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A Phenomenological Study of the Lived Experiences of African American Women in Undergraduate STEM Degree Programs

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Approval Page

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Abstract

A Phenomenological Study of the Lived Experiences of African American Women in Undergraduate STEM Degree Programs. Vernon H. Smith, 2021: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and School of Criminal Justice. Keywords: Bachelor's degrees, educational discrimination, nontraditional students, STEM education

This applied dissertation was designed to provide a better understanding of the lived experiences of African American women in STEM undergraduate degree programs at a 4-year degree granting institution in the southernmost part of central Virginia. The central problem is that there is disparity between the number of African American women with STEM degrees and that of other races in the STEM job market. The existing literature has gaps in the research of African American women's perception of undergraduate STEM programs. Further, the researcher posits there is a lack of consideration for diversity that is detrimental to the United States; the STEM labor force was identified as a critical field to sustain the country's economic growth and national security.

The research addressed the lived experiences of African American women in undergraduate STEM degree programs. The findings could provide an association with the low enrollment and retention of African American women in STEM. The study utilized the social cognitive career theory, the interpretative phenomenological analysis process, and the meaning-making of African American women's lived experiences that enable them to persist and attain their STEM undergraduate degrees. This study applied a qualitative phenomenology method guided by the central research question: What are the critical experiences that influence the lived experiences of African American females in STEM undergraduate programs?

The findings of the study reflected that there are five significant themes that contribute to the lived experiences of African American women in undergraduate STEM degree programs: (a) Living in my skin and bringing emotions in the STEM program; (b) Persistence despite family context: Understanding family make-up and its role in sustaining motivation to remain in STEM; (c) Expectations and misconceptions in the academic environment; d) Support mechanisms while in the STEM program; and (e) Identifying needs for professors and mentors who are of the same race and gender and to increase transparency of financial resources to support African American women in STEM. The participants in the study recognized that implementing transformational practices such as (a) increasing funding for the marketing and recruitment of African American female students in STEM; (b) increasing the number of African American women professors and mentors in STEM courses; and (c) providing mental health and wellness support mechanisms are necessary measures that could address the critical shortage of African American women in STEM.

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Chapter 1: Introduction

Statement of the Problem

Statistics show that fewer minority women are being conferred bachelor's degrees in science, technology, engineering, and math (STEM) over the past decade. The U.S. Census Bureau (2019a) estimates the geographic U.S. population to be 327M in 2018. In 2018, women accounted for 166 million, or approximately 51% of the U.S. population. Of the 166 million women residents in the United States, African American women made up 13% or 22 million residents in 2018 (U.S. Census Bureau, 2019b). One-third of college-educated employees held a degree in the STEM field in 2018. However, only 52% of those with postsecondary training in a STEM field worked in a STEM position (Funk & Parker, 2018).

The Pew Research Center (2019) estimated that there were 30 million college-educated women in the U.S. workforce during 2018. Of the 30 million college-educated women in North America, 518,833 received undergraduate STEM degrees during 2018 (National Science Foundation [NSF], 2020). By comparison, African American women received only 53,902, or 10.4% of the 518,833 undergraduate STEM degrees conferred to women in 2018 (NSF, 2020).

Women in STEM Labor Force

The U.S. Bureau of Labor Statistics (2015) projected over one million STEM professionals will be needed in the U.S. labor industry from 2018-2028 to meet the advancements for economic growth in the United States. Exacerbating this requirement, roughly 2.5 million STEM jobs were projected to go unfilled during 2018 (Smithsonian Science Education Center, 2020).

Women with a bachelor's degree or higher comprised 29%, or 2.12 million of the

STEM workforces during 2017 (National Science Board [NSB], 2019). Recent studies show that the influence of women in STEM has been linked to the advancement of global economic development, gender equality, and the opportunity for females to contribute to the field (Blackburn, 2017; Blackburn & Heppler, 2019; Briggs, 2016; NSB, 2020b). The U.S. Labor Bureau projects the STEM labor force will grow by 12% from 7.31 million in 2018 to approximately 8.05 million in 2028.

Underrepresented Minority Women in STEM

Federal agencies have been tasked to further investigate resource and achievement gaps between African American women and other race/ethnic groups in education to increase their STEM degree attainment (Handelsman & Smith, 2016; NSF, 2018). The NSF (2018) determined that:

> Too many African American students still lack access to the educational resources that offer a fair shot at success…. This lack of access to foundational STEM skills puts African American students at a significant disadvantage in preparing for advanced STEM courses and careers. (p.1)

During 2017, African American women made up only 3% of undergraduate STEM degree participants (McGee & Bentley, 2017). Blackburn's (2017) study exploring the status of women in higher education STEM concluded:

> There is a need to "understand the holistic lived experiences of women in STEM, including intervention and retention strategies that lead to success…"
>
> Documenting the experiences of women in underrepresented minority (URM) groups from all institutions, including community colleges, predominately-white universities, Historically Black Colleges and Universities (HBCUs), and Hispanic Serving Institutions (HSIs) would give voices to traditionally marginalized

groups. (p. 18)

Research Problem

The lack of college-educated individuals in STEM could be a risk in the United States' ability to meet current and future global competitive advantages through economic growth and realized strategic objectives in academia and the business sector (Herman, 2019; NSB, 2020b). Alfred et al. (2018) explored the current deficit of college-educated skilled workers in the STEM labor force. Alfred et al. concluded:

> Scholars have advanced different perspectives regarding the STEM talent pool deficit to include poor-quality public-school education, the small number of students majoring in STEM disciplines at undergraduate and graduate levels, the high rate of attrition among undergraduate STEM majors, and poor-quality programs that inadequately prepare students to perform successfully in business and industry. (p. 116)

Research has identified a shortage of minorities in the STEM labor pool (Alfred et al., 2018). Currently, there is a lack of college-educated African American women in STEM to support the U.S. job market (U.S. Bureau of Labor Statistics, 2015; U.S. Department of Commerce, 2017). Only 8.6% or 11,405 African American women completed undergraduate STEM degrees from 2017-18 (National Center for Education Statistics [NCES], 2019). Arnim (2019) reported that 40% of African Americans switched from STEM degrees, while an additional 26% of African Americans dropped out of college altogether that year.

Xu's (2017) research identified salary potential in the STEM industry is often the driving force for women to enroll in STEM degree programs. The current needs of the STEM industry allow opportunities for African American women with undergraduate

STEM degrees to attain long-term financial benefits that enhance their socioeconomic growth (Maltby et al., 2016). Fayer et al. (2017) reported that the national median salary for all STEM jobs in 2017 was $87,570, almost twice as much as the national median salary of non-STEM professionals ($45,700).

Phenomenon of Interest

Due to current trends in technology, medical, and pharmaceuticals, there is a need for individuals in the United States to fill STEM field positions that are critical to the country's economic competitive advantage in the global markets (American Association of University Women [AAUW], 2020; Briggs, 2016). The National Science Board (NSB, 2018; NSB, 2020b) reported that White women in the STEM workforce dropped from 1995 (81.3%) to 2017 (60.4%), Asian women increased from 9.8% in 1995 to 20.8% in 2017, Hispanic women increased from 2.9 to 7.8, and African American women increased slightly from 5.6% in 1995 to 8.5% in 2017. From 1995 to 2017, there were modest gains by college-educated African American women with STEM undergraduate degrees entering the U.S. workforce from 7.9% to 8.7% (NSB, 2018).

STEM Student Indicators

To increase African American women in STEM programs, President Obama's administration established the White House Initiative on Educational Excellence for African Americans (Handelsman & Smith, 2016). Handelsman and Smith (2016) explored the White House administration's policies aimed at equality for all students in STEM academics as well as the STEM workforce. President Obama concluded:

> One of the things that I've been focused on as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math…. We need to make this a priority to train an army of new teachers in these subject areas

> and to make sure that all of us as a country are lifting these subjects for the respect that they deserve. (Handelsman & Smith, 2016, p. 1)

Increasing the representation of African American females has been identified as essential to the United States remaining a viable competitor in the STEM workforce (Handelsman & Smith, 2016; White House Initiative on Educational Excellence for African Americans, 2014). Historically Black Colleges or Universities (HBCUs) make up 102 colleges out of 4,324 degree-granting institutions, but lead all other colleges and institutions in producing African American women receiving undergraduate STEM degrees. Although HBCUs represent approximately 3% of all colleges and institutions, they award 27% of African American undergraduate STEM degrees (Harper, 2018; NSF, 2017; U.S. Department of Education [DOE], 2016).

HBCUs produced roughly 46% of African American female STEM graduates from 1995 to 2004, although the enrollment of African American women in undergraduate STEM degree programs has steadily declined in other degree-granting colleges and universities since 2004 (Harper, 2018; NSF, 2017). The Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline explored the phenomenon of increasing underrepresented minority (URM) women in STEM postsecondary degree programs, concluding: “minorities are seriously underrepresented in science and engineering, yet they are also the most rapidly growing segment of the population” (Briggs, 2016, p. 1). In 2006, URMs totaled 9.1% of Americans in the STEM workforce, while representing 28.5% of the United States population (Briggs, 2016).

Investigating the discrepancies between African American women in STEM and their actual lived experiences could assist in developing an understanding of how K-12,

postsecondary education, and society shape African American female students' participation in STEM, their low academic performance in STEM-related programs, attainment of degrees, and entry into the STEM labor force.

Background and Justification

The STEM labor force in the United States has been identified as critical to the economic growth and national security of the United States of America stemming from the cold war era with the former Soviet Union (Herman, 2019; U.S. Department of Commerce, 2017). The United States determined that there was a need for geospatial supremacy by transforming the Pentagon's high-tech supremacy, in addition to the strategic objective to boost the U.S. economy through innovative processors and dot-com capital ventures (Herman, 2019). The United States initiative was known as the Second Offset Strategy (Herman, 2019). Post 1980, higher education had concerns that it could not produce the number of STEM graduates needed to support the country (Herman, 2019). In 2014, President Obama introduced the Third Offset Strategy. President Obama concluded:

> Technologies will be critical if the United States is to maintain its military superiority over its rivals, including China. They will also require new levels of scientific and engineering aptitude and understanding, not just from their designers but from producers and users, including the next generation of warfighters. (Herman, 2019, p. 3)

Although U.S. leadership identified a need to increase African American women in STEM, there have been challenges getting African American women to participate in the federal programs (Finkel, 2017; McMurtrie, 2016). Further investigating the lived experiences of African American women in STEM could reveal if these students are

being notified at the recipient level regarding federal funded programs and scholarships. Harper's (2018) study exploring initiatives to introduce younger African American women/girls to STEM showed that policies have not had the success expected by the NSF. Recent data show that when the sciences and advanced math courses are available to lower-income public high schools with a large enrollment of African American students, there were gaps in registration that showed the low numbers of African American students who enrolled in the sciences and math versus the higher percentages of White and Asian students (Harper, 2018). While the courses are available for students in low-income high schools, without further investigation, there is a lack of understanding whether the low enrollment is due to a lack of fundamental skills in science and math courses dating back to earlier education.

Buck et al. (2014) explored gender disparities in STEM-related courses. The study showed that African American female students' proficiency in K-12 advanced mathematics, science, and chemistry was significantly lower than White students (Buck et al., 2014). There were gaps in their research that could not reflect learning environment hindrances that may cause African American females to persist at lower rates than other races/gender do. Investigating the influences which affect African American females' persistence in K-12 STEM activities could reflect a wider understanding of their belonging in academic environments.

Research shows that African American women/female pre-college students are more inclined to enroll in first-year undergraduate psychology and social science programs that "serve" society rather than STEM (McMurtrie, 2016). Without further investigations, there remains a gap between how African American girls view STEM during their K-12 experience and their desire to be in a field that provides support and

nurturing. There is a need to research whether there is a link between isolation due to race/gender biases of individuals within the learning environment and the self-identity of African American girls that causes them to opt toward more gender-normative fields because STEM fields are considered manly, or they cannot handle the rigors of STEM.

Furthermore, understanding the learning environment culture, societal influences, or lack of support from education faculty or family may provide a clearer insight into why African American girls are underrepresented in STEM. During 1995-2014, African American women had higher percentages in attaining degrees in other-than-STEM undergraduate majors such as psychology where graduation rates were 9.19%, and social sciences where graduation rates were 6.82% (NSF, 2017). Further investigation could provide a clearer understanding of why African American female students would rather enroll in psychology and social sciences degrees than STEM degrees. Perhaps, because the degree may be easier to obtain, faculty may be more accommodating, or they feel less pressure to succeed in the programs. Further investigating could find whether there are factors that make African American women leave STEM programs for other degrees.

