostly White people, and then there is me, or maybe two other people of color. (Stephanie, March 18, 2018)

The lack of diversity in STEM classes, gave Joan the impression that her classes were not normal. As a second-year student, Joan discovered that she was the only African American in her class:

I had class my second semester of my sophomore year. I was the only person of color. Like, any color! I was like, “Oh, this is kind of weird on a college campus.” It should be more diverse. (Joan, March 23, 2018)

Co-participants also reflected on the lack of African American role models or people who looked like them represented in the faculty at the university. A co-participant, Amy, a STEM graduate, reflected on how this lack of representation impacted her:

You don’t see future versions of yourself. You don’t see many Black professors. You don’t see many Black people brought for talks. You don’t see that on campus. It seems like you are trying to get to a place that not many people of color get to because you are not seeing it. Whereas, my White contemporaries often see those people at those talks. They are the people at the lecture. At my particular institution, (I want to say I believe these are very respectable occupations) you see people of color in janitorial positions or in food services. Mind you, these people were people who aided me in getting my degree because they were constant sources of help and love and everything. Do you see the difference in those two views of your future or potential future? I think it can do something to the psyche at least temporarily. I was always as a Black student wanting to show to myself and the White counterparts that I have very big ambitions. Even though there is a lack of people who look like me doing it, it doesn’t mean that it is impossible. (Amy, March 19, 2018)

Yvonne believed that having more African American representation in the faculty would have provided more emotional support when classes became more challenging.

Yvonne communicated:

I feel like I would have had more emotional support. My junior year was very hard for me. I was taking three hard science classes at one time for the first time. It was difficult. It was one of those years when I was like; “I don’t want to be at this college anymore.” If we would have had more staff of color in the science field, I could go to them about how I was feeling. That could have helped me emotionally. (Yvonne, March 24, 2018)

In addition to the lack of African American representation, STEM classes at the co-participants’ university were described as hard. Fortunately, Laura had friends she could learn on for support. Laura, a 2017 STEM graduate, confided with her friends that her classes were hard:

I will say I had a few best friends, and we would confide in each other, saying, “I don’t know what is happening this semester. It’s been hard. I don’t know what is going on right now. I feel really down about this.” (Laura, March 18, 2018)

Amy, another 2017 STEM graduate, mentioned that because of her major’s difficulty, she realized it was going to take consistent discipline and there would always be a struggle to get through. Amy reflected on how she survived her major:

I think it was just the understanding for any STEM major that it’s going to be some work. It’s going to be some sacrifice. It is going to take discipline. It’s going to take consistent discipline. That is just what it will take. It is not to say that

people won't struggle. They will struggle and get through it. It is the joy in going through that process that I survived. (Amy, March 19, 2018)

Although Amy earned a STEM degree in 2017, she described the process as frustrating:

All of those moments of stress and triumphs and failures and trial after trial culminated into that piece of paper (the degree). The experience I had at the institution was frustrating. I was in an experience of being one of the only (African American) as a student, and I wasn't really used to that as an experience. (Amy, March 19, 2018)

Lydia, who was beginning her STEM major, had already realized that her undergraduate STEM experience was also a process:

It is daunting coming from high school. I think I really have to sit down and take it step by step. There are people who are going through the same thing and who are able to give advice and the professors and other faculty members are here to help you. Last semester, I tried to challenge myself by taking a physics class. It probably could have turned out differently, but it was my first semester, and I was getting used to what it was like being here. (Lydia, March 20, 2018)

The co-participants of this study described many factors that contributed to the impression that there was an unwelcoming and discouraging environment in STEM. Many of the same factors were identified in Johnson's (2007) research of the three practices that women in science departments found discouraging, such as large lecture classes, and discomfort asking questions in class. In my study, the large size of the introductory classes, the weed-out design of the classes, the low representation of African

Americans in these classes and on the faculty, the decreasing number of African Americans in classes, and the difficulty of these classes revealed that there were aspects of the STEM community that were not encouraging or nurturing to the female, African American STEM undergraduate.

The co-participants that had completed their undergraduate studies or were above their third year of undergraduate school perceived a negative impression of the STEM department because they perceived their introductory classes were weed-out classes. They perceived their STEM major was hard. In addition, all of these co-participants expressed it took time to adjust to their major. The co-participants that were first year students did not remark that they saw their classes as weed-out classes but did collectively mention that they perceived their major as hard or difficult.

**Minority stress.** The experiences of the co-participants revealed there were many sources of minority stress for female, African American STEM undergraduates. Women who were considered minorities because of their gender and ethnicity expressed this minority stress. Co-participants expressed the impact low female representation, gender-based and race-based stereotype threats, negative verbal persuasions, the imposter phenomenon, and microaggressions had on them and their sense of belonging to the STEM community and the university.

Amy was a co-participant who experienced minority stress because of the lack of representation of women in her major. Amy recalled:

I think it was kind of similar to the African American experience because there weren't that many of us. We kind of stuck together. We felt like we all just

wanted to do our best and help each other. We just wanted to demonstrate that we were capable, and we could perform well on this type of material. (Amy, March 18, 2018)

Amy explained that being a representative of a minority group impacted how she interacted in class:

I think we were always so much careful in that major and making sure your reasoning and logic is sound (was important). And making sure you start an argument that makes sense and you can prove it (was important). Even though there weren't many of us, we were very careful. I think we were better. We could see those minute details that were necessary to get the right answer. On the other hand, the male classmates were kind of (not to generalize but to generalize) would go through things faster and make these haphazard errors that could have been avoided by being more thoughtful in what they were doing. (Amy, March 18, 2018)

Being a minority in a classroom contributed to the experience of stereotype threats by the co-participants. Researcher Claude Steele (1999) identified the threat of being viewed through the lens of a negative stereotype as a stereotype threat. Amy also communicated that it was necessary to constantly prove their ability and rightful place in the STEM major. When Amy interacted with her professors, she perceived that the professor doubted her capabilities:

There was this understanding that she (I) may not understand this, so I am going to explain it. There was this need to constantly affirm my aptitude in the subject

matter...like this constant concept of being self-aware and trying to fight against it and prove that I am capable” (Amy, March 18, 2018).

The need to demonstrate that the co-participant could perform higher than the expectations of her professor may have stemmed from the negative interactions, verbal persuasions; she had with one as a first-year student:

My freshman year, second semester, I was speaking with a somewhat advisor for students who want to go into STEM related fields. I was given the advice seeing that I was female and Black, I didn’t have much of a hill to jump over to do well enough to get into the field. I took it that it wasn’t that hard for Black people. To me what it sounded like was that Black people don’t need to work hard or that our working hard isn’t going to measure up anyway. (Amy, March 18, 2018)

This encounter could be classified as a microaggressions. “Microaggressions are demeaning subtle insults against non-Whites. They are subtle, stunning, often automatic, and nonverbal exchanges that are put-downs of Blacks by offenders” (Ford, 2013, p. 206). The outcome of encountering microaggressions in STEM is anger. When students are questioned about how they qualified to attend their university, or when others communicate that their race affords them lower admission standards, they feel as if their abilities are overlooked and their achievements are undervalued.

Co-participants also expressed self-doubt about their belonging in their STEM major. They communicated aspects of the imposter phenomenon. Some conveyed that the level of challenge they experienced made them feel like they were in the wrong university. Yvonne, a STEM graduate, conveyed:

When I think back to my junior year, when I was taking physics, organic chemistry, and biology, (I remember) that was very difficult for me. Coming from a Type A personality, always getting all As prior to college. To go to college and continue to struggle impacted my sense of belonging. I was like, “Maybe, I shouldn’t have come to this institution. I should have gone somewhere else.” (Yvonne, March 24, 2018)

Karen expressed that her racial identity was part of the reason why she felt pressure:

There is a lot of pressure to prove that you belong there. If you were like a White male, they would expect you to be in this building or even an Asian male. They would expect you to do well. But when you are an African American, it is like, “How did you get in here?” It is a lot of pressure to prove that I could do well, and that I belonged in this field. (Karen, March 17, 2018)

Karen further elaborated on her internal struggle:

It’s a feeling you get. You are definitely going to have to prove yourself. If you are on a team, you have to prove that you know what you are talking about and that you are knowledgeable on this topic. It was maybe more internal, like a double consciousness. (Karen, March 17, 2018)

This self-doubt was also voiced by Stephanie, a fourth year STEM major. It made her question if she should continue in her STEM major:

In my upper classes like biology or lecture halls, there aren’t that many African Americans. I think I am the only one who is African American in that class. The other minority is Indian, but I am pretty sure that everyone else in that class is



White. It kind of makes me feel like, “Oh, maybe I shouldn’t do STEM. Maybe, I don’t belong here.” At the same time I feel like I could potentially pave the way or path for other African Americans that want to be STEM majors. (Stephanie, March 18, 2018)

These interactions could impact a student’s overall sense of belonging.

According to the research of Walter and Cohen (2011), “members of socially stigmatized groups, such as African Americans, may be relatively more uncertain about their social belonging in mainstream institutions like school and work” (p. 1447). This uncertainty of belonging or imposter phenomenon can undermine minorities’ performance and health (Walter & Cohen, 2011).

Being an African American STEM major also contributed to many co-participants experiencing stereotype threat because of their race. Many co-participants who were also children of African immigrants felt like they needed to prove that African Americans were capable as an ethnic group. Karen, remarked,

If I didn’t succeed at something, it was almost like a setback in two ways. It was a setback for me, and the way people would expect me to do badly. It kind of added to that feeling of disappointment (Karen, March 17, 2018).

Karen further elaborated,

For African Americans, I feel like if one messes up, it is kind of like that is indicative of that people. If I didn’t succeed, it was almost like, “You see, they all can’t.” Even the female African American population is even smaller than the

African American population. They kind of generalize you. (Karen, March 17, 2018)

Lydia felt stress because of her gender and her ethnicity. Her minority status impacted how she interacted with her group members on tasks:

I feel like African American women are less likely to speak up in group projects, we don't want to be overbearing, and have the rest of the group think, "Oh, she is being loud, trying to dominate the situation." (Lydia, March 20, 2018)

Jeanine's minority status also caused her to hold back. She reflected,

I feel like I can't ask certain questions that would make it seem like I didn't understand the concepts. I would save those kind of sentiments for the group that I was talking about. (Jeanine, March 20, 2018)

Lydia relayed that she wanted to prove her ability so that her professor would believe that African Americans that followed her would be seen as capable, too. Lydia explained,

I feel that way because...it's for the people coming after me. I don't want the professor to feel like those people are bad because of my actions. I want to show my professor that I am more than these stereotypes that you hear about Black people or Black women. (Lydia, March 20, 2018)

The perceptions of the co-participants aligned with the theories proposed by Steele (1999) that minority students with strong academic skills were exposed to a higher pressure of stereotype threat. Steele (1999) proposed that high performing minority students would be impacted because of society's perception and treatment of their group.

When interacting with faculty members, co-participants also expressed they experienced microaggressions. Joan, a third year STEM student, experienced a microaggression because of the perspective of her professor on medical schools at Historically Black Colleges and Universities (HBCUs). Joan communicated,

When I asked my advisor about HBCU medical schools, he really didn't have any information for me. He was like, "I don't know why you would want to do that? Do you just don't feel you belong here? I don't understand why you would feel like that." I was like, of course, he wouldn't understand why I would feel like I would want to go to an HBCU because his view was White. They cannot just truly understand. He didn't say outright, but I could tell he was like, "This shouldn't be your first choice." (Joan, March 23, 2018)

The responses of the co-participants indicated they experienced stress that was associated with their minority status. This experience was also evident in the research of Wei, M., Liao, K., Chao, R., Mallinckrodt, B., and Tsai, P. (2010). These researchers reported that ethnic minority students in Predominately White Universities experience not only general stress that is common to all students but also stress that is uniquely related to their minority status (Wei et al., 2010). The co-participants in this study relayed similar experiences to the participants in Solorzano et al.'s study (2000). The co-participants had the feeling that the faculty had low expectations for their performance. Researcher Claude Steele (1999) identified the threat of being viewed through the lens of a negative stereotype as a stereotype threat. Many co-participants felt the need to validate their presence at the university and enrollment in STEM courses. They experienced an

additional pressure or stress in their experience as a STEM undergraduate because of their race or gender.

All of the co-participants experienced minority stress. All of the co-participants mentioned that they observed a low representation of African American students in their classes. All of the co-participants mentioned that there was a decreasing enrollment of African American students in their STEM their major. All of the co-participants mentioned that there were a lack of role models on campus who were African American, women, and in their STEM department. Most of the fourth-year and graduate co-participants recounted episodes of microaggressions with advisors and faculty when obtaining career counseling. Most of the co-participants that were fourth-year or had graduated described episodes when they experienced imposter phenomenon. Co-participants who were in their first and second year of undergraduate school mentioned they had experienced stereotype threat. They were aware of the negative stereotypes associated with their ethnicity and believed their performance in groups or on assignments or tests would affirm or dispel how others felt about the ability of their race.

**Positive persuasions.** Although there were many elements that impacted their STEM experiences negatively, the co-participants relayed that there were many factors that provided positive persuasions to their sense of belonging to the STEM community. Participants saw themselves as smart; they had peer support from the African American community; there was a positive social persuasion of women's acceptance in the STEM community; there were positive verbal persuasions of their professors and mentors; African American faculty provided positive vicarious experiences; co-participants

provided positive vicarious experiences for others; and parents with STEM education provided positive vicarious experiences for the co-participants.

Despite the rigorous academic challenges of the STEM major, the co-participants found strength in their confidence of their own ability. Amy communicated that when she did not perform up to her own expectations, she did not feel like herself. Amy recounted, “I was always high performing. Not doing well in my freshman year was not myself. I was prohibited from being myself because I was always high achieving over-achiever.” (Amy, March 19, 2018). The co-participant Joan has also used her acknowledgement of her intelligence as a buttress against low expectations. Joan communicated,

On one hand, schools need to increase their diversity but don’t make it sound like I don’t have to be smart as someone else to get into med school. It’s not true. We will still be capable doctors. It rubs me the wrong way. I’ve had people ask me if I got my scholarship because I was Black. It just kind of happens. It’ just like, why can’t I just be smart? I got it because I’m smart. Sorry, you didn’t get one, sorry. If you really want to compare GPAs in high school, SAT scores, ACT scores we can. But just accept the fact that I had good scores. It doesn’t have to be because I’m Black. (Joan, March 23, 2018)

In addition to confidence in their own abilities, co-participants drew support from their African American peers. Amy communicated,

A lot of us had that similar mindset that we were not settling. We didn’t get into this school by settling. We got here by wanting to be our very best. I was

constantly surrounded by people who were very ambitious, just like myself. We were also cognizant of the fact that we were the minority. We uplifted each other and held each other down when things were hard and we wondered, can we do this? (Amy, March 19, 2018)

Other co-participants echoed the benefits of having a strong peer group who were also African American women and STEM majors. The co-participants who were first-year students agreed that it was beneficial to have female African American friends who were also STEM majors. As Jeanine recounted,

We kind of stick together. It is more of a group collective. I think the majority of us are aware that we don't have a great power in numbers. We do, sometimes, hang out after class, and discuss certain things that we find challenging. We just talk after class and make an effort to stick together. In general, on this campus, there are not that many African Americans anyway. We are all kind of a tight knit. We all see that we are all in the same position, and we try to help each other out. We see we are going through the same thing so we are going to work together. (Jeanine, March 20, 2018)

Amy indicated why having peer support from someone of the same ethnicity and gender was beneficial because of the empathy they could provide:

You basically had someone who was there who had that shared experience. They came from a different background (too) and understood what you were going through right then and at that time. They understood it in a way that someone that

wasn't of that racial background would not. They were living with all of those battles within themselves too. (Amy, March 19, 2018)

Yvonne communicated that having African American peers in STEM class made it easier to form study groups:

When you have another Black student in the class, it is like we have this in common. If I wanted to form a study group, I would feel more comfortable going up to that other Black student and asking them to study. Study groups help you a lot. If I am hesitant, I might finally ask the person I was sitting beside, "Do you want to study together?" I could have had someone earlier to study with or work with and had better results. (Yvonne, March 24, 2018)

Co-participants who also had parents with STEM backgrounds indicated they, too, were a source of positive support. Stephanie recounted,

My dad majored in chemistry. He also said there weren't many African Americans in his classes. My mom did a special program where she did med-school in six years. Both of my parents influenced me or empowered me to continue on in my interest. (Stephanie, March 18, 2018)

Another positive social persuasion experienced by many of the co-participants was the articulation that women were welcomed in STEM. This was communicated in representation of their gender in their STEM major and verbally by professors. Joan recounted that there was a large representation of women in their STEM classes:

My campus is kind of weird. There are more female STEM students than male, which I would imagine is not representative of the entire college as a nation. For

the most part, it is female except when you get into math. Math has way more males than females. But in biology, there are way more females. Math and physics men. Everything else is pretty much female dominated. It is kind of nice actually. On the professor side, it is male dominated. (Joan, March 23, 2018)

Stephanie also communicated her delight in the large composition of women in her STEM major. This female majority was exhibited in the student and faculty populations:

At this school, I am very happy. The majority of the professors I had in the STEM classes are all female. For example, I am in a research lab and the professor is a female and for the lab I TA for, the professor is also female. In my post grad plans, I am working in a lab run by females. So at this school at least, I have been able to find a number of female professors to look up to. (Stephanie, March 18, 2018)

Lydia recounted that the high representation of other women in her class helps her experience a level of comfort while learning: “Having an even balance helps me be comfortable I think. I am able to sit down and focus and strive and do well in class” (Lydia, March 20, 2018).

Many co-participants recognized a positive social message that women were encouraged to become STEM professionals. Jeanine communicated,

There is an emphasis now for women to be into more male dominated fields versus fashion design. They want more women in STEM fields like science and technology. Even though I wanted to take a major that wasn’t STEM related,



some parts of me as a woman wanted to be the person that broke barriers for future generations. (Jeanine, March 20, 2018)

Karen heard this message verbally from her STEM professor.

In my classes there are a whole lot more females in it. I've had a female professor at one point. I have a male professor now that is like very feminist. He is very much for the advancement of women in the STEM field. I definitely feel good about being a woman and going forward. My professor would always talk about this conference they have every year where all of these women come together. He would say, "You should really think about applying. You should really think about going to this. There are job offers on the spot, and they want women to go." That kind of told me, they want women here. They want us in this field. They want us to succeed in this field. He keeps pushing this one club for women in computing on campus and pushing women to sign up. He would say, "We need gender equality in this field." I think that kind of encouraged me." (Karen, March 17, 2018)

In Karen's experiences, the verbal persuasion that women are welcomed in STEM was so strong; she communicated that it was difficult to believe it was different for women. For Karen, this resulted in a strong sense of belonging to the STEM community and contributed to a strong sense of self-efficacy. She explained,

They (the department) were definitely supporting women in STEM. I think it grew over time. I don't think it was ever a bad place...I feel like I belong here and

that there are opportunities for me here and that I can succeed in this. (Karen, March 17, 2018)

Co-participants that had female professors benefitted from the vicarious experiences they provided. Stephanie explained the strong impact her interaction with female professors had on her. She communicated that they were role models for her in her personal life and her professional life:

My professors have families. They have kids. It makes me happy to know you can have a great family life and a great professional life. In the media, it always seems that women have to choose one or the other. It makes me proud (to have female professors). I love what they research. Even though their research may seem complicated, you see they can do really complicated things and run labs and lead effectively. It makes me really happy I can learn from them. This definitely empowers me. I feel like I am more myself around them. And being yourself is always good. (Stephanie, March 18, 2018)

Stephanie communicated that she too is a role model for African American STEM students as a TA (Teacher Assistant) in a freshman lab:

I am a TA (Teacher Assistant) for a freshman research lab. The majority of students are African American. This is really great! It makes me really happy. By being there, I am empowering them to continue in their major. My presence says, “We would love to have more African Americans, more people of color take on STEM and conquer it.” (Stephanie, March 18, 2018)

The experiences of the co-participants aligned with the research of Crisp (2010). Adolescents who could identify role models in their social networks were better adjusted than those who could not (Crisp, 2010). In the present study, these role models took many forms: parents, peers, professors, TAs, and heads of research laboratories. Co-participants who had parents with STEM degrees mentioned how they drew counsel and strength from their parents' experiences. Co-participants who had peers who were also African American STEM undergraduates drew counsel and support from other students who could understand what they were going through. Some co-participants who had female professors who were in STEM could not only benefit from their academic or career example, but also from their social message of being able to be a woman in STEM while being able to raise a family.

The co-participants of this study had a variety of people who provided them with support. The co-participant who had parents who had obtained STEM degrees mentioned they used their parents' verbal encouragement to persevere when they encountered academic challenges. Parents who had majored in STEM and also attended a PWI provided an additional level of support. The co-participants that had parents who had experienced a similar educational environment remarked how their parent's counsel provided encouragement to overcome their obstacles and achieve their goals. The co-participants that had been instructed by faculty who vocalized that women were welcome in their major and verbally encouraged women to pursue opportunities benefitted from this verbal persuasion. These co-participants exhibited a strong sense of belonging to their STEM community. Co-participants with majors that were populated

more by women also expressed a strong sense of belonging to their STEM community. These co-participants expressed that they were more relaxed in their classes. All of the co-participants commented on their use of female, African American peers for academic, social, and mental support. Other African American women in STEM gave the co-participants peers who could understand their experiences, provide support in studying, and empathy when the co-participants experienced difficulty.

**Mentoring support.** The co-participants observed that a mentor could provide different types of support. Some co-participants, like Karen, considered someone to be a mentor if they provided academic help or assistance with reaching their mentee's career goals.

I would define a mentor as someone who has knowledge about what you want to have knowledge about. They kind of guide you, lead you, and give you advice on what you want to achieve. (Karen, March 17, 2018).

Some co-participants believed that mentors should provide a combination of academic support and emotional support. Yvonne communicated her definition of a mentor.

Someone you can go to for advice on different matters and multiple facets of your life. They give you good advice, and they also look out for you. They will check up on you and see how you are doing. (Yvonne, March 24, 2018).

Stephanie observed;

It is someone who is there for you and plays a very supportive role in your academic development, but also in your personal development. They kind of weave together your personal and academic lives. They have a more mature

outlook because they are older, or they have more experiences. They have experience in the area of your life you are struggling in. They are willing to have the patience and also the expertise, time, and presence to be there for you.