During 1995-2014, African American women earned their lowest percentage (2.9%) of undergraduate degrees in STEM (NSF, 2017). Existing research does not state why African American women are not participating in federal programs such as the White House Initiative on Educational Excellence for African Americans, or how many have been admitted into the program since its conception (DOE, n. d.). Without further research, there may be assumptions rather than facts that show whether African American women/girls are being informed of the federal initiatives, what support and resources are available to assist in the knowledge and application process, or whether the low graduation percentage is due to negative attitudes and perceptions of the STEM

instruction and curriculum. Further investigation could reveal that African American women/girls do not understand the application process for STEM programs or they may be applying and not qualifying for approval, ot receiving support and resources, or are intimidated by the analytical coursework.

Deficiencies in the Evidence

There is limited research on the lived experiences of African American women in undergraduate STEM studies that trace back to early education. Current research exploring the phenomenon of African American women in STEM lacks empirical studies reflecting the social and interpersonal interactions that influence their decisions to persist or leave STEM undergraduate degree programs. Understanding the lived experiences and self-efficacy of African American women in STEM undergraduate degree programs may provide answers as to why they are underrepresented in this field. The limited research of African American women in STEM focuses on the individuality of African American women in STEM rather than the social and personal interactions between African American women, the education ecosystem, and the STEM industry. Further investigation is needed to understand: (a) how lived experiences affect the academic achievement of gender learning and patterns; (b) implicit intelligence beliefs of STEM undergraduate students and how individuals cope; (c) how to increase students in STEM in K-12; (d) support systems around African American women regarding STEM; and (e) available resources, knowledge, and policies that are afforded to African American students in STEM (King & Pringle, 2017; Lytle & Shin, 2020; Young et al., 2018).

Audience

The target audience for this study is K-12 administrators who create policies that engage African American female students in STEM curricula; higher education

policymakers who may be able to use the research results to improve the lived experiences of African American women/girls in STEM; and legislative and industry leaders who are advocates to establish and implement STEM diversity policies regarding increasing African American women in the STEM workforce.

Definition of Terms

Intersectionality

Coined in 1989 to describe how race, gender, class, and other individual features "intersect" with one another and overlap (Crenshaw, 1989, p. 2; see Coaston, 2019, p. 2).

National Science Foundation

NSF is an independent governmental activity that endorses structural exploration and education improvements throughout all areas of science and engineering (NSF, 2018 p. 1).

STEM (science, technology, engineering, and mathematics)

Previously science, mathematics, engineering, and technology (SMET) and rearranged by Ramaley, then assistant director of education and human resources at NSF in 2001 (Hallinen, 2015, p. 1). Refers to teaching and learning in the fields of science, technology,engineering, and mathematics (Gonzalez & Kuenzi, 2012, p. 2).

STEM Learning Ecosystem

Includes PreK-16 schools; community settings such as afterschool and summer programs; institutions of higher education; STEM-expert organizations such as science centers, museums, corporations, intermediary and non-profit organizations or professional associations; businesses; funders; and informal experiences at home and in a variety of environments. (STEM Funders Network, 2020, p. 1)

Underrepresented Minorities (URM)

"African Americans, American Indians/Alaska Natives, and Latinos— who have historically comprised a minority of the U.S. population" (National Action Council for Minorities in Engineering, 2021). This definition consists of individuals who are identified as underrepresented in the arena of science, technology, engineering, and mathematics (STEM).

Purpose of the Study

The purpose of this phenomenological study was to investigate the academic, social, and interpersonal experiences of African American women in STEM at a 4-year degree-granting university in the southern part of central Virginia. The results of the study will provide a greater understanding of their academic experience and recommendations to improve their enrollment and retention rate in STEM undergraduate degree programs. Understanding the social and interpersonal experiences that affect the "lived" phenomenon of undergraduate African American female scholars and the factors that influence their cognitive behaviors, persistence, or disengage in STEM undergraduate degree programs is identified as critical toward understanding the holistic portrait of African American women and STEM (Blackburn, 2017).

There have been several studies exploring the lived experiences of URM women including African American women (Blackburn, 2017; Finkel, 2017; Rodriguez et al., 2012). African American women have made many sizeable contributions in STEM over the past half-century, yet these hidden figures have been mostly ignored in STEM academics and the STEM industry. The significance of this study is that it will not only enhance Black scholarship but will also cast a light on how African American women in some cases have ignored stereotypes of society by persisting in STEM and why others

chose to leave. Understanding this phenomenon could serve as a catalyst that allows senior academic administrators and the STEM industry leadership to investigate and create/implement policies that encourage more African American women to enroll in STEM academic programs and to contribute to the achievements of their STEM organizations.

Chapter Summary

Chapter 1 presented an overview of the research problem and the purpose of the study. Furthermore, the background and justification of the study was explained in the chapter as statistical data provided the Department of Education and the U.S. Census Bureau show there is a significant gap between African American women in STEM and other race and genders in STEM. This gap has widened over the past two decades as African American women reflect less than 3% of undergraduates conferred a degree in STEM degree programs. There is a need to understand the enrollment, retention, and attainment of African American women in STEM programs and the STEM industry. The United States has identified the shortage of African American women in STEM as critical to the national security of the United States and a missed opportunity to utilize the unique experiences and skills that African American women can bring to STEM. Recent studies show that the engagement of women in STEM has been associated with the advancement of global economic development, gender equality, and the opportunity for females to contribute to STEM academics and the STEM industry. Although African American women have been shown to produce significant innovations in STEM, they are marginalized, faced with microaggressions, inequality, and isolated within STEM. Understanding the lived experiences that cause African American women to enroll, persist, and attain could provide the necessary framework for academia and industry to

decrease their underrepresentation in the STEM industry.

Chapter 2: Literature Review

Chapter 2 presented the literature relevant to the study's purpose, a qualitative analysis of the lived experiences of African American women in a STEM program at a 4-year degree-granting university. The researcher aims to offer recommendations that can help improve their enrollment, persistence, and retention rate. The review is organized into cross-cutting themes consistent in the literature. The themes reveal the influences that hinder the persistence and career aspirations of African American women in undergraduate STEM programs.

The sections are presented as follows: (a) the theoretical framework and its applicability to the retention of African American women in STEM; (b) an outline of the social cognitive career theory and intersectionality of African American women; (c) a focus of African American women in undergraduate STEM programs; (d) how to adapt STEM academics to the cultural experiences of African American women; (e) the hindrances to the self-efficacy of African American women in STEM; (f) an account of African American girls' exposure to K-12 STEM environments; (g) review of African American girls' experiences in outreach and formal STEM programs; and (h) effects of mentoring African American women. Chapter 2 concludes with a summary of the reviewed literature and a delineation of methodologies used in pertinent studies. Finally, the research questions are presented to provide an understanding of the study.

Theoretical Framework

Research that focused on the lived experiences of African American women in STEM and the causes to enroll, persist, or leave STEM degree programs is limited. According to Davis (2019), the complexities and lived experiences of African American women are not as definitive as critical race theory, nor as simple as Black feminism in a

singular sense. Rather, it should be viewed in the plural context (feminisms). Black feminisms have been described as "intellectual, artistic, philosophical, and activist practice grounded in black women's lived experiences" (Davis, 2019, p. 3). Inequalities for African American women in academia include (a) societal preconceptions, (b) exclusion in academic structures, and (c) subservient treatment in the workforce that may be directly related to their self-efficacy when choosing to stay in the STEM field of their choice to avoid it (Alfred et al., 2019; Crenshaw, 1989; Fouad & Santana, 2017; Ko et al., 2013).

Social Cognitive Career Theory (SCCT) emphasized that distinct characteristics including gender and race, familial background, and socioeconomic status affect lived experiences, self-efficacy, outlook, and beliefs (Fouad & Santana, 2017). Fouad and Santana utilized SCCT during their investigation of factors that influenced African Americans' choices, in particular African American women, enrolled in STEM or aspiring to be in the STEM workforce. SCCT was suitable because of its intersectionality: (a) how students develop academic and career interests, (b) how students select those academic programs and career choices, and (c) how students obtain academic and career success (Dickinson et al., 2017; Fouad & Santana, 2017).

The SCCT model is an appropriate theoretical framework for this study. The theory can provide an explanation of social classifications and the intersectionality of gender, race, interpersonal influences, and how identified marginalized individuals/groups choose their education and career aspirations (Crenshaw, 1989; Dickinson et al., 2017; Fouad & Santana, 2017). According to Alfred et al. (2019), it is essential to investigate the influences that affect the lived experiences of African American women, as they relate to their academic persistence and their aspirations in the

STEM industry.

SCCT and Intersectionality of African American Women

SCCT is a career theory that is frequently used to predict career choices based on the lived experiences of gender and race across diverse ethnic and White populations (Fouad & Santana, 2017). In knowing the challenges that African American women face in academics and industry, studies using the SSCT model and intersectionality contended that their underrepresentation in STEM may be deeper than just their lack of interest (Dickson et al., 2017; Fouad & Santana, 2017; see also Davis, 2019; Hernandez et al., 2017). Crenshaw (1989) coined the term intersectionality to address; "how race, gender, class, and other individual features 'intersect' with one another and have similarities" (p. 140). Furthermore, Crenshaw (1989) and Davis (2019) recognized that society traditionally places African American women lower than the identity or discriminations when the term 'woman' is used, especially when compared to White women. Davis posited the following:

> African American women experience racism, sexism, and classism that are inseparable. Their needs and worldviews are distinct from those of black men and white women. There is no contradiction between the struggle against racism, sexism, and all other isms. All must be addressed simultaneously. (p. 3-4)

The intellectual, artistic, and philosophical traits of African American women provide invaluable experiences and diverse thinking which is often overlooked within the STEM learning ecosystem and industry (Davis, 2019; Fouad & Santana, 2017; Harper, 2018). Several studies suggested the interconnection between the self-efficacy of African American women and the introduction of negative influences affect their choice between persistence and retainment in STEM (Alfred et al., 2019; Dickinson et al., 2017; Fouad &

Santana, 2017; Ko et al., 2013). Alfred et al. stated that negative influences caused the underrepresentation of women of color in STEM to deteriorate from a concern to a national crisis. Influences may stem from biases and prejudices centered on society's duality discrimination and stigmas of being African American and a woman who may lack cognitive intellect and competence to succeed in STEM (Ellison et al., 2020). However, African American women have been recognized as having unique learning experiences and skills that offer academia and organizations leadership qualities (Davis, 2019; Dickinson et al., 2017). Notwithstanding, African American women encounter complex situations from both within and outside their cultural communities. Environmental obstacles such as sexism, stereotypes, socioeconomic disadvantages, familial influences, and political bureaucracy offer challenges in their pursuit of STEM academics and career aspirations (Mau & Li, 2018).

Kelman (2006) explored the stereotype theory and posited that the association with an individual or particular group encourages behaviors that are homogeneous with that individual or group's patterns. Individuals take on the mentality of their social and cultural environments when making possible life-changing decisions. Morton and Parsons (2018) expanded this theory by emphasizing the social influences of race and gender identification also correlates to a decrease in educational success due to the stereotype threat. African American women encounter stereotype threats within their communities and cultures, STEM-related activities, at predominantly white institutions (PWIs), and their jobs (Morton & Parsons, 2018). According to Morton and Parsons, the pressures to succeed can often cause a decrease in academic performance or work output due to anxiety from trying to prove the negative stereotypes regarding the group or culture they identify with are untrue. Stereotype threat in STEM is a form of

intersectionality that correlates with SCCT and the experiences of African American women's choice of academic and career aspirations (Morton & Parsons, 2018; see also Crenshaw, 1989; Davis, 2019). The retention of African American women in academics and industry may be caused by decades of marginalization, exclusion by discrimination, inadequate acceptance from within social cultures (stereotype threat), and political subjugation by institutions and their policies; vital influences that are perceived in SCCT and intersectionality (Crenshaw, 1989; Davis, 2019; Fouad & Santana, 2017).

According to Crenshaw (1989), the intersectionality experienced by African American women is far beyond the combination of racism and sexism. Crenshaw posited that the inclusion of African American women in established institutional programs and the creation of anti-racism policies directed at gender and race was not enough to remove holistic oppression from within the United States' various cultures. African American women's self-identity along with their worldview is influenced by their racial and social interactions within their cultural environment (Morton & Parsons, 2018). Establishing their self-identity and sense of belonging to a culture provides meaning-making of the oppression and struggles they face in STEM undergraduate programs and their desire to persist (Morton & Parsons, 2018). Interestingly, Byars-Winston and Rogers (2019) found that minorities in STEM undergraduate degree programs were influenced more by self-efficacy and only minimally by self-identity when making choices relating to academic study and career aspirations in STEM.

Minority students had a reluctance to choose STEM and questioned the efficacy of seeing themselves in STEM academics or as a professional in the industry; as if they did not fit the mold set forth by society's description of a STEM professional (Byars-Winston & Rogers, 2019). Byars-Winston and Rogers discovered that when it came to

choosing to pursue STEM, the social interactions between African American students and their peers/mentors and career role models had a greater impact on their academic and career aspirations than stereotypes associated with an individual's racial-cultural norms. This finding was in contrast to the SCCT and the intersectionality of African American women (Dickinson et al., 2017; Fouad & Santana, 2017; see also Crenshaw, 1989).

Dickinson et al. (2017) indicated that the applicability of SCCT, career counselors, and mentors affect African American women's self-efficacy. This is a vital part of their academic and career decision-making and directly correlates with their interest in STEM and career aspirations (Dickinson et al., 2017). The researchers suggested that career counselors should encourage African American women students to engage with family members or constructive role models, preferably those who are in STEM-related careers. These fields have an underrepresentation of African Americans. Dickinson et al. (2017) found that African American women's familial dynamics, verbal encouragement, and vicarious learning had the highest impact on their learning influences, and high self-efficacy and confidence in expected outcomes, rather than individual accomplishments. The researchers concluded that there is a need for future researchers to conduct additional studies to understand what role learning experiences in SCCT, familial economic status, and academic climate plays in the self-efficacy and persistence of African Americans. In particular, the expected outcomes of African American women pursuing STEM in academics and career choices (Dickinson et al., 2017).

African American Women in Undergraduate STEM

The influences of mentors and peers who have a cultural/ethnic sameness were evident from 1995 to 2004. HBCUs ranked first in the percentage (46%) of African

American women completing STEM undergraduate programs, more than any other 4-year degree-granting institution (Harper, 2018; NSF, 2017). During 2012, HCBUs generated 25% of all undergraduate degrees in STEM received by African Americans. HBCUs offer African American students cultural development, an environment that nurtures academic support, inclusion, and a sense of belonging to their community; often, the institutions match their unique and complex dynamics (Nichols & Evans-Bell, 2017). Table 1 presents African American women ranked in the lowest percentile of women receiving bachelor's degrees in STEM outside of HBCUs.

Table 1

Percent of STEM Bachelor's Degrees Conferred to U.S. African American and White Women

Year	Total	African -American	White
2014-2015	100	8.8	61.5
2015-2016	100	8.7	60.6
2016-2017	100	8.7	59.3

Note. The data is adapted from Table 318.45: The Number and Percentage Distribution of Science, Technology, Engineering and Mathematics Degrees/Certificate, and Sex of Student: 2008-2009. National Center for Educational Statistics. (2017).

URM women who attend HBCUs previously had the highest attainment in STEM undergraduate degrees; they also have the highest drop-out rate in STEM degree programs than other races/genders (Beasley & Fischer, 2012; Stanich et al., 2018). Table 2 illustrates the percentage of attrition for undergraduate students in STEM degrees by race/ethnicity and gender in 2012 (Beasley & Fischer, 2012). Johnson (2019) found that having an African American role model (e.g., advisor, community member, mentor, or instructor) was key to increased retention rates of African American women in STEM fields.

Table 2

Percent of Students Who Declare STEM and Leave STEM Programs by Race and Gender

	Declare STEM				Leave STEM			
Race/Ethnicity	Male	N	Female	N	Male	N	Female	N
African American	22	353	19	638	47	98	41	64
White	24	475	17	523	32	64	39	74
Hispanic	23	384	14	532	34	75	44	88
Asian	29	417	18	542	14	86	34	104

Note. The data is adapted f rom Table 1: Percent of Students that Declare and Leave STEM fields by Race and Gender. Beasley and Fischer. (2012).

Johnson et al. (2019) found that African American women and African American men who serve as role models enhanced the sense of inclusion for African American women college students. The researchers acknowledged that a professor who had a race and cultural sameness increased social identity overall in STEM academics. Additionally, there was a sense of belonging and allyship in STEM for African American women in undergraduate programs (Johnson et al., 2019). In contrast, African American women majoring in STEM undergraduate programs at PWIs faced stereotypes and feelings of isolation in their classes. The consensus was that they believed they had to work harder to prove themselves capable to classmates and instructors and continually demonstrate management of coursework rigor, yet African American women were treated as if they were less intelligent, could add no value to the classroom culture, and could not accomplish the coursework (Johnson et al., 2019).

Ong et al. (2018) suggested that African American women do not persist in STEM due to social and interpersonal influences in education and industry. Systemic and

systematic processes implemented by leaders in education and industry-focused on trying to fix the student through the marketing of STEM programs or by creating STEM-related initiatives. Marketing and initiatives were the focus rather than the investigation of any underlying social and interpersonal influences that affect the retention of African American women in STEM (Ong et al., 2018). There are numerous gaps in what leaders see as the problem and how to correct it.

Meanwhile, Ireland et al. (2018) sought to understand the link between society's intersectionality of African American women in STEM. African American women in STEM experienced psychological intersectionality (e.g., self-identity, interest, inclusiveness, attainment, and stereotype threat) and associated emotions and behaviors that caused them to feel ignored or detached (Ireland et al., 2018) from the rest of their peers and professors in STEM undergraduate programs. Ireland et al. concluded that some African American women's individual and familial identities are believed to be more important than developing an identity in STEM, and any feelings of isolation in STEM learning environments may affect their racial/ethnic and cultural identity, as well as their retention in STEM.

President Obama tasked federal agencies and industry to develop long-term strategies to introduce and retain more African American and minority women students to STEM programs to allow URM women greater opportunities in education and the workforce, which will ultimately improve their communities (Handelsman & Smith, 2016; Harper, 2018). There is a need to hire and train highly skilled STEM teachers and academic professors that mirrors culturally diverse URM women. Administration from the White House cautioned education and industry leaders that failing to engage URM groups, in particular women, may cause gaps in the U.S. STEM labor pool (Handelsman

& Smith, 2016). More notably, the initiative aimed at increasing the number of African American and minority women in higher education STEM has yet to bolster the industry's workforce demands (Harper, 2018). Ireland et al. (2018) revealed that the key to African American women's success and retention in STEM academics is developing culturally relevant pedagogy and curriculum in the classroom.

STEM Academics and Cultural Experiences of African American Women

Ireland et al. (2018) identified that within STEM academic environments, it is important that skilled teachers design and provide culturally relevant pedagogy to ensure African American women receive a more robust educational and training curriculum. Ireland et al. found that teachers in the higher levels of education especially should attend professional development, as well as have established methodologies for mentoring African American women in STEM. The researchers recommended a focus on the sociological and psychological needs of African American women to address their cognitive and educational attainment in STEM (Ireland et al., 2018; see also Alfred et al., 2019; Fouad & Santana, 2017; Ko et al., 2013).

Dickinson et al. (2017) concluded that career counseling by teachers, parents, and academic career counselors is important to African American students as they journey through postsecondary education and their career aspirations, especially those in underrepresented fields. Further investigation was suggested to examine the pass-over (handing off) of high school academics and career counseling to first-year undergraduate African American students career counseling through partnerships with advisors, mentors, and family members (Dickinson et al., 2017). In a separate study, Collins (2018) examined African American women students in STEM and the influences of self-concept, educational strengths, and reinforcement of cultural values as methods of

learning in higher education. The researcher disclosed that African American women experience different stages of self-identity in STEM. Using Ford's Female Achievement Model for Excellence (F2AME), Collins determined that African American women students' self-image was based on external social and support factors such as family, school, and community-based outreach programs.

African American women students indicated that perceived microaggressions toward them created emotional triggers that made them feel marginalized; causing self-doubt in STEM (Collins, 2018; see also Covarrubias & Fryberg, 2015; Maltby et al., 2016). Collins' study indicated that African American women student's success was based on their attitudes, ability to cope with social biases, and self-efficacy in their STEM learning. The researcher suggested that institutions should shift from traditional theories based on racial disparities and pinpointing how broken down an academic system or process is, to encouraging unification of an all-inclusive community instead of racial division within the learning environment. Collins established that there was a gap in the STEM pipeline line which causes a lack of persistence, retention, and success for underrepresented students. This requires further investigation along with an analysis of the connection between the cultural communities of African American women and how they relate to self-identity in STEM.

Cultural influences from within higher education may hinder African American women's ability to develop self-efficacy in STEM due to differing views of discrimination (Dancy et al., 2020). The lack of support from all racial demographic groups, predominantly from White male students, makes African American women students feel segregated from the rest of the class. Dancy et al. discovered that African American women in STEM faced microaggressions in STEM undergraduate programs

based on White male student's lack of acknowledgement of discrimination in STEM environments. White male students in STEM believed that there were race and gender inclusion processes in place and therefore no discrimination existed due to everyone being treated the same as White males (Dancy et al., 2020). The researcher discovered that African American women students had high-stress levels and lacked confidence, which resulted in mostly White male students' implicit biases of aptitude, rather than perceptions of segregation or gender alienation. Implicit biases are usually stated as the actions of prudent Americans' biases to subconsciously associate African Americans with negativity, and to attach positivity to White Americans (Dancy et al., 2020; see also Dickinson et al., 2017).

Society's biases theorize that men and women have different interests and abilities, and therefore have preconditioned aspirations in fields of study, as set by the society in which they live (Riegle-Crumb et al., 2016). Data reflected that women who chose careers predominantly held by men were judged compared to the expected results of men in the same fields. Riegle-Crumb et al. discovered that the paths between women and men who enrolled in unconventional gender-atypical majors and those who chose fields that were more gender-normative were biased. Male students experienced favorable differential treatment and engagement between faculty and peers in STEM courses.

Within the same courses, women experienced negative differing treatment in the gender-atypical courses (Riegle-Crumb et al., 2016). Women students articulated that they felt despair and discomfort when interacting with faculty and classmates, as though their existence had been shelved in the course. The researchers found that women in gender-atypical degrees experienced stereotypes and preconceptions that women in other

normative degrees did not face. This often resulted in switching degree programs. Riegle-Crumb et al. concluded that gender segregation in academics and industry hinders both men and women, reflecting the non-normative selection of education and career choice is seen from both genders. However, male students, as opposed to women in academics, retain their male gender advantages when enrolled in female-dominated degree programs (Riegle-Crumb et al., 2016). Male postsecondary majors may be deemed necessary by their peers and faculty who believe that the efficacy of their field is potentially enhanced by male existence; the male perspective is accepted as enriching to the framework of communal values and diversity. Social views of stereotypical preference of one gender over another are relative to SCCT and may cause some female students to switch from male-dominated undergraduate programs such as STEM (Fouad & Santana, 2017; Riegle-Crumb et al., 2016).

Community involvement has a positive influence on STEM career aspirations for URM women. Their social and cultural values such as dedication to the community may have a link with the underrepresentation of minority women in STEM academics and careers (Diekman et al., 2015; Fouad & Santana, 2017). Diekman et al. stated that dedication to the community and communal goals is a fundamental human nature created through parents, community, and social interactions to form communal goal orientations. Communal goals orientation is an individual's psychological state to control their motivations, which orients to one's self; while communal motivation is an orientation that aligns with the desire to help others and a commitment to one's community (Diekman et al., 2015). Research from Diekman et al. indicated that women are perceived to have a higher communal goal orientation to help or nurture which traces back to their upbringing and interactions within their community. This desire to help others is

witnessed by women having a larger concentration in academic degrees and career fields such as public administration, family sciences, and education—especially African American women (NSF, 2018. Whereas boys were steered by their communal environment toward more manly classes or occupations due to societal stereotypes. These gender-orientations rather than aptitude may explain why there are gaps between men and women in STEM (Diekman et al., 2015).