(Stephanie, March 18, 2018)

The co-participants of this study had different types of mentoring relationships. Some of had formal mentoring relationships where they were assigned a mentor because of a university initiative. Other co-participants had informal mentors that they chose themselves to receive the support they needed.

Karen had an informal mentoring relationship with a faculty member. Karen communicated,

He gives me advice on the field, opportunities I should go for, and things I should look out for and classes I should take. He gives me more professional support.

(Karen, March 17, 2017).

Lydia had a formal mentor who provided support through academic guidance. Lydia said,

She is my pre-med advisor. She has been very helpful. If I have questions on the classes I should take or on my resume, she could answer those questions for me because she is in the department that I want to go into. I think she is making it less daunting. At the beginning, before I started, looking at all of the requirements was overwhelming. Going to talk to her kind of helped ease my fears and helped me know that I was on track, and I am getting there. (Lydia, March 20, 2018)

Even when the mentor was not directly connected to the major of the co-participant, students benefitted from the ability of the mentor to connect them with people in the area of their interest. Yvonne communicated,

[The most important aspect of my mentoring relationship is] support. Even if your mentor is not particularly knowledgeable in your field, they would give you support and help you find someone to help you. (Yvonne, March 24, 2018)

Other co-participants valued the mental health support their mentor provided when they were extremely stressed about their academic performance. Amy communicated,

[She] showed me it was necessary to take care of one's self to take care of other people. For me, she would tell me, "Maybe it is time to take a moment or take a break. Let's construct a plan and see where you can go from there." I think it showed me it was necessary to rejuvenate. Rejuvenate your mind. Rejuvenate your spirit without feeling like you are slowing down. All of those things are necessary to be your best self. You can't be your best self if you are completely drained. (Amy, March 19, 2018)

Jeanine also benefitted from the mental health support her mentor provided:

I feel like I am trying to get more emotional support now (from my mentor). I feel like I am pretty strong in terms of academics, but there are times or some instances when I have sacrificed my mental health just to do better in class. That's really not healthy. Sometimes, I talk to my mentor about that. (Jeanine, March 20, 2018)

These responses were aligned with the research of Liang (2002), which indicated that mentoring relationships that match the needs of the population could buffer the effects of stress due to transition or adjustment. In some cases the stress was buffered by the display of empathy. The ability of the mentor to exhibit empathy was important to some co-participants. As Lydia indicated,

[The most important part of a mentoring relationship] is having that repertoire and banter where they understand where you are coming from and going from there and providing the best advice for that person. (Lydia, March 20, 2018)

In addition to empathy, co-participants valued the vicarious experiences the mentors were able to share as role models for them to achieve their future aspirations.,

[I] can do it because she has done it. This is the path you might have to take, but it is a path to get you where you want to be. I just appreciated that. With my experience compared to hers, she told me that it is possible to major in STEM and how to get there. (Amy, March 18, 2018)

These experiences aligned with the mentoring research of Campbell and Skoog (2004). They reported that the women of their study benefitted from mentoring relationships, which provided support, encouragement, and expertise for the students. Liang (2002) reported that mentoring relationships high in relational qualities were associated with higher self-esteem and less loneliness. Co-participants who were further along in their STEM track needed multiple sources of support: academic and psychosocial. In addition to exposure to career possibilities or paths to graduate school,

the co-participants benefitted from the psychosocial support of empathy, empowerment, and authenticity.

All of the co-participants who were third-year and beyond developed an informal mentoring relationship. All of the co-participants who were in their first year experienced a formal mentoring relationship. Most of the co-participants that were close to the end of their STEM undergraduate experience used their mentors to navigate their course load. Their mentors provided positive verbal affirmations of their ability and strategies to study and improve their academic performance. One co-participant, Joan, used her mentor to help her become aware of the opportunities that were available after she graduated. The co-participants who were in the beginning of their academic career as a STEM undergraduate used their mentors to schedule classes and learn of academic opportunities like internships and summer programs. The co-participants in this study who were first-year students did not reflect on experiences when their mentors provided psychosocial support like empathy, friendship, or empowerment. All of the co-participants who had graduated with a STEM degree remarked how they appreciated their mentors because they were accessible and provided a space to be their authentic selves. Their mentors provided a space to release their frustrations, devise a plan to get better, affirm their ability, and even geek out over their love for science.

### **Summary**

In chapter four, a detailed description of the lived experiences of eight female, African American STEM students at a PWI was provided. Four major themes were



identified from the interviews with the co-participants: (a) Discouraging Academic Environment, (b) Minority Stress, (c) Positive Persuasions, and (d) Mentoring Support.

Many of the lived experiences of the co-participants were similar. Co-participants found the introductory STEM classes they took as first-year students to be too large and impersonal. The size and structure of these classes did not provide students easy access to their professors. Some participants whose parents were unfamiliar with the college experience had to overcome an additional barrier of familiarizing themselves with the resources that were available on campus for additional help. Co-participants also shared their experiences of minority stress. Many felt a level of discomfort because they represented an ethnic minority. The low representation of African Americans in their classes had a negative impact on some participants. Because they were aware of a negative stereotype that Black women were loud or argumentative, they were unwilling to speak up in class or in small group activities. Co-participants who were also a minority in their major because of their gender, reported having similar experiences because of their gender.

The co-participants recognized the importance of having peers who shared their drive, determination, major, gender, and ethnicity. Peers who were African American women were mentioned often as a resource for encouragement, debriefing, study partners, and empathy. Finally, co-participants found support with their mentors. Even when the mentor was assigned to them formally, such as a major advisor, co-participants reported feeling better after interacting with their mentor. Mentors provided academic support, psychosocial support through empathy, and mental support to help students deal

with the stress of a challenging major and a challenging schedule. The descriptions and quotes provided in this chapter permitted the voice of the individual to be heard and the collective experience to be understood.

## **CHAPTER FIVE: DISCUSSION OF FINDINGS**

To gain an understanding of the lived experiences of female, African American, STEM undergraduates at an elite PWI, it was beneficial to ask the co-participants to examine their experiences through multiple identities: STEM student, African American, and as a woman. Each lens provided an additional layer of understanding to the lived experiences. Each identity contributed to the overall experiences each co-participant had as a STEM undergraduate.

### **Research Questions and Answers**

Face-to-face and telephone interviews presented co-participants with open-ended questions to explore their lived experiences as a female, African American STEM undergraduate at an elite PWI, and as a female, African American STEM undergraduate in a mentoring relationship. Co-participants who were still students at the institution were interviewed in person, and co-participants who had graduated in May of 2017 were interviewed by phone. Co-participants were given the opportunity to reflect upon their experiences through their identities as STEM students, an African American student, and as a woman. Co-participants were not asked to rank their connection to each identity. Instead, they were asked to use these identities to relate what comes to mind when they describe their STEM community as a STEM student, an African American student, and as a woman. I viewed each identity as a contributing factor that provided an interpretation of an experience or a perception of an experience. The responses from these interviews provided the answers to the research questions.

**Research Question 1.** The first research question asked, “What are the lived experiences of female African American STEM undergraduate students of the STEM community at an elite PWI?” Initially, the co-participants did not find the STEM community as welcoming. This finding was in alignment with previous reporting that the environment of STEM disciplines at a PWI was unwelcoming (Carlone & Johnson, 2007). They perceived their introductory classes to be too large and impersonal. They also considered these classes to be weed-out classes that were designed to remove potential majors out of STEM majors. This finding was in alignment with the findings of previous research on the institutional barriers that hinder STEM degree completion. Research indicated African American students believed there was an ideology of weeding out students from STEM majors (Green, 2008).

The co-participants were discouraged by the low representation of African Americans in their classes. All of the co-participants held this perception. The National Science Foundation (2017) confirmed low representation of African American women among those who earned Bachelor’s degrees in STEM. In 2014, African American women earned only 4.23% of the degrees in biological science, 2.61% of the degrees earned in computer science, 2.35% of the degrees earned in mathematics, and 2.83% of the degrees earned in physical science.

The co-participants who were beyond their second year of study remarked that representation of African Americans was decreasing in their majors. The National Action Council for Minorities in Engineering (2012) confirmed a decreasing representation of African Americans in STEM majors as they matriculate from first year to graduation.

The small and decreasing representation of African Americans in the student population created minority stress for most co-participants. They became careful in their performance and hyper aware of the cultural differences that existed between themselves and their classmates. This created the stress of presenting a consistent image of ability, competence, and superior work ethic. Co-participants believed their performance not only reflected on their abilities as individuals, but on the abilities of their race. This finding was in agreement with the research on stereotype threat (Steele, 1999). The co-participants were aware of the negative stereotypes that were associated with their race and gender and labored to present an alternative example to others of competence, ability, and excellence. Researchers Solorzano et al. (2000) also reported that the participants of a study of the experiences of African Americans at three PWI Research I universities felt racial microaggressions within academic spaces in the form of stereotype threats and racial discrimination.

To counter the impacts of minority stress, co-participants used African American peers who were also women for emotional and academic support. This finding aligned with previous research that indicated that women in male-dominated fields used relational experiences to buttress their confidence so that they could succeed (Zeldin et al., 2008). Female, African American peers provided empathy for co-participants who experienced frustrations because of academic and social challenges. Female, African American peers provided academic support by being available for study sessions, study groups, positive peer pressure, and motivation to continue to be a top-performing and overachieving student. This finding was aligned with previous research indicated that

study groups increase academic performance and graduation rates for students of color (Hrabowski & Maton, 2009). Jeanine reported how her study group of African American peers helped her:

When we did our midterms, we had a strict schedule. We were going to go to tutoring on these days. We were all going to ask questions about things we weren't clear about. We exchanged strategies to help us study better, perform well, perform better in class. (Jeanine, March 20, 2018)

Amy echoed how her peers helped her achieve her academic goals. She communicated:

A lot of us had that similar mindset that we were not settling. We didn't get into this school by settling. We got here by wanting to be our very best. I was constantly surrounded by people who were very ambitious, just like myself. We were also cognizant of the fact that we were the minority. We uplifted each other and held each other down when things were hard, and we wondered, *Can I do this?* I come from schools over populated with minorities and only had White friends, and then I go to a school where there are not a lot of people of color and I form and become a part of this community that is really just people of color. (Amy, March 19, 2018)

These findings align with research that investigated why African American women leave STEM fields. Researcher McPherson (2013) reported that limited peer support and limited teacher support were factors that contributed to African American women leaving STEM fields. My research showed that peer support was a beneficial element that helped female African American students stay and succeed in their STEM majors.

Most of the co-participants who had a large female representation in their major expressed a high degree of acceptance and sense of belonging in their major. They expressed that they clearly heard persuasions that women were welcome in the STEM profession and were encouraged to increase their participation. In the majors that had a large representation of women in the faculty, co-participants voiced that they could see future versions of themselves. They observed that the female professors had families, challenging jobs, and leadership roles. Seeing women in these roles provided vicarious experiences for the co-participants and allowed them to project that this future was a possibility for them as well. However, there were some co-participants who did not express this vicarious experience because of the enrollment of women in the major or of female representation in faculty. These co-participants expressed that even though they were women, they believed others viewed them more by their Black ethnicity than by their female gender. In these cases, co-participants' reflections of a desire to succeed were evidence that they could get through or survive the non-nurturing environment.