Diekman et al. (2015) exposed that the STEM field is identified as being non-communally goal supporting because STEM fields are traditionally viewed as positions that do not involve collaborating with or helping others. The researchers concluded that the culture within the STEM industry views it as a field that provides both individual activities and the opportunity to help others. Women were found to occupy more academic and medical jobs in STEM, possibly due to communal goal orientation; while men occupied more engineering, technology, and life science roles. The researchers suggested that to increase the participation of women in STEM, institutions should incorporate communal goal rewards and practices that align with the communal goal motivation of women to collaborate with and help others (Diekman et al., 2015). In particular, the interconnection between the commitment to community, and the pressures of cultural norms of African American women, potentially links SCCT and their choice of education in STEM undergraduate programs and career aspirations in the field; as discovered in previous studies (Dickinson et al., 2017; Fouad & Santana, 2017). Understanding the lived experiences of African American women in STEM undergraduate programs could allow leaders in education, industry, and government to create policies that may increase the number of African American female students in STEM (Fouad & Santana, 2017).

Several studies indicated that there is ambiguity between legislative initiatives to decrease the underrepresentation of African and other minority women in STEM (Fouad & Santana, 2017; Harper, 2018; Herman, 2019). There are initiatives by the government and institutions to increase URM women in STEM; however, there are obstacles both in postsecondary institutions and industry that cause URM women to enter or stay in STEM at a rate lower than males (Covarrubias & Fryberg, 2015; Fouad & Santana, 2017, Harper, 2018; Riegle-Crumb et al., 2016). Numerous studies found that systemic and systematic measures that were put in place were not strategically implemented to maximize the participation and self-efficacy of African American and other minority women in STEM education or careers (Fouad & Santana, 2017; Harper, 2018; Young et al., 2019; McGee & Bentley, 2017; Morton, 2020; Ong et al., 2018; Wade-Jaimes et al., 2019).

Hindrances to Self-Efficacy of African American Women in STEM

African Americans position attaining their education as an important component to self-efficacy. Winkle-Wagner (2015) revealed that African American women in postsecondary education have historically faced biases and marginalization because of the duality of being both a woman and an African American. Winkle-Wagner (2015) indicated that there are traditionally two key factors that hinder African American women in postsecondary degree programs; sociological and psychological areas of concentration that deal with the mental and affective behaviors of African American women. Using the Cultural Matching Theory (CMT) as their theoretical framework, Covarrubias and Fryberg (2015) identified traditional college students (e.g., continuing-generation or White) have advantages over first-year African American students when the norms of a campus environment match their ideology of being independent. Covarrubias and

Fryberg inferred that some African American students had feelings of disconnectedness from their family and found it harder to adjust to adversity and conflict while away in college. The researchers revealed that African American students were less successful in establishing their self-identity and becoming independent, as opposed to White or continuing-generation students in the same collegiate learning environments.

Covarrubias and Fryberg (2015) recognized that African American students were influenced by outside of college factors such as family achievement guilt; the pressure to support parents and family members who were left behind and never attended college (see Banks-Santilli, 2015). African American students experienced an obligation to carry on cultural and community norms to support their families back home, and still maintain their individual and familial expectations academically (Banks-Santilli, 2015; Covarrubias & Fryberg, 2015). However, Covarrubias and Fryberg discovered that in contrast, White students were more resolved, as they seemed to be self-consumed and more independent within their collegiate environment. Results from studies suggested that there may be gaps between family support/expectations from African American families and cultural communities that may not be realized in White families or communities (Covarrubias & Fryberg, 2015; Mau & Li, 2018). Covarrubias and Fryberg discovered the family achievement guilt of first-generation African American college students and continuing-education college students whose parents were college-educated. They suggested more studies to investigate African American college students and family achievement guilt to understand how to remove factors that hinder the success of African American college students (Covarrubias & Fryberg, 2015).

Over the past two decades, African American women have increased enrollment and attainment of undergraduate degrees as a whole (National Center for Education

Statistics [NCES], 2017). However, only one in five African American women older than 25 hold undergraduate degrees, while one in two Asian and one in three White women of the same age have received their undergraduate, respectfully (Winkle-Wagner, 2015). Winkle-Wagner (2015) stated that African American women who transferred from a 2-year college to a HBCU had a higher sense of belonging, value, and were encouraged to develop their self-efficacy as a scholar while still maintaining their individualism. Winkle-Wagner concluded that African American women attending predominantly White institutions (PWIs) may not experience the same encouragement and warm acceptance as those who attended HBCUs. HBCUs have awarded the most STEM undergraduate to African American women over the past 25 years, ranking them first among any other 4-year degree-granting institution (Harper, 2018; see also NSB, 2017).

Leath and Chavous (2018) identified a need to understand the racial and learning environment climate between African American women students in predominantly White male STEM programs at PWIs. The researchers found that cultural behaviors and racial stereotypes in learning environments affect the lived experiences of African American women in STEM degree programs. Leath and Chavous indicated that the lived experiences of African American women students affected not only their motivation to stay in postsecondary STEM education, but also their choice to leave STEM programs. According to the researchers, African American women experienced higher anxiety and more uncertainty in STEM programs when negative influences affected their persistence and aspirations, while their White women peers were less affected. The study results uncovered that the women in STEM majors across race demographics reflected high scholastic competence, but lacked self-concept toward academics, and had greater uncertainties regarding self-fulfillment than women in non-STEM majors (Leath &

Chavous, 2018). The researchers concluded that African American women who left STEM all together for other degree programs sustained persistence and attainment in meeting their new academic goals.

African American women in STEM have traced microaggressions, as well as negative social and interpersonal influences back to their early adolescence, during K-4 education. Traditionally, society and education measured STEM as a field associated with the privileged, competitive, and individualistic occupations held by White males (Crenshaw, 1989). The research of Ong et al. (2018) explored the challenges of African American women to persist in STEM undergraduate programs and the influence to find or establish STEM counterspaces in postsecondary environments. Their study presented different ways of approaching counterspaces to obtain more heterogeneity by including women in STEM from multiple races and ethnicities, unlike traditional programs that are designed for one specific race and gender.

African American female students in postsecondary STEM, unlike their White male counterparts, leave STEM undergraduate programs due to not having a sense of belonging (Ong et al., 2018). Their study revealed that African American women students who do persist in STEM found counterspaces or safe havens such as informal and formal STEM outreach programs during and after school time. The researchers established that counterspaces removed isolation, marginalization, and microaggressions, especially those haven programs that were specifically designed for mentoring and encouraging African American women in STEM undergraduate programs.

Ong et al. (2018) found that African American women in their STEM undergraduate programs identified research PWIs as high-risk and high-anxiety environments, which necessitated having counterspaces. Additional findings in the study

indicated five possible counterspaces for African American women in STEM undergraduate programs: (a) peer-to-peer relationships, (b) mentoring relationships, (c) national STEM diversity conferences, (d) STEM and non-STEM campus student groups, and (e) STEM departments as counterspaces. Ong et al. (2018) determined that individual and learning environment microaggressions and marginalization experienced by African American women in STEM undergraduate programs can be quite intimidating and stressful, especially when coming from White males at a PWI. Counter space and safe havens provide a necessary environment where African American women may establish networking relationships, receive one-on-one mentoring, encouragement, and career counseling (Ong et al., 2018).

Dortch and Patel (2017) explored the experiences of African American women in STEM and their identification with minority stereotypes and prejudices. The researchers found microaggressions and marginalization affected African American women in STEM as early as their K-12 academics. The marginalization of African American women students was found to affect their self-efficacy and career aspirations. Dortch and Patel's study revealed that African American women face a myriad of intentional and unintentional influences that made them feel ostracized in their aspirations to grow academically and be successful in the workplace. The findings of the study uncovered that African American women were perceived to be overly aggressive, defensive, controlling, and direct. The researchers concluded that the factors influencing the self-efficacy of African American women were more abundant at PWIs than traditional 4-year degree-granting institutions.

One study investigated how African American women responded to contextual influences and their persistence in K-12 and postsecondary STEM undergraduate

programs (McGee & Bentley, 2017). The researchers claimed that negative influences encountered by African American girls in K-16 did not hinder their persistence. The findings by McGee and Bentley suggested that African American women can highly achieve in STEM programs unlike stereotypes of society, institutions, and industry. Stereotypes affiliated African American women/girls in STEM as not academically intelligent or dedicated to achieving in STEM (Morton, 2020).

Results from studies by Dortch and Patel (2017) and McGee and Bentley (2017) indicated African American women faced many microaggressions such as verbal insults, threats due to their race, and isolation within learning institutions. However, McGee and Bentley found that African American women in STEM displayed a coping mechanism to deal with stereotypes and racial microaggressions from society and educational institutions. The results of McGee and Bentley may indicate gaps in the literature. The researchers revealed that some African American women in K-16 STEM programs may not work hard or lack resilience when dealing with personal shortcomings. Contextual influences may not be the driving forces that cause African American women to persist or move forward to careers in STEM (Wade-Jaimes et al., 2019). Hindrances for African American women in STEM begin long before college.

African American Girls' Exposure to K-12 STEM Environments

African American women face challenges in STEM as early as K-12 (NSB, 2020a). McGee and Bentley's (2017) research disclosed that some high school counselors advise African American females far less than White and other URM students in high school to enroll in math and science; even though advanced placement math and science courses are often a prerequisite for entrance into college math and science programs. The Department of Education (2016) concluded:

> One-third of public high schools serving predominantly African American students offer calculus. Only about 40 percent of public high schools serving predominately African American students offer physics. This lack of access to foundational STEM skills puts African American students at a significant disadvantage in preparing for advanced STEM courses and careers. (p. 1)

King and Pringle (2019) investigated the lack of URM populations in STEM academic programs. African American female students outperformed African American male students 131 to 129 on the eighth-grade national math assessment (NSB, 2020a). Meanwhile, African American girls lagged behind White females (159), White males (161), Asian females (169), Asian males (171), Hispanic females (136), and Hispanic males (141) on the 2015 National Assessment of Educational Progress eighth-grade math (NSB, 2018). African American females' scored a 131 on average, while African American males scored 126, White females 162, White males 158, Asian females 159, Asian males 159, Hispanic females 139, and Hispanic males 131, respectively on the 2014 National Assessment of Education Progress for eighth-grade technology and engineering literacy assessment (NSB, 2018). The 2018 National Assessment of Education Progress scores for eighth-grade statistics reflects African American students' average scores were consistent with the 2014 assessment. The averages scores for African American students as a whole was 132, White students 163, Asian students 169, and Hispanic students scored 139 on the National Assessment of Education Progress for eighth-grade technology and engineering literacy assessment (NSB, 2018). The assessments reflected that African American students lagged behind other races in early education STEM.

The National Resource Council (NRC) acknowledged that OST STEM programs

are a vital cog in STEM environments, which they defined as “the dynamic interaction among individual learners, diverse settings where learning occurs, and the community culture in which they are embedded” (Feder & NRC, 2015, p. 5). According to Barnes and Lenzi (2017), one of the reasons that there is an underrepresentation of women in STEM might be because they may not be introduced to STEM early enough in their academics. The purpose of their study was to understand the connection between K-12 girl’s participation in STEM outreach programs and its impact on their persistence in STEM K-12, postsecondary, and possibly on to STEM careers. Their research revealed that there is more of an emphasis to target girls in high school to participate in STEM outreach programs, whereas girls in K-4 and middle school had little to no participation. Barnes and Lenzi stated that elementary K-4 is where the majority of learning occurs, as well as initial aspirations of career area development. Barnes and Lenzi (2017) found that most girls in K-12 who were introduced to STEM lacked the fundamental skills in math, science, and chemistry to persist in postsecondary STEM or the STEM workforce.

Wade-Jaimes et al. (2019) investigated the outside-of-school-time (OST) STEM programs to understand the relationship between OST and African American girls’ ability to persist and achieve in STEM. Wade-Jaimes et al., combined activity theory, communities of practice, and critical race theory as the framework for their study. The results revealed that high school girls increased their participation in out-of-school STEM programs where real-world applications were used, but early elementary school girls had little to no participation in STEM after school programs. The researchers identified gaps in the participation of girls in after school programs. African American girls’ participation in after school STEM programs were hindered by systemic institutional processes. Due to the limited understanding of African American girls’ urban

communities and real-world applications depicting their lived experiences, African American girls in K-12 are not as prominent in STEM out-of-school programs (Wade-Jaimes et al., 2019). Systemic obstacles in STEM out-of-school programs unbalanced the scale of participation between African American women in socioeconomically challenged communities and other races and genders in STEM.