**Research Question 2.** The second research question asked, “What are lived the experiences of female African American STEM undergraduate students with their mentors?” The co-participants used a variety of resources to obtain mentors and had informal and formal relationships with their mentors. The co-participants who were first-year students identified formal mentors that were helping them progress in the program. They identified their major advisors to be their mentors. These mentors provided primarily academic support. They advised on the courses the students should take, the research opportunities that were available, counsel on resume writing, and pathways that

would lead to graduation. The co-participants that were first-year students were satisfied with this type of academic support.

The majority of the co-participants who were beyond their second year depended on informal mentoring relationships for both emotional support and academic support. Although most of these mentors were affiliated with the university, they were not the academic advisors that they were assigned to them as first-year students. These informal mentors were people they had heard giving talks, and professors that were referred to them by other professors when the co-participants expressed the need for extra help in class. These mentors provided help to the students by giving positive verbal persuasions and verbally affirming the ability they saw in the undergraduates. They provided space for the students to express their frustrations. Co-participants remarked that they were happy because their mentors were accessible and there for them. The co-participants who graduated in 2017 indicated that their relationship with their mentor was developed over several sessions. Discussions had to be held multiple times, and perseverance and confidence were built overtime. Hearing the counsel of a mentor attached to the profession helped the co-participants that were past their second year at the university. They were able to discuss with the co-participants how to manage their schedules and their workloads. Mentors were able to advise students on how to manage stress and how to maximize their mental health. These informal mentors were also able to help the co-participants understand how to achieve their career goals. One co-participant specifically chose her mentor because he was the medical school advisor. She valued his professional knowledge and thought his expertise in the process could work in her favor. Mentors



provided a positive persuasion to the co-participants that by assuring their competence. Co-participants were able to see an alternate version of themselves and experiences. They were able to avoid overgeneralizing their failures or struggles. They were able to see pathways to accomplish their goals because of their interactions with their mentors. This function of mentoring was in alignment with previous research on college mentoring that indicated mentoring could reduce isolation and alienation in students and provide support as students navigate through the college experience (Hunn, 2014). The co-participants who had experienced academic challenges used their mentoring relationships to figure out how they could achieve their goals of a STEM career. This was in alignment with previous research on how university faculty can support students' aspirations. According to Perna (2009), faculty who were helpful to students went beyond content and intentionally reinforced the students' aspirations and encouraged them to consider post-graduate programs.

None of the co-participants were able to find a mentor in their major who was an African American woman at their university. Each of the co-participants expressed a desire to build a relationship with someone who shared their race, gender, and background in their STEM major. Karen communicated that she would have liked to have a mentor who was like her. When she gave the description of the perfect mentor, she said, "someone who is female and African American, does STEM, and went to a university that is like this one" (Karen, March 17, 2018). She indicated that this person would be able to understand what she was going through and thought that this person would be able to make her feel like she "got it" or understood her experience and

perspective. Jeanine believed that a woman who was African American in her STEM major would provide emotional support. She communicated, “I feel like she would be like a mother to me. She would be like my mom. I probably would call her every day” (Jeanine, March 20, 2018). The co-participants of this study had difficulty finding role models who looked like them based on race and gender.

### **Study Limitations**

Even though the co-participants shared the characteristics of attending the same university as a STEM undergraduate student, being a woman over eighteen-years-old, being an African American, and having a mentoring relationship, differences within categories could limit the generalizability of this study. At the university where the research was conducted, STEM majors differed in the number of women who were represented in the classes and in African American representation in a major. Co-participants who were minorities in the major because of their gender had a more negative perspective on the STEM experience than co-participants who had a higher female representation in the major. Co-participants defined differently what they thought a mentor was. Some co-participants defined mentors in relation to their ability to provide academic support that would lead them into their careers or STEM profession. Other co-participants defined mentoring in relation to the person’s ability to provide both psychosocial support and academic support. Co-participants also varied in terms of background: their family’s STEM educational background, their family’s college experience, and the number of generations since their relatives had emigrated from

African countries. The diversity of the participants and the size of the sample produced these study limitations.

### **Study Implications**

Universities need to examine how undergraduates are inducted into their STEM culture. STEM experiences should be structured to promote STEM persistence through consideration of the size of introductory classes, the size of African American student representation, the representation of African Americans within the STEM faculty, and the representation of women within the STEM faculty. Universities must prepare to educate students with different needs. Students may have similar academic backgrounds but differ in STEM legacy, generational college experience, immigration status of their family, socio-economic status, and experiences as a minority student. These individual characteristics may individually impact how students experience the STEM community at an elite PWI.

This study reveals that size matters in STEM study. The size of introductory STEM classes matters to STEM undergraduates who are beginning their STEM training. The percentage of African American and female representation in the student population and in the STEM faculty can determine if there is a welcoming and nurturing environment for the women who are acquiring their STEM skills and building their STEM identities. Without even taking a class instructed by the sole, female, African American STEM professor on campus, co-participants mentioned the benefit they experienced. The co-participants remarked that higher representation of African American women in STEM would provide support because there would be someone who

was on the campus who would truly understand what they were going through. Without adequate representation, the co-participants questioned their belonging. With inadequate representation, co-participants had problems seeing future versions of themselves. They did not feel as if they were fully understood or that their experiences were fully validated by people of a different gender or ethnicity.

Another implication is that students in STEM programs have different needs. Students whose parents did not go to college need a different type of support than students who had two parents who went to college and earned STEM degrees. Students who took advanced coursework in a high school that had a large minority population may need a different type of support than a student who took advanced coursework in a high school with a small minority population. Students who are in different years of their STEM track may need different types of opportunities to build different types of mentoring relationships. The co-participants who were in their first year of study were satisfied with a mentor who primarily provided advice on the sequence of classes and information about the major. The co-participants who had been in the major beyond two years stressed how they needed their mentors to provide emotional support, empathy, and understanding of their frustrations and experiences. Faculty need to be able to recognize the needs of students who are reaching out for help and provide different levels of guidance or connections with other faculty members to provide suitable student support that promotes retention, affirmation, and success.

Many co-participants communicated that they were verbally told that women were welcomed in the STEM community. However, none of the co-participants

communicated that they verbally heard any professor say that the STEM community sought to welcome African Americans. Universities should also verbally and socially affirm belonging for African American students in STEM majors. This could be done by hosting African American STEM professionals on the campus for discussions, speeches, and research symposiums. The co-participants would benefit from the vicarious experiences of other professionals who share their ethnicity and gender. This would enable the co-participants to connect with people in STEM careers who may have had to overcome similar obstacles as undergraduate STEM majors.

In some STEM majors, co-participants remarked that the representation of women in their courses was quite high and equaled or surpassed male representation. None of the co-participants communicated that the number of African Americans surpassed the number of Caucasians in their STEM courses. Although some co-participants indicated that they had female STEM instructors who provided them with an image of themselves as a future STEM professional, none of the co-participants communicated that they had a STEM instructor who was African American or of African descent.

### **Recommendations for Future Research**

Future researchers could deepen the understanding of the experiences of female African American STEM undergraduates by examining their lived experiences at an HBCU. This study could be the basis of a comparative study that examines how these experiences differ when the minority becomes the majority. This study could also reveal the impact that sub-cultures have within the African American minority group. For example, do students who are bi-racial and African American have a different lived

experience as students who identify as solely African American? An examination of the experiences of female STEM undergraduate students at an HBCU would provide insight and understanding of the experiences of minority students who make up the majority of the student body. The essence of the experiences of the co-participants could be obtained by asking students to reflect upon their experiences using their identities as STEM students, as African Americans, and as women. This data could lend itself to a comparative study that examines how the experiences of the co-participants differ from the experiences reported in this study. In addition, the co-participants could be selected based on a similar characteristic. For example, all of the co-participants of a future study could be STEM majors, African American, women, or first-generation college students. All of the co-participants of a future study could be children of parents with STEM legacy or STEM careers.

Additional research could also investigate the different experiences African American women have in majors that have a large representation of women and a small representation of women. These qualitative studies could be used as a springboard for mixed method studies. Future research could use a combination of inventories that quantify aspects of identity and use these scales in conjunction with an investigation of sense of belonging, self-efficacy, persistence in STEM majors, or school satisfaction.

Understanding of the lived experiences of African American women in STEM undergraduate majors would assist universities in creating a shared STEM community that produces persistence and a sense of belonging. The improved STEM culture of the

university would contribute to an increased representation of African American women in STEM professions.

## **Conclusion**

The co-participants found that being at an elite PWI as a STEM undergraduate major was challenging. Large introductory courses that were considered weed-out courses and that had low representation of African Americans in the student and faculty populations were challenging aspects of their education. Even when classes became smaller, these courses continued to provide a challenge to the co-participants because of the decreasing enrollment of African American students, and the increased academic challenge these courses presented when multiple STEM courses had to be taken in one semester. Co-participants used a variety of interpersonal relationships to affirm their confidence in their abilities and to receive academic support. Finding mentors who had graduated from the college or had obtained STEM degrees provided co-participants with a living example of someone who had achieved a goal that they also wanted to achieve. Finding mentors who possessed knowledge of the academic pathway to graduation or medical school provided co-participants with support by enabling them to understand themselves better and find academic strategies that would help them be successful academically. The co-participants were also able to find encouragement by identifying with other women in the STEM profession. Interacting with female, STEM professors provided many co-participants with a sense of belonging and the belief that they, too, could succeed in the STEM profession.

When the leadership of the University of Maryland Baltimore County investigated why minority students were not succeeding in STEM majors, they constructed focus groups of students, faculty, and staff (Hrabowski & Maton, 2009). The input of these focus groups resulted in changes in practice of the university. The university made an effort to make their university experience less competitive and more supportive for STEM students. To accomplish this goal, study groups were systematically formed; tutorial centers were strengthened; faculty were required to provide feedback to students early in the semester; and the Meyerhoff Scholarship Program was created. The Meyerhoff Scholarship Program began with a cohort of male African American STEM students. It provided participants with financial assistance, mentoring and networking opportunities, and academic advising. Participants in the Meyerhoff program were provided opportunities to participate in research, attend conferences, participate in paid internships, and study abroad. Eventually, the STEM community at large on the campus of UMBC adapted the practices of the Meyerhoff Scholarship Program. As a result, there was a transformation of the university culture. Hrabowski and Maton (2009) described the new community as one that possessed inclusive excellence:

At the core of the theory that supported UMBC's successful institutional change is the development of a setting, or climate, that empowers students and sets the stage for them to excel academically. Indeed, the change on our campus which aimed to expand access to programs and foster academic achievement was part of a larger transformative process that the Association of American Colleges and Universities has termed "inclusive excellence." Such a process focuses not only



on underrepresented students, but also on all students, faculty, and administrators, and it looks at how they affect the culture of an institution, its mission, values, traditions, and norms. In the early days of UMBC's transformation, the most important step we took was to identify inclusive excellence as a university priority by reaffirming our determination to help students from diverse backgrounds not only to survive, but also to excel. (p. 15)

The findings of this research indicate that universities need to understand the culture of their university from the viewpoint of its students. Understanding how students of different ethnicities, national origins, generational college history, STEM legacy, and gender interpret their experiences within the STEM community can lead to STEM persistence. To fill the need for STEM workers of the future, it will be necessary for the university to adapt to the diverse needs of its diverse students.

## APPENDIX A

### RECRUITMENT FLYER

# What Is Your Experience? Share your experience as a female, African American, STEM undergraduate

Today, we know the historical accounts of African American women in STEM. What is your point of view as a contemporary woman in STEM? If you are at least 18 years old, a STEM undergraduate, and have a mentoring relationship (informal or formal) with someone in the STEM field, you are invited to participate in the dissertation study of Reginald Johns, PhD candidate @ the College of William and Mary.

#### Contact Information

Reginald Johns  
(757) 723-1183  
rojohns@email.wm.edu

Participants will be interviewed for one hour about their experiences as a STEM student. The identity of all participants will be masked for reporting purposes.

APPENDIX B  
LETTER OF CONSENT

Dear Participant,

The following information is provided for you to decide whether you wish to participate in the present study. To participate in this study, you should be at least eighteen years old, a science technology, engineering, or mathematics undergraduate major who has a formal or informal mentoring relationship. The expected benefit associated with your participation in this study is an increased understanding about the experiences African American women have in STEM majors and with mentors at an elite Predominately White Institution.

You were selected to participate in this activity because you responded to an email or personal invitation to participate in a study that seeks to discover the lived experience of being an African American woman in a STEM undergraduate major at an elite Predominately White Institution. There will be 6-10 participants in this study. Data will be collected by interviews that should take up to one hour.

You should be aware that you are free to decide not to participate or to withdraw participation at any time without affecting your relationship with your university or mentor. You may choose not to answer a question or a group of questions if you experience a level of discomfort.

The purpose of this study is to discover the lived experience of African American women in undergraduate school within STEM fields. After the interview, participants

will be asked to review a written transcript of their responses, and asked to provide clarification or elaboration of their responses if necessary.

Data will be collected in person or by phone and recorded using PhotoBooth. Data collection will involve an audio recording, video recording, written notes, and a written transcription of the interview questions and answers. The written transcript will be made available for you to review and edit to clarify meaning. An electronic copy of the results of the study will also be shared with you at the completion of this study. At the end of this study, video and audio recordings will be destroyed after the final presentation to the dissertation committee. The identity of the participants will be masked in all stages of the report as well as university affiliation. During the interview or phone conversation, participants will be addressed by a different name, and the name of the university will not be used.

There may be possible psychological discomfort experienced when questioned. As a participant, you have the right to refuse to answer a question, skip a group of questions, or refuse to complete the interview at any time you deem necessary. Refusing to answer a question or refusing to complete the interview will not incur a penalty with your university or academic program.

If you have any questions that arise with your participation in this study, please contact my dissertation chair, Tracy Cross, Ph. D. at (757) 221-2210 or [tlcross@wm.edu](mailto:tlcross@wm.edu). You may report any problems or dissatisfaction to Thomas Ward, Ph.D., Chair of the School of Education Internal Review Committee at 757-221-2358 or [tjward@wm.edu](mailto:tjward@wm.edu) or

Dr. Raymond McCoy, Chair of the Protection of Human Subjects Committee at the College of William and Mary at 757-221-2783 or [rwmcco@wm.edu](mailto:rwmcco@wm.edu).

If you agree to participate and you would later like to withdraw from the study, please email the researcher at [rojohns@email.wm.edu](mailto:rojohns@email.wm.edu).

Please sign this consent form to acknowledge your understanding of the nature and purpose of these procedures. A copy of this consent form will be given to you for your records.

Date

Signature of Participant

Reginald O. Johns

Ph.D. Candidate

College of William and Mary

## APPENDIX C

### CO-PARTICIPANT PRE-INTERVIEW PROTOCOL CHART

<p>Interview: Greet student as she enters, thank her for coming, put her at ease and begin completion of consent form.</p> <p><b>Means to Access:</b> Meaningful experiences prior to college that directed co-participant towards STEM undergraduate major</p>	
<p>Provide co-participant with 2 copies of consent form: one to keep and one to sign and return.</p>	<p>Review the consent form and ensure she consents to participation in the study and the recording.</p> <p>Highlight:</p> <ol style="list-style-type: none"> <li>My role as interviewer.</li> <li>Voluntary participation; ability to refuse to answer or end the interview at any time.</li> <li>Confidentiality</li> <li>60 minute time commitment.</li> <li>Opportunity to ask questions at the end.</li> <li>How the interview will be used.</li> </ol>
<p>Explain why the co-participant has been chosen to participate in this study.</p>	<p>E.g., “Our purpose in meeting today is to learn about your experiences at an elite college as a female African American STEM undergraduate. Your interview will contribute to phenomenological research that examines the lived experiences of a student who may be a minority in her field of study because of her gender and/or ethnicity. It will examine your experiences in your major of choice and your experiences with your mentor.”</p>
<p>Provide an overview of the questions.</p>	<p>E.g., “Generally, I will want to hear how you make sense of what you have experienced in college and how you have made sense of your experiences. Specifically, I will ask you to reflect and talk about your experiences at this university. I will provide the structure, but I will let you steer the conversation. I will begin by asking how you became interested in STEM as a major. I will also ask about the adults in your life who directed you toward STEM as a major; and why you chose this college for your undergraduate studies.</p>

## APPENDIX D

### CO-PARTICIPANT INTERVIEW PROTOCOL CHART

<b>Means to Access:</b> The experiences of female African American STEM undergraduate students of the STEM community at a Predominately White Institution (R1)		
<p>Our conversation so far has given me some context to how you became a STEM major in the educational institution of your choice. Let's now begin to talk about your experiences at your university.</p> <p>Tell me about your experiences here as a student.</p>	<p>When you think about your experiences as a STEM major at this school, what stands out in your mind?</p> <p>Possible probes:            *Can you describe an experience that exemplifies this description?            * Why was this important?            *How did this experience affect you?            * How did this experience empower or prohibit you from being yourself?</p>	<p>Three practices of science departments that the women found to be discouraging: large lecture classes, asking questions in class, and engaging in research (Johnson, 2007). These questions may reveal the perspective of African American women in these areas.</p>
<p>Tell me about your experiences as an African American student.</p>	<p>When you think about your experiences as an African American undergraduate student in the STEM field, what stands out in your mind?</p> <p>Possible probes:            * Can you describe a</p>	<p>At Predominately White Institutions (PWI), African American students reported feelings of alienation, sensed hostility, racial discrimination, and lack of integration (Allen, 1992). These questions will provide insight if the co-</p>

<p>Tell me about your experiences here as a woman in a STEM major.</p>	<p>particular example of this?  *What were you aware of at that time?  *How did this experience impact you?  *What did you take away from this experience?  *How did this experience shape your sense of belonging to the STEM community?  *How did this experience empower or prohibit you from being yourself?</p> <p>When you think about your experiences as a female STEM major, what stands out in your mind?</p> <p>Possible probes:  *Can you describe a particular example of that?  *What were you aware of at that time?  *How did this experience make you feel?  *How did this experience shape your sense of belonging to the STEM community?  *How did this experience empower or prohibit you from being yourself?</p>	<p>participants' experiences lead to positive integration into the STEM community or alienation or lack of belonging.</p> <p>In past research, women relied on relationships with family, academic members, and peers to nurture their self-esteem and develop persistence to overcome personal, social, and academic obstacles (Zeldin, Britner, and Pajares 2008). These questions may reveal that the co-participant's identity as a woman has an impact on the type of experiences they are having at the university.</p>
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<b>Means to Access:</b> The experiences of female African American STEM undergraduate students with their mentors.		
Tell me about your mentor	<p>How would you define the word 'mentor' ?  What do you think is the most important aspect of a mentoring relationship?  When you think about your mentoring experiences, what stands out in your mind?</p> <p>Possible Probes  *Can you describe a particular example of that?  *How did these experiences influence you in relation with your peers in STEM?  *How did these experiences influence you in relation with your STEM major?  *How did your experiences with your mentor impact how you see yourself?</p>	<p>These questions will identify the mentoring experiences, whether co-participants value more the psychosocial function or the career function of the mentoring relationship (Ragins and Kram, 2007).</p> <p>The mentoring of women was reported to be beneficial when it provided support, encouragement, and expertise (Campbell and Skoog, 2004).</p>
Tell me about any connections or themes you see among your STEM experiences here.	Draw out description and meaning.	
Are there any other experiences that you would like to share about being an African American woman who is a STEM major at an elite Predominately White Institution?	Draw out description and meaning.	

## APPENDIX E

### INTERVIEW PROTOCOL AND ITS CONNECTION TO RESEARCH AND RESEARCH QUESTIONS

Questions	Research Question They Address	Connection to Research
<p>Icebreakers: Icebreakers How did you become interested in STEM? Did you have an influential relationship or experience in STEM while in high school that directed you to STEM as a major? Why did you choose this University to pursue your major?</p>		
<p>When you think about your experiences as a STEM major at this school, what stands out in your mind?</p> <p>Possible probes: Can you describe an experience that exemplifies this description? Why was this important? How were you impacted by this experience? How did this experience empower you or prohibit you from being yourself?</p>	R1	Three practices of science departments that women found to be discouraging were large lecture classes, asking questions in class, and engaging in research (Johnson, 2007).
<p>When you think of your experiences as an African American person, what stands out in your mind?</p> <p>Possible probes: Can you</p>	R1	At PWIs African American students reported undergraduate student in the feelings of alienation, sensed hostility, racial discrimination, and lack of

<p>describe a particular example of this? What were you aware of at that time? How did this experience impact you? What did you take away from this experience? How did this experience shape your sense of belonging to the STEM community? How did this experience empower you or prohibit you from being yourself?</p>		<p>integration (Allen, 1992).</p>
<p>When you think about your experiences as a female STEM major, what stands out in your mind?</p> <p>Possible probes: Can you describe a particular example of that? What were you aware of at the time? How did this experience make you feel? How did this experience shape your sense of belonging to the STEM community? How did this experience empower you or prohibit you from being yourself?</p>	R1	<p>Women relied on relationships with family, members, and peers to nurture their self-esteem and develop persistence to overcome personal, social, and academic obstacles (Zeldin et al., 2008).</p>
<p>How would you define the word mentor? What do you think is the most important aspect of a mentoring relationship? When you think of your mentoring relationship, what stands out in your mind?</p> <p>Possible probes: Can you describe a particular example of that? How did</p>	R2	<p>Women relied on relationships with family, academic members, and peers to nurture their self-esteem and develop persistence to overcome personal, social, and academic obstacles (Zeldin et al., 2008).</p>

these experiences influence your relationship with your STEM major? How did your experiences with your mentor impact how you saw yourself?		
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## APPENDIX F

### POST-INTERVIEW CHECKLIST

Turn recorder off.

Thank co-participant for participating.

Answer any questions co-participant has about the study.

Provide my contact information for further questions or additional information they think of that is relevant to the conversation today.

Tell co-participant I enjoyed meeting them and that I will provide by email a written transcript of today's conversation.

Distribute gift card.

Write reflections as researcher.