Chen et al. (2019) investigated the effects of first-year high school teachers in STEM and their influence on the self-identity of high school girls in STEM. The researchers used the social practice theory to understand how female students understand self-identity in STEM. This theory was used because it measured how females in STEM developed self-identity and who they were based on lived experiences. Nevertheless, female students were highly dependent on what others thought of them. Positivity and reinforcement by male STEM teachers were found to be helpful for African American female students developing STEM identity in male-dominated STEM courses.

Chen et al. (2019) posited that the interests and self-identity of female students were stronger when having a female teacher who mentored them. Student-teacher matching with the same gender could be viewed as biased, assuming women teachers are more in tune with the hindrances that female students face (Chen et al., 2019). The researchers concluded that there is an appearance that same-sex teacher-student relationships in high school STEM courses resonate more with female students when they are developing their self-identity and success in the learning environment.

A study by Stearn et al. (2016) explored the influence of same-sex teacher-student relationships to understand if same-sex teacher-student interactions enabled students to persist in high school STEM courses. Stearns et al. utilized Krislov's theory of representative bureaucracy (TRB), which claims that a bureaucracy that is typical of the

individuals it serves will mirror the interests of those individuals (Krislov, 2012; Stearn et al., 2016). The study revealed that White female students who attended high schools with female STEM teachers were almost certain to progress to postsecondary STEM degrees. The study confirmed that although there were policies created to close the gap of the underrepresentation of women in STEM undergraduate programs, there was no bearing on African American women's persistence in high school STEM or their desires to continue to STEM in postsecondary education (Stearn et al., 2016). This creates a gap in understanding why one demographic of women did not persist, while others did. The researchers concluded that further investigation is needed to understand the influences that cause the persistence in the STEM gap between White and African American female students in high school.

African American female students have been identified as unique, complex, and their learning experiences are based on things that are more related to their lived communities. Acknowledging and nurturing African American female students in STEM before their middle school years is vital to their persistence and aspirations in STEM. According to Young et al. (2019), outside-of-school-time STEM programs may not relate to African American girls and their distinctive way of learning. The purpose of their study was to understand the influences of outside-of-school-time programs' relationship with the persistence and career aspirations of African American girls in gifted academic programs. The researchers discovered that African American girls in STEM face dual marginalization (student of color and female learner), which creates systemic and systematic challenges toward persistence and fitting in their learning environments (Young et al., 2019; see also Wade-Jaimes et al., 2019).

During the study, many African American female students expressed cultural

conflicts in their learning environments, which prevented them from receiving equal treatment and opportunities (Young et al., 2019). The results of the study indicated African American girls in gifted programs believed STEM curriculum and instruction did not reflect them nor their lived experiences (Wendt & Apugo, 2019). The researchers indicated that, similar to previous studies, African American females in middle school STEM programs found it hard to connect STEM programs in school with their everyday cultural experiences (Young et al., 2019; see also Wendt & Apugo, 2019). The researchers concluded that the experiences and careers introduced to African American girls during formal STEM academics were different than those within their lived social communities (Young et al., 2019; see also Wendt & Apugo, 2019).

Young et al. (2019) presented similar results as those found in McGee and Bentley's (2017) study; in recognizing that if African American girls' interest in STEM-related activities is not nurtured in elementary school, these girls will not have the skills in middle and high school to stay motivated to pursue STEM programs later. The researchers found that familial support, cultural competencies, and community partnerships were key influencers to support the self-efficacy of African American female students' persistence and career aspirations in STEM (Young et al., 2019; see also McGee & Bentley, 2017; Wendt & Apugo, 2019). The researchers postulated that creating cultural-specific out-of-school-time programs similar to the lived experiences of African American girls in gifted programs could narrow the underrepresentation gap between African American women in STEM and other gender and races (Young et al., 2019).

Kang et al. (2019) explored mechanisms to assist women of color in shaping a sense of self in STEM. The theoretical framework for their study was the social practice

theory (SPT), which argues that the best measure of the underrepresentation of African American women in STEM is possible through their lens. Kang et al. found that self-identity is better nourished from outside-of-school-participation in STEM outreach programs. Results from the study indicated that African American female students may benefit from stronger self-identity if outreach programs were offered equally across urban environments, not just a select few, and were specifically created for African American female students. Findings of Kang et al.'s study were in contrast to Ladson-Billings' (2006) study, which claimed the gap in attainment between African American female students and White students is real, but attention is given to the wrong influences such as sociological and psychological influences. Kang et al. concluded that the more comfortable African American students are in performing STEM tasks, the stronger their self-identity becomes. Kang et al. (2019) suggested further studies using longitudinal investigations to fill in the gaps of their study by measuring African American female student's STEM participation at home or community. They also suggested interviewing African American female students a second time during their later grades to gauge their lived experiences and progress from participating in out-of-school programs rather than analyzing surveys (Kang et al., 2019).

Mau and Li's (2018) study examined factors that influenced STEM career aspirations of underrepresented high school ninth-grade students to explore the issues influencing African American female students to enroll in high school STEM courses. Using Mau and Bikos' (2000) career aspirations model, Mau and Li examined whether the individual, institution, familial or other relationships influenced African American female students to pursue STEM education or STEM careers. Mau and Li's study focused on two research areas: (a) deltas in pursuit of familial/parental education and career

background, institutions/academics, and personal relationships that affect the pursuit of roles in STEM and career aspirations; and (b) how those connections influence students who are seeking a STEM occupation.

Mau and Li (2018) noted that there may be factors during the adolescence of African American girls that made them less inclined to follow the education and career aspirations of their parents, as opposed to White female student's choice to follow their parent's footsteps in higher education and occupations (Mau & Li, 2018). The researchers found that African American girls in high school were influenced more by their parents' friends when deciding on education and career aspirations, whereas White female students in high school were more influenced by their familial interactions. White students with a higher socioeconomic status, higher parental academic expectations, those who excel in advanced STEM courses, and have interests in STEM sustained their self-efficacy (Mau & Li, 2018).

African American Girls' Experiences in Outreach and Formal STEM Programs

Koch et al. (2019) investigated the relationship between inner-city economically challenged African American and Latina teenage girls' perseverance and career aspirations, and interconnected support systems at home and various educational settings. The researchers selected six female students out of 45 who participated in the *Girls Innovating with Technology as Entrepreneurial Environmental Engineers* (InnovaTE^3) STEM outreach program. Koch et al. found that African American and Latina girls' perseverance in STEM was dependent on positive parental intervention, and emotional support from family members, classmates, and mentors in community programs. The researchers indicated that the participant's familial social customs and family dynamics had a high impact on their resolve in STEM and non-STEM activities. African American

and Latina girl's energy in STEM mirrored that of their parent's enthusiasm and encouragement in STEM. Equally, African American and Latina girls had lower aptitudes and outlooks in STEM domains when their parents had low involvement.

Participants in the study had career aspirations that aligned with their parents' or another household member's link to a specialized occupation or similar interest (Koch et al., 2019). The researchers concluded that parents' interest in STEM activities surpassed the impact of other adults and mentors in school and STEM outreach programs were a positive influence in African American and Latina girls' self-efficacy to persist in STEM education, as well as support their career aspirations. Further research was implicated to expand the sample size of participants and to conduct a longitudinal study to gain a deeper understanding of how across-setting activities influence URM teenage girls' support and persistence in STEM (Koch et al., 2019). The researchers also recommended further studies to examine the integration of parents in the design of afterschool outreach STEM programs and activities, to understand how STEM relates to the social and cultural experiences of everyday life of African American and Latina girls.

In contrast, McGee and Bentley (2017) examined the impact of introducing African American women to STEM programs early in their adolescence on their persistence and attainment in STEM. The researchers posited that the influence of STEM in K-12 programs, although stressful, enabled African American girls to have high achievement in STEM. Although teachers encouraged African American female students, microaggressions from other students created anxiety, a sense of exclusion, and self-doubt (McGee & Bentley, 2017). This finding revealed that systemic and institutional influences provide more challenging, yet higher persistence and attainment for African American women, while the learning environment may be unconventionally gendered

atypical.

African American girls thrived more in STEM due to encouraging reinforcement from their parents. However, there are critical years where African American girls have been shown to lose interest in STEM-related subjects beginning in the fourth grade through eighth grade (Koch et al., 2019). King and Pringle's (2018) study examined the interests of African American girls in STEM during their fourth through eighth grade who participated in a community-based STEM program, I AM STEM. The researchers aimed to understand if the African American girls' learning experiences in an informal STEM outreach program transferred to their learning environments at school. The STEM summer program was conducted at a socioeconomically disadvantaged inner-city community center in the Southeast region of the United States (King & Pringle, 2018). The researchers identified themselves as participants of the study, serving as chaperones, photographers, and observers during STEM field trips.

The six African American girls selected for the study also served as co-researchers and knowledge originators; using their voices and activities to convey their informal and formal STEM experiences (King & Pringle, 2018). The results of the study indicated that the I AM STEM program generated some STEM interest in Grade 4 through Grade 8 African American female students. King and Pringle suggested that African American female students displayed independence, competitiveness, and assertiveness during their STEM summer program which crossed over to persistence in STEM activities at school. However, African American female students in the study identified race and gender as the greatest influences on their participation in STEM at their school rather than the I AM STEM experience (King & Pringle, 2018). According to the researchers, gender stereotypes and racism experienced at school may affect the

participant's persistence in STEM activities at school and detract from any positive effects generated during the informal program.

King and Pringle (2018) inferred the necessity for further research. Additional observations may be necessary to see how I AM STEM participants viewed STEM during later grades. Differences in successes or failures experienced by African American female students who participated in I AM STEM compared to those who did not, yet share the same STEM learning environment and come from different communities, should be investigated. The study results may have researcher bias as the participants were co-researchers being led by the researchers. Participants may have answered questions favorably to please the researchers due to their close relationship during STEM activities and field trips (King & Pringle, 2018). Still, more research into mentoring and fellowship programs can only enhance URM enrollment in STEM programs.

Mentoring African American Women in STEM Undergraduate Programs

Dennehy and Dasgupta (2017) conducted a multi-year longitudinal field experiment to investigate whether peer mentoring by same-gender advanced students in STEM provided any underlying advantages to first-year women students in STEM undergraduate programs. Dennehy and Dasgupta's results demonstrated that the mentees found no difference in quality, number of interactions, or level of encouragement between male or female mentors. However, the participants felt closer and more familiar with same-gender mentors than they did with their male mentors. Dennehy and Dasgupta revealed that participants who did not have a mentor and those with male mentors, experienced a significant drop in self-efficacy, sense of belonging, and eventually lost interest in STEM. In contrast, women students with female mentors retained a positive self-efficacy and a sense of belonging, although they experienced some intimidation

throughout their first year of college (Dennehy & Dasgupta, 2017).

Dennehy and Dasgupta (2017) concluded that female peer mentors, who are a little more advanced in college, may contribute to the mental development and an increased sense of belonging to women new to STEM undergraduate programs. Further investigation is required due to limitations during the study created by unequal representation amongst the race and ethnicity of the participants (Dennehy & Dasgupta, 2017). According to the researchers, White women students made up 67.3% of the study, Asian 17.3%, while African American and Hispanic women consisted of 2.7% each.

Morton (2020) assessed the retention of African American women in STEM undergraduate programs to understand what environmental and systemic factors influenced student persistence. Morton discovered that unlike PWIs where safe havens to support minority-specific women in STEM had to be created, HBCUs were already communal goal-friendly for African American women students in STEM undergraduate programs. The study also found that HBCU administrators, faculty, and mentors enabled transformative experiences that allowed African American women to voice their experiences in inviting and safe counterspaces (Morton, 2020). The findings of the study revealed that African American women developed their self-identities and had a higher sense of belonging from fellowship with other individuals in the learning environment. Whereas they felt disillusioned at PWIs due to isolation and marginalization. Morton concluded that HBCUs provided spaces that mirrored the lived experiences and community values that African American women saw every day. The researcher stated that this atmosphere allowed African American women students to entangle their social-cultural experiences with those traits and traditions established by HBCUs. Although African American women in STEM had better experiences at HBCUs than PWIs, there

were similarities at both institutions such as the lack of African American women faculty members teaching STEM courses (Morton, 2020).