## APPENDIX G

### WM COMPLIANCE EMAIL

STATUS OF PROTOCOL EDIRC-2018-02-11-12687-tlccross set to active

WM Compliance <complli@wm.edu> Feb 23

to me, tlccross, edirc-l, TLCross, rojohns, tcross

This is to notify you on behalf of the Education Internal Review Committee (EDIRC) that protocol EDIRC-2018-02-11-12687-tlccross titled A PHENOMENOLOGICAL INVESTIGATION OF THE LIVED EXPERIENCES OF FEMALE AFRICAN AMERICAN UNDERGRADUATE STEM STUDENTS AT AN ELITE PREDOMINATELY WHITE INSTITUTION has been EXEMPTED from formal review because it falls under the following category(ies) defined by DHHS Federal Regulations: 45CFR46.101.b.2.

**Work on this protocol may begin on 2018-03-01 and must be discontinued on 2019-03-01.**

Should there be any changes to this protocol, please submit these changes to the committee for determination of continuing exemption using the Protocol and Compliance Management application ( <https://compliance.wm.edu> ).

Please add the following statement to the footer of all consent forms, cover letters, etc.:

THIS PROJECT WAS FOUND TO COMPLY WITH APPROPRIATE ETHICAL STANDARDS AND WAS EXEMPTED FROM THE NEED FOR FORMAL REVIEW BY THE COLLEGE OF WILLIAM AND MARY PROTECTION OF HUMAN SUBJECTS COMMITTEE (Phone 757-221-3966) ON 2018-03-01 AND EXPIRES ON 2019-03-01.

You are required to notify Dr. Ward, chair of the EDIRC, at 757-221-2358 (EDIRC-L@wm.edu) and Dr. Jennifer Stevens, Chair of the PHSC at 757-221-3862 (jastev@wm.edu) if any issues arise during this study.

Good luck with your study

# APPENDIX H

## SUMMARY OF CODES AND CO-PARTICIPANT FREQUENCY

Code	A	Je	Jo	K	La	Ly	S	Y
Introductory STEM classes are too big	X			X			X	
STEM department is too small and insufficient				X				
Introductory classes are weed-out classes	X		X	X	X		X	X
STEM is hard	X	X		X	X		X	X
Adjusting to major takes time	X	X				X		X
Participants see themselves as smart	X	X	X	X	X	X	X	X
Low African American representation in student population	X	X	X	X	X	X	X	X
Stereotype threat	X	X	X	X		X	X	X
Decreased self-efficacy	X	X			X	X		X
Imposter phenomenon	X			X	X		X	
Positive verbal persuasion	X	X		X				
Negative verbal persuasion	X	X				X		
End goal provided motivation to persevere	X	X		X	X		X	X
Decreasing African American representation	X	X	X	X	X	X	X	X
Microaggressions due to lack of understanding	X	X		X				X
African American peer support	X	X	X	X	X	X	X	X
Lack of role models on campus	X	X	X	X	X	X	X	X
Parents provide vicarious experiences						X	X	
Participants provide vicarious experiences for others							X	
Racial stereotype threat	X	X	X	X	X	X	X	X
Gender stereotype threat	X							
Low female representation		X		X	X			
Female majority in major			X			X	X	X
Female faculty provides vicarious experiences							X	X
Positive female social persuasion	X		X	X		X	X	X
Defines mentoring in relation to goals	X	X	X	X			X	
Defines mentoring in relation to psychosocial support						X		X
Mentor provides vicarious experiences	X		X			X	X	
Mentor provides academic advice		X	X	X		X	X	X

Mentor provides mental health support	X	X			X		
Mentor provides empathy	X			X		X	
Mentor provides positive verbal persuasion	X	X		X	X		X
Mentor provides space for authenticity	X		X	X	X		X X

Note. A = Amy, Je = Jeanine, Jo= Joan, K = Karen, La = Lauren, Ly = Lydia, S = Stephanie, Y = Yvonne



# APPENDIX I

## SUMMARY OF CODES AND SAMPLE CO-PARTICIPANT STATEMENTS

### EXPERIENCES AS A STEM STUDENT

Codes	Sample Co-participant Quotes
<b>Introductory STEM classes are too big</b>	
	<p>“I guess it was a bit overwhelming at first. The bigger it is, the less personal it is in terms of your relationship with the professor. I think with the amount of work and the amount of people in the class, it is hard for them to give us individual feedback we would need. I think that was a problem with a bigger class and trying to give us a good foundation in the field.” -Karen</p>
<b>STEM department is too small and inefficient</b>	
	<p>“It’s a good program, but it is much smaller (than I expected). I don’t think it is as organized as it could be. I don’t think it is run efficiently. The first semester I came here, there were two intro classes. There were a lot of people needing to take this class. That is a huge downside. I think if it was bigger, you would have more professors to teach the intro level classes which are the biggest classes.” -Karen</p>
<b>Introductory classes are weed-out classes</b>	
	<p>“At this school, a lot of students start out in science or biology, and a lot of students drop off. The number steadily decreases. I think it is kind of sad. I originally wanted to be a bio major, but the intro bio class is such a weed-out class, and I just didn’t like the department.” -Joan</p>
	<p>“Everyone above me told me it was a weed out class. It is not designed for people who want to think outside the box. They wanted very specific answers to their questions, and if you strayed a little away from that then you were no good anymore. They always emphasized, if you don’t do well in this class, you will not be admitted. The grade in that class was usually not good.” -Joan</p>
	<p>“There were a lot of people who dropped out of STEM. I had a friend who was in my bio class and now she is international relations major. There are still some of the same people I began with, but the classes get smaller and smaller.” -Joan</p>

### **STEM is hard**

“I think it was just the understanding for any STEM major that it’s going to be some work. It’s going to be some sacrifice. It is going to take discipline. It’s going to take consistent discipline. That is just what it will take. It is not to say that people won’t struggle. They will struggle and get through it. It is the joy in going through that process that I survived.” -Amy

“All of those moments of stress and triumphs and failures and trial after trial culminated into that piece of paper (the degree). The experience I had at the institution was frustrating. I was in an experience of being one of the only as a student, and I wasn’t really used to that as an experience. It just showed you that there are constant moments of discomfort in life, and you have to go through that to get to that level of comfort. You won’t ever be comfortable forever.” -Amy

“I will say I had a few best friends, and we would confide in each other; saying, ‘I don’t know what is happening this semester. It’s been hard. I don’t know what is going on right now. I feel really down about this.’” -Laura

### **Adjusting to major takes time**

“It is daunting coming from high school. I think I really have to sit down and take it step by step. There are people who are going through the same thing and who are able to give advice and the professors and other faculty members are here to help you. Last semester, I tried to challenge myself by taking physics class. It probably could have turned out differently, but it was my first semester, and I was getting used to what it was like being here.” -Lydia

### **Participants see themselves as smart**

“I was always high performing. Not doing well in my freshman year was not myself. I was prohibited from being myself because I was always high achieving over-achiever.” -Amy

### **Low African American Representation**

“The million science course I have to take to graduate (stands out in my mind). Within those lectures, based on race, there are predominately White people, and then there is me or maybe two other people of color.” -Stephanie

### **Stereotype Threat**

“There was this need to constantly affirm my aptitude in the subject matter. I just always remember needing someone to tell me, “You are doing well, or you are going to get it. In my classes, the class looked a certain way, and I didn’t. Logically, there is nothing that the class is made of that should affect your performance. But we are psychological being(s). Psychologically, it was really, really taxing. Like this constant concept of being self-aware and trying to fight against it and prove that I am capable.” -Amy

### **Decreased Self-Efficacy**

“I was always high performing. I was prohibited from being myself because I was always a high achieving, over-achiever. The typical college student is top of the class, and took all of the AP courses. Stress and anxiety were there, but it was kind of part of the package. Getting to my third undergraduate year, you are faced with the same stress and anxiety, but you are not doing well. I felt a loss of identity. I was struggling to find that and got a little back to myself by senior year.” -Amy

“At this school, everyone’s the best! The tables have turned. In science class, there was a definite shake to my confidence. We would be in science class about 8 hours a day, and I remember feeling, ‘I’m not ready for this.’ I was struggling but interesting enough, I would be able to do any and all of the assignments. It was weird to feel like I wasn’t prepared. But then, my friends would feel the same but in the end, we were doing really, really well. We kind of took that as a sign for courage to take with us.” -Amy

“I had to learn how to study and how not to take on too much. A part of studying well is time management. I just believed if I had passion in all of these courses, and they were offered that semester (I should take them). I had a pretty good sense what I needed to do in all of those courses and I would just do well. But really, I wasn’t honest with myself in taking the time that I needed. For some of these courses, I just couldn’t produce code or something within a week. I couldn’t do it. It just took me a while. I think it all got off with that low C at the beginning of my freshman year. Thinking, ‘Oh, gosh, this is really a downward trend. I was doing well in the beginning, what happened between my first grade and this grade. What do I need to change?’ I was really nervous and stressed about that.” -Laura

### **Imposter Phenomenon**

“About two weeks ago, I was doing a project in one of my STEM courses for my major. I had spent about 10 consecutive hours in one area working on a project. I wasn’t even a quarter of the way done. I spent the whole day there. At first I felt like spending that much time made me feel like me who.... (Voice drops off) I felt like I was taking a lot more time than necessary. That day, I did realize the majority of the class was in there with me. We did all spend collectively about 10 to 12 hours there. I feel like we are all doing the same amount of work.” -Jeanine

“When I think back to my junior year, when I was taking physics, organic chemistry, and biology, (I remember) that was very difficult for me. Coming from a Type A personality, always getting all as prior to college. To go to college and continue to struggle impacted my sense of belonging. I was like, “Maybe, I shouldn’t have come to this institution. I should have gone somewhere else.” -Yvonne

### **Positive Verbal Persuasion**

“My advisor said, ‘It is normal to feel that way initially. And I think you’re good. You will do fine.’ That encouraged me and helped me figure out how to stick it out.” -Karen

### **Negative Verbal Persuasion**

“My freshman year, second semester. I was speaking with a somewhat advisor for students who want to go into STEM related fields. I was given the advice that seeing that I was female and Black, I didn’t have much of a hill to jump over to do well enough to get into the field. I took it that it wasn’t that hard for Black people. To me what it sounded like was that Black people don’t need to work hard or that our working hard isn’t going to measure up anyway.” -Amy

### **End Goal provided motivation to persevere**

“All of my life, since I was a kid, I wanted to be a physician. I wasn’t going to let one professor steer me away.” -Joan

## APPENDIX J

### SUMMARY OF CODES AND SAMPLE CO-PARTICIPANT STATEMENTS EXPERIENCES AS AN AFRICAN AMERICAN STEM STUDENT

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Codes	Sample Co-participant Quotes
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#### **Low African American Representation**

“You can kind of tell when you go into class, and you are the only one. I had class my second semester of my sophomore year. I was the only person of color. Like, any color! I was like, ‘Oh, this is kind of weird on a college campus.’ It should be more diverse.” - Joan

“I grew up in upstate New York. For me this is a lot of African Americans. There weren’t a lot of African Americans where I grew up. There were like 2% or 4%, so having 8% is more to me.” -Joan

“It didn’t hit me too hard. In my AP/IB high school classes, I was already one of the few Black, African American students. I was already used to being one of the minorities.” - Stephanie

“Because there is a lower number of African Americans in STEM for pre-reqs and then requirements, if you are pre-dental or pre-med, you have people that you see repeatedly in your classroom. When you do have that group of friends, when you form study groups, you can really form friendships that way. I don’t think I would have found them so easily if there weren’t so few of us.” -Laura

#### **Decreasing African American Representation**

“I was expecting to see a lot less females, but it is about equal. The majority of them were Caucasian.” -Jeanine

“In freshman year, you had those larger classes of intro for the major, intro bio classes. There are a lot of people there. Everyone who takes those classes is like pre-med or biology majors. Sophomore year and above, you tend to get smaller classes. Then, I

realized that a lot of friends that I had who were (X) majors are not here anymore.” - Stephanie

### **Microaggressions Due To Lack of Understanding**

“When I asked my advisor about HBCU medical schools, he really didn’t have any information for me. He was like, ‘I don’t know why you would want to do that? Do you just don’t feel you belong here? I don’t understand why you would feel like that.’ I was like, of course, he wouldn’t understand why I would feel like I would want to go to an HBCU because his view was White. They cannot just truly understand. He didn’t say outright, but I could tell he was like, “This shouldn’t be your first choice.” -Joan

‘I was speaking with a somewhat advisor for students who want to go into STEM related fields. I was given the advice that seeing that I was female and Black, I didn’t have much of a hill to jump over to do well enough to get into the health related field. Granted, she was giving me advice. I took it (to mean) it wasn’t that hard for Black people. To me, what it sounded like was that Black people don’t need to work hard or that your working hard isn’t going to measure up anyway. With the need to prove I was good enough, I over-performed.” -Amy

### **Stereotype Stress**

“If I didn’t succeed at something, it was almost like a setback in two ways. It was a setback for me, and the way people would expect do bad. It kind of added to that feeling of disappointment.” -Karen

“For African Americans, I feel like if one messes up, it is kind of like that is indicative of that people. If I didn’t succeed, it was almost like, “You see, they all can’t. Even the female African American population is even smaller than the African American population. They kind of generalize you.” -Karen

“I feel like African American women are less likely to speak up in group projects, we don’t want to be overbearing, and have the rest of the group think, ‘Oh, she is being loud, trying to dominate the situation.’” -Lydia

“I feel like I have to really pay attention. I can’t really play around in class because it is more obvious that I’m not doing what I am supposed to do compared to my White female counterparts.” -Lydia

“I feel that way because...it’s for the people coming after me. I don’t want the professor to feel like those people are bad because of my actions. I want to show my professor that I am more than these stereotypes that you hear about Black people or Black women.” - Lydia

“At times, I felt like an extreme minority. I’m not just a person of color; I am also queer. There are not a lot of me. Like in the biology department, there is only one female, person color with tenure.” -Stephanie

“In class, there are not a lot of us. I wouldn’t say certain things. It feels like you are trying to get somewhere, but it is difficult.” -Amy

“We all have our own personality, but it does come off that we are a single body. That couldn’t be further from the truth. I know there are a couple of people who are from different countries, and we have an array of cultures to share. I feel like that sometimes gets masked in that we all kind of act in a collective sometimes. We don’t try to do that, but I believe it comes off that way.” -Jeanine

### **Imposter Phenomenon**

“There is a lot of pressure to prove that you belong there. If you were like a White male, they would expect you to be in this building or even an Asian male. They would expect you to do well. But when you are an African American, it is like, “How did you get in here?” It is a lot of pressure to prove that I could do well, and that I belonged in this field.” -Karen

“It’s a feeling you get. You are definitely going to have to prove yourself. If you are on a team, you have to prove that you know what you are talking about and that you are knowledgeable on this topic. It was maybe more internal, like a double consciousness.” -Karen

“In my upper classes like biology or lecture halls, there aren’t that many African Americans. I think I am the only one who is African American in that class. The other minority is Indian, but I am pretty sure that everyone else in that class is White. It kind of makes me feel like, ‘Oh, maybe I shouldn’t do STEM. Maybe, I don’t belong here.’ At the same time I feel like I could potentially pave the way or path for other African Americans that want to be STEM majors.” -Stephanie

### **African American Peer Support**

“A lot of us had that similar mindset that we were not settling. We didn’t get into this school by settling. We got here by wanting to be our very best. I was constantly surrounded by people who were very ambitious, just like myself. We were also cognizant of the fact that we were the minority. We uplifted each other and held each other down when things were hard, and we wondered, “Can I do this?” -Amy

“You basically had someone who was there who had that shared experience. They came from a different background and understood what you were going through right then and at that time. They understood it in a way that someone that wasn’t of that racial

background would. They were living with all of those battles within themselves too.” - Amy

“There are very few of us. There are not a lot of African Americans in the STEM field. I know I had one that was in my dorm my freshman year. That was really cool to have someone to share that experience together.” -Karen

“When you have another Black student in the class, it is like we have this in common. If I wanted to form a study group, I would feel more comfortable going up to that other Black student and asking them to study. Study groups help you a lot. If I am hesitant, I might finally ask the person I was sitting beside, ‘Do you want to study together?’ I could have had someone earlier to study with or work with and had better results.” -Yvonne

“We kind of stick together. It is more of a group collective. I think the majority of us are aware that we don’t have a great power in numbers. We do, sometimes, hang out after class, and discuss certain things that we find challenging. We just talk after class and make an effort to stick together. In general, on this campus, there are not that many African Americans anyway. We are all kind of a tight knit. We all see that we are all in the same position, and we try to help each other out. We see we are going through the same thing so we are going to work together.” -Jeanine

“When we did our midterms, we had a strict schedule. We were going to go tutoring on these days. We were all going to ask questions about things we weren’t clear about. We exchanged strategies to help us study better, perform well, and perform better in class.” - Jeanine

“The people I surround myself with help me stay focused. They are also STEM majors. Our classes overlap. Sometimes we share materials, and we help each other. And they are also very driven. It helps me stay motivated. We are always in the library working, or we are in the dorm working. We are always helping each other to keep going. It gets hard after awhile. It’s hard to keep going.” -Lydia

“One is my roommate. We met one of the other girls in the group across the hall from us. Another one lives in the same area. We ended up coming together, and we are all kind of from the same cultural background. We are all children of immigrants from Africa. That kind of bonds us well.” -Lydia

### **Lacking Role Models On Campus**

“You don’t see future versions of yourself. You don’t see many Black professors. You don’t see many Black people brought for talks. You don’t see that on campus. It seems like you are trying to get to a place that not many people of color get to because you are not seeing it. Whereas, my White contemporaries often see those people at those talks. They are the people at the lecture. At my particular institution, (I want to say I believe



these are very respectable occupations) you see people of color in janitorial positions or in food services. Mind you, these people were people who aided me in getting my degree because they were constant sources of help and love and everything. Do you see the difference in those two views of your future or potential future? I think it can do something to the psyche at least temporarily. I was always as a Black student wanting to show to myself and the White counterparts that I have very big ambitions. Even though there is a lack of people who look like me doing it, it doesn't mean that it is impossible.”  
-Amy

“It would be nice to know you have a professor that looks like you and can understand what you are going through as an undergrad.” -Joan

“I would like to have the experience (of mentoring) with someone who is a Black female. It is actually really, really rare. I feel like she would be like a mother to me. They would be like my mom. I probably would call them every day. If there was a Black female in that field, I would like to get her perspective on how she dealt with things. I like my mentor. I don't want to say I would have chosen a different person. They have given me really great advice that was invaluable. It would have been nice to have someone like me. ” -Jeanine

### **Parents Provide Vicarious Experiences**

“My dad majored in chemistry. He also said there weren't many African Americans in his classes. My mom did a special program where she did med-school in six years. Both of my parents influenced me or empowered me to continue on in my interest.” -Stephanie

### **Co-Participant Provides Vicarious Experiences**

“I am a TA (teacher's assistant) for a freshman research lab. The majority of students are African American. This is really great! It makes me really happy. By being there, I am empowering them to continue in their major. My presence says, “We would love to have more African Americans, more people of color take on STEM and conquer it.” -  
Stephanie

APPENDIX K

SUMMARY OF CODES AND SAMPLE CO-PARTICIPANT STATEMENTS

EXPERIENCES AS A FEMALE STEM STUDENT

Codes	Sample co-participant Quotes
<b>Racial Stereotype Threat</b>	
	<p>“I don’t feel as much pressure as a woman. I don’t think they would think of me as a representative of women. ” -Karen</p> <p>“I really didn’t think about also being female in these courses. My thoughts were like, “I’m African American.” -Laura</p> <p>“You are just always going to see more women than men. I don’t think it would alleviate the pressures of being an African American. You are still with people who don’t look like you.” -Joan</p> <p>“I think it makes it a litter hard to make you feel like you belong. They try to act like it really doesn’t matter, but I know at the of the day, it really does matter.” -Lydia</p> <p>“I feel like African American women are less likely to speak up in group projects, we don’t want to be overbearing, and have the rest of the group think, ‘Oh, she is being loud, trying to dominate the situation.’” -Lydia</p> <p>“I feel like I have to really pay attention. I can’t really play around in class because it is more obvious that I’m not doing what I am supposed to do compared to my White female counterparts.” -Lydia</p> <p>“I feel that way because...it’s for the people coming after me. I don’t want the professor to feel like those people are bad because of my actions. I want to show my professor that I am more than these stereotypes that you hear about Black people or Black women.” - Lydia</p>

“Like, Black people can’t do better or be better for ourselves, and we are lazy, and we aren’t going to amount to anything. Things like that. I feel like I have to work twice as hard to get to the same spot as my White counterparts. It’s sad but true.” -Lydia

“We don’t really notice a difference in gender. In some points, we don’t look at that like we are separate. Even though there is a larger representation of female, they are still Caucasian. In our sub-group, there are Caucasians, and then there is us. I feel like the outside people don’t really see that we are separated by our gender. They see that we are as collective. If I thought about it more, I would probably be frustrated by it. We all have so much to offer. There is only so much I can do. I can’t really change how people perceive things.” -Jeanine

“It is really frustrating, but there is really nothing I can do about how they feel or the collective stereotype they have about all of us in regards to our gender, our culture, or where we are from. They feel this one particular way, about all of us.” -Jeanine

‘I was speaking with a somewhat advisor for students who want to go into STEM related fields. I was given the advice that seeing that I was female and Black, I didn’t have much of a hill to jump over to do well enough to get into the health related field. Granted, she was giving me advice. I took it (to mean) it wasn’t that hard for Black people. To me, what it sounded like was that Black people don’t need to work hard or that your working hard isn’t going to measure up anyway. With the need to prove I was good enough, I over performed.’ -Amy

### **Gender Stereotype Threat**

“There was this understanding that she (I) may not understand this, so I am going to explain it.” -Amy

“I would say, I think it was kind of similar to the African American experience. Because there weren’t that many of us, we kind of stuck together. We felt like we all just wanted to do our best and help each other. We just wanted to demonstrate that we were capable, and we could perform well on this type of material.” -Amy

### **Low Female Representation**

“There weren’t many of us and as you go up in classes, you know they get smaller.” Amy

“There were just none of us. It was very, very few. I think we were always so much careful. In that major and making sure your reasoning and logic is sound (was important). And making sure you start an argument that makes sense and you can prove it (was important). Even though there weren’t many of us, we were very careful. I think we were better. We could see those minute details that were necessary to get the right answer. On the other hand, the male classmates were kind of (not to generalize but to generalize)

would go through things faster and make these haphazard errors that could have been avoided by being more thoughtful in what they were doing.” -Amy