Mondisa (2015) sought to understand and explain the mentoring methodologies by selected African American STEM mentors within postsecondary undergraduate STEM degree programs. The findings reflected African American STEM mentors' philosophy on guiding African American women STEM undergraduates. Their practices included (a) advising their mentees honestly with the same communal goal orientation to help a family member, (b) developing their mentee's mindfulness about taking a "holistic view" of their objectives and recognizing that their strategies should mesh with their "big picture," (c) offering resources that allowed their mentees opportunities for trial and error situations that afford capturing lessons learned from their experiences, and (d) providing a level of understanding that examined and comprehended their mentee's experiences (Mondisa, 2015). The researcher identified limitations due to the small sample size (five) of the study. According to Mondisa, future research should focus on the mentoring styles of other African American STEM mentors which could present deeper understandings regarding various approaches used by mentors who support African American women students in STEM.

Maltby et al. (2016) examined first-generation African American women's experiences in the Women in Science and Engineering Residence Program (WISE RP) to understand the influences of the living-learning program's impact on self-identity. Living-learning communities are campus environments that nurture education, social, and career aspirations through mentoring from peers and academic faculty. Maltby et al. indicated that incoming first-generation African American women transitioned to college and STEM better when participating in STEM living-learning communities. The study

results showed that minority first-generation undergraduate women students who participated in WISE RP during their first year of college substantially increased their attainment of bachelor's degrees in STEM (Maltby et al., 2016). The participants also continued to complete a master's degree in STEM at a rate almost three times that of minority women who were not first-generation students. Maltby et al. found that African American women students who participated in living-learning communities experienced less discrimination and marginalization and higher self-identity than the first-generation students who participated in the Covarrubias and Fryberg (2015) study.

In contrast, Covarrubias and Fryberg examined the challenges that first-generation African American women faced that influenced their aspirations to successfully achieve their academic goals. Maltby et al. (2016) accounted for supporting organizations within the academic environment to lessen the challenges to African American women students. There are gaps between Covarrubias and Fryberg's research and Maltby et al.'s study that presented differing findings regarding the challenges and influence that encourage persistence or hinder African American women's attainment in STEM. African American women in undergraduate programs have the lowest persistence and retention among first-year undergraduates than any other ethnicity (Racial Differences in College Persistence and Retention Rates, 2019). Ironically, Riegle-Crumb et al. (2019) found that there are gaps in STEM retention rates; White students who enrolled in STEM undergraduate programs graduated at 43%, while Hispanic students graduated at 29% in STEM, and African American students at 22% in STEM.

Ramsey et al. (2013) examined the influence of living-learning communities and the link with the underrepresentation of women and their persistence in STEM undergraduate programs. The researchers found that first-year women undergraduates

who participated in the Women in Science and Engineering (WISE) program experienced greater self-efficacy and persistence. Ramsey et al. found that there were positive social factors that influenced women's self-efficacy. Interaction experiences with like-minded, same-gender individuals attributed to a sense of belonging due to shared degree programs and their specifically gender-designed STEM living environment.

Ramsey et al. (2013) identified limitations in their study of only 137 female students; 86 White women, 27 Asian American women, 2 Latina women, and 13 African American women participated in the study. The researchers determined that previous studies, including their own, showed improvement for women in general. Moreover, STEM programs specifically designed for URM women may have different outcomes (Ramsey et al., 2013). According to Blackburn (2017), research that investigates the lived experiences of URM groups may give voices that capture the meaning-making of their marginalization by society, education, and industry. Blackburn (2017) stated:

> There continues to be a need to understand the holistic lived experiences of women in STEM, including intervention and retention strategies that lead to success. What can reduce a chilly campus climate? When and where do these strategies need to be in place to be most effective? Documenting the experiences of women in URM groups from all institutions, including community colleges, predominately-white universities, HBCUs and HSIs would give voices to traditionally marginalized groups…. Further research on women's identities and sense of belonging is needed as cultural changes shift away from biases and stereotypes. (p. 251).

Research Questions

The research questions that guided this phenomenological study are:

1. What are the academic, social, and interpersonal experiences of African American females in STEM undergraduate degree programs?
2. What are the experiences of African American females as they persist in their courses in a STEM undergraduate program?
3. What successes and challenges do African American females face in STEM undergraduate degree programs?
4. What advice and/or recommendations do African American females provide faculty and program administrators to support and retain other African American females in their STEM undergraduate degree program?

Chapter Summary

The focus of this chapter was to understand how SCCT affects the decision making of African American women to achieve success in STEM education or their persistence toward their career aspirations in STEM. SCCT was chosen due to its proven positive career theory model that connects lived experiences and self-efficacy of diverse populations including African American women. SCCT highlights ethnicity, gender, family setting, socioeconomic status, the effects of cultural beliefs, lived experiences, and self-efficacy (Fouad & Santana, 2017). The SCCT model can provide a narrative of social classifications and the intersectionality of gender, race, interpersonal influences, and how identified URMs decide on education and professions (Crenshaw, 1989; Dickinson et al., 2017; Fouad & Santana, 2017). Attrition for African American women in business and education is the result of discrimination, exclusion, institutionalized suppression, and marginalization (Crenshaw, 1989; Davis, 2019; Fouad & Santana, 2017).

African American women and African American men who mentor or provide

fellowship for African American women college students enriched their inclusion in any academic program (Johnson et al., 2019). An instructor of the same culture and race improved URM's social identity in STEM. Additionally, there was a sense of belonging and allyship in STEM for African American women in undergraduate programs (Johnson et al., 2019). This was especially true at HBCUs where there were fellowship and support mechanisms for African American students (Morton, 2020). African American women in STEM are faced with microaggressions as early as K-4 education.

Women, in general, are not encouraged to participate in STEM activities or learning at school (Barnes & Lenzi, 2017). Culturally diverse female K-12 teachers and college professors who are highly skilled in STEM, curriculum and instruction that is culturally relevant, and focus on the psychological and sociological needs of URM are necessary to attract more African American women (Ireland et al., 2018).

There are limited studies that examine the lived experiences of African American women in STEM that can be traced back to K-12 academics. Much of the relevant literature focuses on societal biases and stereotypes, socioeconomic status, and inequalities due to race and gender in higher education and the workforce. This researcher evaluated literature regarding the sociological behaviors and attitudes reflecting African American women in STEM undergraduate programs, choice of academics, persistence, and career aspirations. A comprehensive search was conducted to review literature analyzing underrepresented African American women in STEM.

Chapter 3: Methodology

Aim of the Study

This study aimed to understand the lived experiences of African American women in STEM undergraduate degree programs at a four-year public university in the southernmost part of central Virginia to potentially make recommendations to improve their enrollment and retention rate. African American women have been described as having resilience, are intellectual, artistic, and philosophical members of society, yet they are often ignored or overlooked in academia and the workforce (Davis, 2019; Riegle-Crumb et al., 2016).

The significance of this study is that it may increase the understanding of the role of how familial, cultural, institutional, and industrial influences affect African American women and girls' decision-making toward enrollment and retention in STEM programs. Alfred et al. (2019) indicated that "to address the absence of women of color in STEM, it is important to understand the forces that hinder and support their career development, beginning with early childhood experiences and throughout education and work environments" (p. 1).

Qualitative Research Approach

The researcher used a qualitative research approach to investigate the academic, social, and interpersonal experiences of African American women in STEM at a 4-year public university in the southern part of central Virginia. Creswell and Poth (2018) found, "It is appropriate to use qualitative research when there is a need to study a group or population, identify variables that cannot easily be measured, or hear silenced voices" (p. 45). The researcher used the evolving definition of qualitative research that aligns with the qualitative research approach established by Denzin and Lincoln (1994, 2000, 2005,

2011). The authors stated that the continuously changing landscape of qualitative investigation extends from social constructs to interpretivism, and then on to equality in the world (Creswell & Poth, 2018). Denzin and Lincoln (2011) concluded:

> Qualitative research is a situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (p. 3)

The researcher used a qualitative methodological congruence (Morse & Richards, 2002) concept that purposes, questions, explores, and seeks a deeper cohesive whole of the participant's phenomenon. Creswell and Creswell (2018) posited:

> A qualitative research approach explores and understands the meaning of individuals or groups ascribed to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. (p. 4)

Also, qualitative research allows the researcher to peel back the many layers of rigorous data collected while analyzing and interpreting the participants' recall of their lived experiences (Creswell & Creswell, 2018; Creswell & Poth, 2018).

Phenomenological Approach

The researcher used a phenomenological design for this qualitative methodology to describe the participants' lived experiences of the phenomenon as it exists in their consciousness (Creswell & Creswell, 2018; Creswell & Guetterman, 2019). The philosophical movement known as phenomenology was founded by Edmund Husserl (1859–1938), a philosopher born in the municipality of Prossnitz in Mähren, then part of the Hapsburg Austro-Hungarian Empire but now Prostějow in Moravia in the Czech Republic. Phenomenology is key in preventing the misrepresentation of the participant's true meaning, intentions, or original meanings when expressed in the researcher's point of view or biases (Schwandt, 2015; Smith et al., 2012). The phenomenological approach insists that researchers must reject the way we perceive the world of everyday life as "mere appearance" to judiciously describe the normal meaning-making of everyday life experiences (Schwandt, 2015).

Similar to Creswell and Poth's (2018) epistemological objective of phenomenology, this researcher sought to reduce the gap between his sense of understanding of the phenomenon and that of the participant's consciousness of their experiences while collecting subjective evidence from the participants. The researcher relied upon the participants' recall of events and experiences to become intertwined as an insider in order to understand the participants' subjective evidence as it was lived and consciously experienced.

The objective of using the phenomenology approach was to bring a broader sense of the participant's experiences and meaning-making caused by worldviews to the forefront of the study (Creswell & Creswell, 2018; Smith et al., 2009). Phenomenology has been identified as key in preventing the misrepresentation of the participant's true

meaning, intentions, or original meanings when expressed in the researcher's point of view or biases (Schwandt, 2015; Smith et al., 2009). The phenomenological method requires that researchers must reject the way he/she perceives the world of everyday life as a mere appearance of personal or societal views to judiciously describe the normal meaning-making of everyday life experiences of the participants in the study (Schwandt, 2015).

In particular, the researcher depended on interviews conducted with the participants and captured transcripts (Smith et al., 2009) to interpret the participant's meaning-making of their phenomenon (Creswell & Poth, 2018). The researcher captured the description of the everyday life, or their lifeworld events, as described by the participant's verbal expression of their comprehension, recollection, beliefs, and evaluation and decision making caused by their phenomenon (Schwandt, 2015). Distinctively, phenomenology investigation aimed to achieve an extensive search to reach the keystone understanding, explicitly that is, the arena where individual experience emerges, as the "thing itself," as those things are interpreted in consciousness (Fuster-Guillén, 2019).

Interpretative Phenomenological Analysis

This study concentrated on a more interpretive viewpoint as the researcher described the true meaning-making of the participant's experiences rather than explaining his understanding of those experiences (Creswell & Poth, 2018, Smith et al., 2009; van Manen, 1990). Smith et al. stated: "interpretative phenomenology analysis (IPA) is a qualitative research approach committed to the examination of how people make sense of their major life experiences" (p. 1). IPA allows participants in a study to express the sense-making of their experiences relating to their worldview, in their voice, as it applies

to their phenomenon. Smith et al. indicated that "the complex understanding of 'experience' invokes a lived process, an unfurling of perspectives and meanings, which are unique to an individual's embodied situated relationship with the world" (p. 21).

Smith et al. (2009) posited that IPA is a process that researchers may use to capture and assess an individual's cognitive unit of experiences as ordered in their levels of and sense-making over time. Dilthey (1976) and Smith et al. (2009) recognized that a participant's ability to recall the most meaningful lifeworld experiences suggests higher comprehensive units of experience believed to take on distinct meaning such as major life events or accomplishments. Meanwhile, meaning-making of experiences at the lowest importance tends to be smaller units of interpretation such as elements of day-to-day life experiences (Dilthey, 1976; Smith et al., 2009). Smith et al. described comprehensive units of experience as major impact events occurring in a portion of an individual's life, while the smallest units of experience in an individual's life is simply called an experience in an individual's everyday lifeworld. Dilthey (1976) stated the following:

> Whatever presents itself as a unit in the flow of time because it has a unitary meaning, is the smallest unit which can be called an experience. Any more comprehensive unit which is made up of parts of life, linked by a common meaning, is also called an experience, even when the parts are separated by interrupting events. (p. 210)

Basics of Philosophical Hermeneutic in IPA

Hermeneutics is a Greek term that stems from the word *hermeneuein,* meaning to interpret (Smith et al., 2009). Hermeneutic phenomenology focuses on the subjective experience of individuals and groups. Its objective is to uncover the world as experienced by individuals through their lifeworld narratives (Kafle, 2011). Its beginnings emerged

from the philosophical foundations to provide truer doctrines for interpreting biblical writings, and interpretation of a wider range of historical documents and scholarly works (Smith et al., 2009). The researcher utilized philosophical hermeneutics, which implies a comprehensive and systematic analysis approach to human understanding (Gadamer, 1977).