### **Imposter Phenomenon**

“There needs to be courses on the psychological shift. There are courses on the academic shift, but I feel like there needs to be some course on how you navigate the psychological issues in the academic setting. If you had a way to explain to people, ‘you are not dumb because you are a particular gender or a particular race. Psychologically, you might face that and here is how you navigate that when you feel that. Confront the elephant that will definitely show up in the room by saying, “You are capable.”’ -Amy

### **Female Majority**

“My campus is kind of weird. There are more female STEM students than male which I would imagine is not representative of the entire college as a nation. For the most part, it is female except when you get into math. Math has way more males than females. But in biology, there are way more females. Math and physics men. Everything else is pretty much female dominated. It is kind of nice actually. On the professor side, it is male dominated.” -Joan

“At this school, I am very happy. The majority of the professors I had in the STEM classes are all female. For example, I am in a research lab and the professor is a female and for the lab I TA for, the professor is also female. In my post grad plans, I am working in a lab run by females. So at this school at least, I have been able to find a number of female professors to look up to.” -Stephanie

“I think in general, females are well represented in the STEM field in class I have taken. I’ve seen a pretty even balance between males and females.” -Lydia

“Having an even balance helps me be comfortable I think. I am able to sit down and focus and strive and do well in class.” -Lydia

“I just feel like there is a camaraderie with women in general. Women tend to be more open and treat each other in that type of way. They tend to be more mature. In general, I had more female friends in STEM. When trying to form a study group, I am more likely to go to female members of the class.” -Yvonne

### **Faculty Provide Vicarious Experiences**

“My professors have families. They have kids. It makes me happy to know you can have a great family life and a great professional life. In the media, it always seems that women have to choose one or the other.” -Stephanie

“It makes me proud. I love what they research. Even though their research may seem complicated, you see they can do really complicated things and run labs and lead effectively. It makes me really happy I can learn from them.” -Stephanie

“This definitely empowers me. I feel like I am more myself around them. And being yourself is always good. In high school, at the top of my head, I only had one female STEM teacher. The other female teachers were like for English or Spanish. That was the beginning of my career. When I got to college, I said, “Oh, this is great!” -Stephanie

### **Positive Social Persuasion**

“I never felt like an outsider. I never felt like it was weird for me to pursue any course I was interested in. It was just like I was anyone else taking a course. The strong affirmative comes from the complete lack of experience of feeling left out or excluded.” - Laura

“In my classes there are a whole lot more females in it. I’ve had a female professor at one point. I have a male professor now that is like very feminist. He is very much for the advancement of women in the STEM field. I definitely feel good about being a woman and going forward.” -Karen

“My professor would always talk about this conference they have every year where all of these women come together. He would say, ‘you should really think about applying. You should really think about going to this. There are job offers on the spot, and they want women to go. That kind of told me, they want women here. They want us in this field. They want us to succeed in this field. He keeps pushing this one club for women in computing on campus and pushing women to sign up. He would say, ‘We need gender equality in this field.’ I think that kind of encouraged me.” -Karen

“As I progressed, they were definitely for it. They were definitely supporting women in STEM. I think it grew over time. I don’t think it was ever a bad place.” -Karen

“I feel like I belong here and that there are opportunities for me here and that I can succeed in this.” -Karen

“There is an emphasis now for women to be into more male dominated fields versus fashion design. They want more women in STEM fields like science and technology. Even though I wanted to take a major that wasn’t STEM related, some parts of me as a woman wanted to be the person that broke barriers for future generations.” -Jeanine



APPENDIX L

SUMMARY OF CODES AND SAMPLE CO-PARTICIPANT STATEMENTS

EXPERIENCES WITH MENTORS

Codes	Sample Co-participant Quotes
<b>Defines Mentor In Relation To Goals</b>	
	“I would define mentor as someone who has knowledge about what you want to have knowledge about. They kind of guide you, lead you, and give you advice on what you want to achieve.” -Karen
	“Someone that guides or provides leadership.” -Stephanie
	“It is someone who is doing what you aspire to do.” -Amy
	“It is someone who is invested in your success. It is anyone who wants to see you succeed and will help you succeed.” -Joan
	“Someone that I feel like I could go to and talk about classes, opportunities outside of school, and what I should do over the summer when I am on break.” -Jeanine
<b>Defines Mentor In Relation to Psychosocial Support</b>	
	“Someone who is there to support you in your decisions and provide guidance and guide you where you want to go.” -Lydia
	“Someone you can go to for advice on different matters and multiple facets of your life. They give you good advice, and they also look out for you. They will check up on you and see how you are doing.” -Yvonne
<b>Definition Combines Academic Goals And Psychosocial Support</b>	
	“It is someone who is there for you and plays a very supportive role in your academic development, but also in your personal development. They kind of weave together your personal and academic lives. They have a more mature outlook because they are older, or

they have more experiences. They have experience in the area of your life you are struggling in. They are willing to have the patience and also the expertise, time, and presence to be there for you.” -Stephanie

### **Mentor Provides Vicarious Experiences**

“She actually didn’t major in the same thing that I did, but she does do what I hope to do eventually.” -Amy

“You can do it because she has done it. This is the path you might have to take, but it is a path to get you where you want to be. I just appreciated that. With my experience compared to hers, she told me that is possible to major in STEM and to get there.” -Amy

### **Mentor Provides Academic Advice**

“He gives me advice on the field, opportunities I should go for, and things I should look out for and classes I should take. He gives me more professional support.” -Karen

(My mentoring relationship) “gave me an extra spark. It made me feel like I could do this, or I am shooting for something that is bigger than this. It definitely encouraged me speaking with him. Taking time with him gave me a lot of confidence in things I could do and what I was able to achieve.” -Karen

“She is my pre-med advisory. She has been very helpful. If I have questions on the classes I should take or on my resume, she could answer those questions for me because she is in the department that I want to go into. I think she is making it less daunting. At the beginning, before I started, looking at all of the requirements was overwhelming. Going to talk to her kind of helped ease my fears and helped me know that I was on track, and I am getting there. ” -Lydia

“He gave me really solid studying tips and things I can do to improve my retention and resources I could seek out for help. Also, what would be a good path of things I can do for my major and things I should do over the summer and opportunities that I probably would not like to miss out on.”? -Jeanine

“He is very knowledgeable about medical school. He used to be the pre-med advisor. I definitely wanted him for that aspect.” -Joan

(The most important aspect of my mentoring relationship is) “support. Even if your mentor is not particularly knowledgeable in your field, they would give you support and help you find someone to help you.” -Yvonne

“One time I went in and I was thinking of other career paths that were related (to my major). She sent me links, emails of someone she knew that was a director of a program



that she knew. I went to her more for academic things like that; like writing my resume.”  
-Yvonne

“It wasn’t really one experience but the repetition of the experience of breaking down the how many credits I was taking that semester and the courses I was taking and how I was preparing for them. I had to keep going through that same experience, knowing where I went wrong and learning how I was going to do better. I definitely had a lot of motivation. I really wanted to take time to fix it. Here was someone who was just as passionate as me about fixing it.” -Laura

### **Mentor Provides Mental Health Support**

(Being with my mentor) “showed me it was necessary to take care of one’s self to take care of other people. For me, she would tell me, ‘Maybe it is time to take a moment or take a break. Let’s construct a plan and see where you can go from there.’ I think it showed me it was necessary to rejuvenate. Rejuvenate your mind. Rejuvenate your spirit without feeling like you are slowing down. All of those things are necessary to be your best self. You can’t be your best self if you are completely drained.” -Amy

“I feel like I am trying to get more emotional support now (from my mentor). I feel like I am pretty strong in terms of academics, but there are times or some instances when I have sacrificed my mental health just to do better in class. That’s really not healthy. Sometimes, I talk to my mentor about that.” -Jeanine

### **Mentor Provides Empathy**

“The most important aspect of a mentor is how comfortable you feel with the person who is mentoring you. You can be as honest and get as much out of the relationship as possible.” -Karen

(The most important part of a mentoring relationship) “is having that repertoire and banter where they understand where you are coming from and going from there and providing the best advice for that person.” -Lydia

“You have to be comfortable with your mentor. If you feel like there is any kind of judgment or lack of understanding of where you are from where they are, you are not going to be able to get what you need from the mentoring relationship.” -Laura

“I think it’s guidance coupled with candor and also an understanding of what does this person need. I think you can definitely help someone and aid them and give them advice and be honest (to learn) what they need to do to get from Point A to Point B.” -Amy

### **Mentor Provides Positive Verbal Persuasion**

“I know at first when I was having trouble; he was like, ‘You’re fine. I’ve been through the same things.’ That really helped, knowing that things get better.” -Karen

“They have consistently rooting me on, saying, ‘You’re doing great!’” -Jeanine

### **Mentor Provides Space for Authenticity**

“He was just there for me. This was really a process of me getting better. I think he helped by give me belief in myself and not feeling hopeless. He would say, ‘Let’s breakdown your semester right now and all of your extra-curriculars and see how you feel about it. Let’s go over the next semester and see if that’s better.’ He really helped me self-analyze in a way that was very objective and not subjective. I was kind of thinking, ‘I’m just not good enough. My brain works differently. I have plateaued. There’s no way I can learn. I’m not that good anymore.’ He kind of just helped me push through that belief by helping me objectively self-analyze and also just by being there. I would send him emails. We would meet at these crazy times. Our meetings were always at least an hour. I could cry, and I would get better. It would be better. In order to have tenacity or grit to hang on, you need supportive people around you who are just going to be there.” - Laura

“Knowing they are an email away, and they will respond in the next few days. Knowing they are a phone call away.” -Laura

“We have a shared connection over science. We kind of geek over that. I used to go on these trips with the church and we were sometimes at the same site. We would talk about how we were going to build this ramp or staircase using some engineering or measurements.” -Stephanie

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### **Education**

**Ph.D. Educational Policy, Planning, and Leadership**, College of William and Mary, August 2018.

**Masters of Science in Educational Leadership**, Old Dominion University, August 2007.

**Gifted Endorsement**, Shenandoah University, May 1997.

**Masters of Arts in Elementary Education**, Hampton University, May 1994.

**Bachelor of City Planning**, University of Virginia, May 1991.

### **Work Experience**

**Director**, Department of Academic Advancement and Enrichment, Hampton City Schools. Coordinates the gifted eligibility process, provides training for teachers in gifted education, manages budget for program operation, and oversees implementation of the gifted resource program by gifted resource teachers, (2018-present)

**Manuscript Reviewer**, *Journal for the Education of the Gifted*. Provides peer review of manuscripts considered for publication, (2015 - present)

### **Testing and Evaluation**

**Gifted Local Plan Technical Reviewer**, Virginia Department of Education. Used state standards to evaluate local plans for gifted education for divisions across the Commonwealth of Virginia, (2014)

**Gifted Program Evaluation**, Department of Academic Advancement and Enrichment, Hampton City Schools. Researched and Implemented Evaluation tool, the College of William and Mary's Center for Gifted Education *Test of Critical Thinking*, to assess the growth of participants in the gifted resource program, (2008)

### **Awards**

**Paper Presenter**, **American Educational Research Association**, Self-Efficacy of African American Women in STEM, Chicago, IL (2015)

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