Gadamer (1977) claimed that philosophy in itself is hermeneutics and argued that our perception of the world is not primarily theoretical but practical. The researcher used hermeneutic phenomenology during the IPA process because it rejects the idea of suspending personal opinion or researcher bias due to the same ethnicity, similar social inequalities, and common academic/industry fields of African American female students participating in the study (Kafle, 2011). According to the author, hermeneutic phenomenology favors recognizing that both researcher and the responses of the African American female students in STEM undergraduate programs are subjective and contextual. This study consisted of a small number of participants; 10 or fewer, as is the practice in IPA studies (Creswell & Creswell, 2018; Creswell & Guetterman, 2019; Smith et al., 2009; van Manen, 2016). Smith et al. (2009) stated that this approach enables a deeper look at the sameness and contrasts between participants.

Participants

Selection Process

The participants consisted of (a) African American females, (b) presently enrolled in a STEM undergraduate degree program; or (c) an alumna who graduated within the previous 3 years in the 4-year STEM undergraduate degree program at the research site located in the southern part of central Virginia, United States. Participants were selected based on their relevance to the intent of the study.

Research Site

The research site was a 4-year degree-granting institution in the southern region of central Virginia, United States that offers undergraduate STEM degree programs. The population is approximately 4,000 students with a 91% acceptance rate, of which African American females make up 21.9% of the total undergraduate student enrollment. The researcher requested the assistance of university academic advisers, STEM program department personnel as well as posted invitations to recruit participants at the research site through the university's web-based social media platforms such as STEM online groups, Facebook, and LinkedIn. Participants were asked to email the researcher if they accepted the invitation to participate in the study. The researcher then emailed the participants a consent form, a proposed schedule, and a link to the Zoom virtual video conferencing web address.

Sampling Process

The researcher used purposive sampling, which is a qualitative standard with an IPA orientation for this study (Smith et al., 2009). The researcher used this method of sampling because IPA is an idiographic approach, meaning it seeks to understand in-depth detail of the experiences for a specific individual and what meaning-making this individual is trying to create from those experiences. Purposive sampling was beneficial to this phenomenological study because it could provide a better understanding of distinct phenomena representing specific circumstances, and IPA studies are conducted on smaller sample sizes (Smith et al., 2009).

Additionally, a sample size for the qualitative phenomenology design ranges from 3-10 participants when conducting IPA studies (Creswell & Creswell, 2018; Creswell & Poth, 2018; Dukes; 1984; Smith et al., 2009). This researcher used a sample of eight

participants for whom the study was meaningful. The purposeful sample included African American female undergraduate students in STEM who have experiences central to the phenomenon, their availability for participation in the study, and those who shared similar lived experiences to see what they shared with each other (Smith et al., 2009).

Purposeful sampling is a non-probability sampling method that researchers use to select participants, not for their representativeness, but for their applicability to the central phenomenon, research questions, investigative framework, and their explanation or account of experiences being developed in the research (Creswell & Guetterman, 2019; Creswell & Poth, 2018; Patton, 2015; Schwandt, 2015). Smith et al. (2009) stated:

> Sampling must be theoretically consistent with the qualitative paradigm in general, and with IPA's orientation in particular. This means that samples are selected purposively (rather than through probability methods) because they can offer a research project insight into a particular experience. Most frequently, potential participants are contacted via referral, from various kinds of gatekeepers; opportunities, as a result of one's contacts; or snowballing (which amounts to a referral by participants). (p. 48-49)

Virtual Interview Setting

The researcher used Zoom, a web-based, virtual video-conferencing tool to conduct the interviews. One of the major benefits of using web-based video conferencing is that it affords the researcher the ability to capture data through individual, in-depth interviews in audio/video. This methodology enables the researcher to go over the recording many times, which allows the researcher to capture the participant's perspectives of an experience verbatim (Bloomberg & Volpe, 2019). Another benefit of using a web-based virtual tool is that its flexibility allows the interviewer and participants

to be located ubiquitously without having to be at the research site during implemented social distancing mandates due to the Coronavirus Disease-2019 (COVID-19) pandemic.

Data Collection and Instruments

Creswell and Guetterman (2019) stated there are several methods of collecting qualitative data (e.g., interview surveys, one-on-one interviews, personal observations, or note-taking). Asmussen and Creswell (1995) indicated that interview protocols are used when conducting IPA research studies. The researcher conducted in-depth, one-on-one interviews using a semi-structured interview-protocol. This method is consistent with instruments used for IPA studies (Smith et al., 2009. An interview protocol has shown to be the best means of collecting trustworthy and valid data (Creswell & Creswell, 2018; Creswell & Guetterman, 2019; Creswell & Poth, 2018, Smith et al., 2009). The interview schedule questions were derived from themes that emerged from the literature review and were based on the understanding of lived experiences of African American women (Smith et al., 2009).

Castillo-Montoya (2016) concluded that when preparing for interview research, it is important to create an interview protocol refinement framework. The researcher created a semi-structured, open-ended, interview protocol (see Appendix), which consisted of a four-phase process. Castillo-Montoya concluded that within the four-phase process the researcher should (a) make sure the interview questions align with the study's research questions, (b) establish investigative-based dialect with the participants, (c) use the interview instrument to gather feedback, and (d) test the interview protocol using a pilot test. The interview protocol refinement process supports the efforts to strengthen the reliability of interview protocols used in qualitative research and thereby contribute to improving the quality of data obtained from research interviews (Castillo-Montoya,

2016). The internet protocol consists of relevant questions focused on understanding the central phenomenon of underrepresented minority women in STEM as well as their lived experiences that affected their consciousness of day-to-day events (Creswell & Creswell, 2018; Creswell & Poth, 2018).

The interview process was aimed at allowing the participants to comfortably share their understanding of the world through their experiences and points of view. The interview questions were grounded in epistemological format, which delved into the investigation of what separates confirmed belief from opinion (Smith et al., 2009). Most noticeably, the research questions in this study are categorized into themes that appeared prominently in the exhaustive literature review located in Chapter 2 of this study. These segments served as an overarching umbrella that identifies how interview questions support the centralized research question: What are the critical factors influencing the lived experiences of African American females in STEM undergraduate programs? The resultant four questions support the primary research questions:

1. What are the academic, social, and interpersonal experiences of African American females in STEM undergraduate degree programs?

2. What are the experiences of African American females as they persist in their courses in a STEM undergraduate program?

3. What successes and challenges do African American females face in STEM undergraduate degree programs?

4. What advice and/or recommendations do African American females provide faculty and program administrators to support and retain other African American females in their STEM undergraduate degree program?

These questions were used by the researcher to stimulate open-ended responses

from the participants. Their answers allowed the researcher to generate emerging themes as well as form comparisons and contrasts to find the connections between the themes (Smith et al., 2009). The researcher's goal was to use the interview protocol to explore the social, cultural, institutional, and familial experiences that affect the enrollment and retention rate of first-year undergraduate African American women in STEM.

Instrument Validation

Smith et al. (2009) stated that in measuring the validity of an instrument, the researcher must ensure that the content within the instrument is relevant to the interview questions and measures the content for which they are intended.

Expert Panel

The researcher used the assistance of colleagues who are familiar with the purpose and context of the study to act as panel members to review the semi-structured interview protocol guide and provide their input. In qualitative research, the researcher often uses an expert panel and pilot testing to assess the validity of the interview protocol (Creswell & Creswell, 2018). Establishing the validity of the instrument ensured that the researcher captured content that is reflective of the phenomenon of the study. The expert panel used for this study consisted of (a) a female doctorate-level faculty member who is the qualitative research lead at her university, author of many articles published in peer-reviewed journals, and who is of African American origin; (b) the second expert is a world-renowned Caribbean-American male who is a bioengineering physician who lectures globally, as well as being a mentor to African American college students; and (c) an African American female who is a corporate leader in the technology industry who mentors African American females. Each was selected based on the significance of the study along with their ability to enhance Black scholarship. The researcher modified the

interview protocol based on recommendations from the expert panel by merging similar feedback into existing questions or removing questions that were not relevant to the study. The panel as a whole agreed that the focus and interview questions adhered to the lived experiences of the participants' life-world.

Pilot Testing

The researcher conducted a pilot test using a semi-structured interview protocol upon IRB approval to assess whether the participants in the study comprehended and could answer the interview questions (Creswell & Guetterman, 2019). The participants from the pilot test were not used for the actual study. This approach allowed the researcher to modify, adapt, or remove interview questions based on pilot study participants' responses before using it with the actual participants (Castillo-Montoya, 2016; Creswell & Guetterman, 2019).

Conducting the Pilot

The researcher conducted a pilot test with the instrument with the assistance of a local professional African American woman in STEM who is also a recent graduate of a STEM bachelor's degree program from a 4-year degree-granting university. The pilot participant graduated from a university similar in enrollment size and percentage of African American women students as the research site. This pilot interviewee has similar characteristics to the participants that the researcher intends to recruit for this study (Maxwell, 2013). This piloting phase was conducted using Zoom, along with the audio recording mirroring the same procedures that were used for the study's actual interviews.

Interviewing the Investigator

Chenail (2009) stated that interviewing the investigator as the interviewee has the advantage of identifying any unclear or ambiguous statements in the research protocol.

The researcher can utilize feedback and observations to modify, change the direction, or use intuition that the interview protocol would never do. Chenail (2009) stated that interviewing the investigator allows the researcher to take on the role of the interviewee. In this study, the researcher asked a colleague from the STEM field to serve in the role of the interviewer, while the researcher was the interviewee. The interview was conducted within the same virtual interview platform in which the actual participants were interviewed. This enabled the researcher to experience exactly what the interviewees in the study would have to undergo and allowed him to make changes to the instrument and the interview process.

Procedures

The researcher was required to address two levels of permissions and authorizations to conduct the research study. The researcher submitted a proposal and all required documents to the university's institutional review board (IRB) for approval to conduct research. Since this study involved human participants, the researcher had received permission to conduct this study at the research site from their IRB. After receiving approval to conduct the study, the researcher sent invitations to participate in the study to the research site's Facebook, STEM groups/clubs, and STEM faculty/researchers seeking volunteer participants. The researcher sent an email containing details of the study and a consent form to those who responded indicating an interest to participate in the study.

The researcher sent an email with the virtual web-application link to schedule a day and time to speak with the participants over Zoom, to answer any questions they may have had, and to go over the informed consent form. This allowed the participants to be further informed about the details of the study and to ensure that they understood that it

was strictly voluntary, with an opportunity to pause or withdraw at any time. The researcher conducted individual, one to one, half-hour, semi-structured interviews with each participant using Zoom. The researcher created an interview protocol based on themes in the literature review and aligned with the core research questions for the study. The semi-structured interview protocol that was used in this study is in the Appendix.

Data Analysis

The researcher followed the six-step data analysis procedure outlined in the IPA process (Smith et al., 2009). According to Heidegger (1962/1927), the IPA process is an interpretation mechanism used in hermeneutics and IPA studies (Smith et al., 2009). The researcher followed the IPA process to analyze the first transcript in detail, then moved on to the second, third, and subsequent transcripts. Smith et al. (2009) stated that the following six-step process should be used when conducting an IPA. The six-step IPA process consists of:

1. Reading and rereading the interview transcript data through immersing oneself in the original data;

2. Initial noting to capture semantic content and language in the interview transcript at its very basic exploratory note level and saved as a Microsoft (MS)Word file;

3. Developing emerging themes from interview transcripts by reducing the volume of data to discrete chunks of data to re-organize the data into fragmented experiences of the participants;

4. Searching for connections across emergent themes within the transcripts by ordering the themes chronologically as they came up within the transcript;

5. Moving to the next interview individually by starting the steps over again with a new participant’s transcript; and

6. Looking for patterns across the interviews by comparing each table to see what associations are there and how does each interview help illuminate the next interview.

Sutton and Austin (2015) stated that the IPA process is more than just capturing what participants say, but getting immersed into and fully understanding what is said by an individual to comprehend their lifeworld from their viewpoint. The researcher transcribed and checked the captured data after analyzing each participant's recorded video/audio interviews. The researcher used the transcript option in Zoom to capture all interviews and save them as Microsoft (MS) word files. The researcher then listened to the Zoom recording of the interview, taking notes throughout, correcting any misspellings, grammatical errors, and ensuring that pseudonyms were in place so as not to identify the participants or the research site.

Ethical Considerations

The researcher used ethical practices while conducting this study. Before conducting the study, the researcher had completed the CITI Training Institution Review Board modules and received approval from his chair, IRB, and the research site's IRB. The researcher showed respect to the participants by disclosing the purpose of the study, that participation was strictly voluntary, and that the participants have the right to pause or withdraw from the study at any time.

The researcher: (a) minimized disruptions to academic and personal daily schedules in pursuit of qualitative data for this study; (b) abstained from using pressure tactics toward the participants to sign consent forms or guide the participants to a certain answer; and (c) applied a level of sensitivity by recognizing the needs of vulnerable populations (Creswell & Poth, 2018). While collecting data, the researcher showed respect for the research site and its reputation, avoided deceiving participants, and

informed the representatives of the research site and participants of the technical requirements necessary at the research site.

Data from the interview protocol answers and Zoom recordings were safeguarded and stored on an encrypted protected virtual private network at the researcher's institution. The data will be stored until governing directives and policies state they are to be destroyed or returned to the participant. During the interviews, there were moments when participants disclosed sensitive information. The researcher reported data that had been compiled at the aggregate level of broad themes to safeguard the identities of individuals. Pseudonyms were used when using direct quotes from the participants.

Trustworthiness

The researcher utilized the collected data expressed as the "lived" experiences by participants due to the IPA processes' detailed steps that integrate phenomenological interpretation. The researcher offered to use member checking to validate the data captured during the interviewing process, but the participants did not want to review the transcripts due to the auto-transcript option captured in Zoom. The participants could see their comments in real-time. Member checking transfers validity from researcher to participants in the study (Creswell & Miller, 2000). Participants serve as fact-checkers to ensure the researcher has captured their sense-making of lifeworld events. Continuous dialogue regarding the researcher's interpretation of the participants' reality and expressed consciousness ensured the validity of data (Creswell & Creswell, 2018).

Bracketing

The researcher understands the importance of removing obstacles to quality data collection and capturing the interviewees' essence of their experiences. Therefore, the researcher bracketed pre-existing apprehensions, gut feelings, preconceived notions, and

philosophies. The researcher focused on attentiveness and closely regard the words of the interviewees by actively listening to the participants' expressed phenomena. After each interview concluded, the researcher used hermeneutics to understand the meaning of interpreted data as well as the intentions of the original meaning-making of the participant's experiences (Creswell & Creswell, 2018; Smith et al., 2009).

Potential Researcher Bias

According to Sutton and Austin (2015), researchers did not attempt to disregard or sidestep their personal biases. Alternatively, reflexivity dictates that researchers reflect on and plainly articulate their views and subjectivities so that readers may obtain a clearer understanding of the filters through which questions were asked, data were collected and analyzed, and findings were described. Sutton and Austin (2015) stated "From this perspective, bias and subjectivity are not inherently negative but they are unavoidable; as a result, they should be articulated up-front in a manner that is clear and coherent for readers" (p. 226). The researcher is an African American male who is currently a part-time adjunct professor with 9 years of higher education instruction and curriculum development in STEM computer science, computer information systems, technology, and cybersecurity at the graduate and undergraduate degree program level. The researcher is also a consultant with over 30 years of high-level information technology expertise supporting federal agencies such as the Department of Defense, Department of Education, the National Institute of Standards and Technology, the White House, and several Fortune 500 companies. In this capacity, the researcher witnessed first-hand the low participation rate of African American females in STEM undergraduate degree programs as well as in the STEM field. The researcher is also an advocate of diversity, equality, and inclusion of women in academics and the workforce. The researcher

practiced epoché by bracketing and suspension of trusted lived experiences and consciousness due to being the same ethnicity as the participants, having experienced similar social inequalities, and having first-hand observation in an academic/industry setting comparable to that of the African American women who participated in the study.

Chapter Summary

A qualitative phenomenological study approach was designed to understand this study's research questions and find a shared connection between the critical experiences that contributed to African American female students and the retention, and attainment in undergraduate STEM degree programs. This chapter summarized the aim of the study; the qualitative methods research approach; participants, along with the sampling strategy; instruments used and content validity; and procedures, including permissions, qualitative data collection and analysis, and confidentiality and safeguarding of the research study data.

Chapter 4: Findings

This phenomenological study captured the lived experiences of African American women in undergraduate STEM degree programs. Those experiences are explained in this chapter, which will help the reader understand the critical influences and obstacles experienced by African American women during their tenure in college, including familial, interpersonal, academic, and social interactions.

Presentation of the Findings

The study was guided by the following researcher questions:

1. What are the academic, social, and interpersonal experiences of African American females in STEM undergraduate degree programs?
2. What are the experiences of African American females as they persist in their courses in a STEM undergraduate program?
3. What successes and challenges do African American females face in STEM undergraduate degree programs?
4. What advice and/or recommendations do African American females provide faculty and program administrators to support and retain other African American females in their STEM undergraduate degree program?

Background of Participants

The study population consisted of eight African American female students who are seniors in college or recent graduates ages 20-42. They reside in various cities in the United States. The participants attended a HBCU and were all regionally located in the central southeastern area of Virginia. Below, the researcher describes each participant's background. For confidentiality purposes, the researcher used pseudonyms to identify the participants as well as their university.

Claudia

Claudia is a 42-year-old African American female graduate who dropped out of college due to giving birth to her first child and returned many years later to earn her undergraduate STEM degree. She grew up in the central southeastern region of Virginia and attended a HBCU. During her primary years, Claudia grew up in a dual-parent home with her older female and male siblings. Claudia's parents separated during her time in middle school, and Claudia along with her siblings lived with their mother. Claudia, as a young girl, had a desire to help and heal others. She attended an apprentice vocational school for nursing while in high school, which prepared her for STEM in college.

Lekeisha

Lekeisha is a 21-year-old African American female graduate of the undergraduate STEM degree program. She grew up in the central southeastern region of Virginia and attended a HBCU. Lekeisha has always loved using analytics and problem-solving to understand technical things around her. She has one older sibling and grew up in a dual-family household where attaining an education and graduating from college was stressed. Lekeisha attended her first STEM outreach program during middle school where she participated in programming and coding challenges. During high school, Lekeisha participated in STEM clubs where she learned critical and analytical thinking to solve IT support problems. Lekeisha stated that her K-12 access to STEM prepared her for college.

Maya

Maya is a 20-year-old African American female double-major student in an undergraduate STEM degree program who attends a HBCU in the central southeastern region of Virginia. Maya grew up in a rural area in upstate New York with both of her

parents. Maya was introduced to STEM by her father who graduated from a HBCU as an engineer. Maya always had a fascination with math since she was a small child, and this lead her toward challenging courses to become an engineer like her father. Maya participates actively in several STEM outreach programs at her university and is a STEM tutor in her community.

Tamara

Tamara is a 35-year-old African American female STEM degree graduate who is also a single mother. She withdrew from an undergraduate STEM degree program due to giving birth to her first child, enrolled back in college 10 years later with the encouragement of her institution's faculty, and graduated with her STEM degree. She resides in the central southeastern region of Virginia and attended a HBCU. Tamara was introduced to STEM by her female African American high school chemistry teacher. Tamara's high school chemistry teacher was her first mentor and eased her fears regarding STEM courses. Tamara was persuaded to join the robotics team by her chemistry teacher, and that experience sparked her interest in STEM. Tamara had visions of using mathematics and pre-engineering in her future. She found her new interests in STEM to be cool and enjoyed critical thinking.

Jasmine

Jasmine is a 21-year-old African American female graduate who received her undergraduate STEM degree from a HBCU located in the central southeastern region of Virginia. She was raised along with her siblings in Georgia in a single-parent household by her mother. She was introduced to STEM at an early age by her divorced mother who is a prominent industrial engineer in the STEM industry. Jasmine's commitment to her education and STEM was brought on by having a mother that was great in science and

math. Jasmine is mentored by a renowned woman in the STEM science and medical field and often shadows her to get the real-world experience of women in STEM.

Brianna

Brianna is a 23-year-old African American female student in STEM who was born in South Carolina but currently resides in the central southeastern region of Virginia. Before attending a HBCU college, Brianna and her sibling, who are both children of divorced parents, went back and forth every summer or every other school year to attend schools in South Carolina and Virginia. She was introduced to STEM by her father and grandfather who were both researchers. Brianna stated her academic introduction to STEM and other African Americans in STEM was actually when she attended the HBCU. Brianna stated her role model is her older sister who is also in the STEM industry.

Debra

Debra is a 27-year-old African American female graduate of a STEM undergraduate degree program who was born in Georgia, and her parents were both in the military. Debra was raised by her paternal grandparents on rural farmland from early childhood due to the separation and the eventual divorce between her parents. Her interest in STEM was created by her curiosity in treating sick farm animals. She would create self-made treatments consisting of herbs found in the surrounding forest. Debra was introduced to STEM academics during her high school AP honors classes, where most students gravitated to either industrial engineering, textiles, or agricultural classes. Debra eventually attended a HBCU in the central southeastern region of Virginia.

Nikki

Nikki is a 32-year-old African American female nontraditional student who began

her college career in her late 20s. She attended a predominantly White, non-profit, 4-year degree-granting university. She is married and hails from Indianapolis, Indiana. Nikki left her home in Nigeria to pursue a better lifestyle for herself in the United States. Nikki had an early fascination with technology as a small child, often playing with her father's electronics and cell phone. Nikki's background was in the banking and finance industry where she realized that was not her passion. She is currently a network security engineer in the STEM industry.

Themes

The researcher performed a data analysis of the participant's transcripts by using the initial noting process as described by Saldaña (2016) to keep each participant's data entrenched in their language. The researcher grouped codes into a smaller number of categories and finally into an even smaller number of themes (Saldaña, 2016). Verbatim excerpts from the transcripts were used to illustrate these themes. This provided integrity as it showed the source of the researcher's interpretations. The researcher created a report that reflects the results of the study using the IPA process. The themes below were discovered during this process.

Theme 1: Living in my Skin and Bringing Emotions into the STEM Program

Each participant expressed their experiences in lacking confidence as an African American woman who was trying to escape the racial and gender stigmas of African American women in society as well as being an African American woman who is also a student in an undergraduate STEM degree program. Some ascribed the lack of confidence to their upbringing or lack of an ideal setting as a child, a higher spiritual calling, while others described the emotional hardships ranging from the traditional thinking of an African American woman's role to take care of the home and kids and

supporting the many extracurricular events of their children. Seven out of eight participants shared that they brought personal emotions such as self-doubt into their academic world that stemmed from racial views of society and suppression as an African American woman and an African American woman in STEM. Three of the eight conveyed that there were experiences outside of academics that hindered their identity but not their persistence in STEM. Brianna stated:

> I'm already at a disadvantage because my parents are kind of divorce, so I was already in an unstable environment you know. You have to think about my base, my foundation first to even understand if I will be prepared for something later on in my life. I was just kind of doubting myself and I had no confidence but I still pushed through.

Brianna compared her experiences as an African American woman living under the microscope of societal racism and how it carried over into her psyche while trying to persist in STEM. Brianna stated:

> I just kind of had to have tunnel vision, so that stuff wouldn't bother me because if you think about it you're just like, kind of blocked up and so worried about racism that that alone will make you angry and crazy. I still process everything because most of the times I treat this other headspace so I can at least get through today. I mean my subconscious knows what's going on, but my consciousness don't want to get there until I'm home.

Equally, Maya explained that her experiences were sent from a higher power. She went on to state that oftentimes being the only, or one of two African American females in her class made her feel isolated, and at times she felt like an object that stood out where all else was the same. Maya stated:

> I would just add that it is really hard to like to persevere through all these classes and especially when you get a bad grade on something. But for myself, I've been, I feel like I've kind of been training for this since high school because I've always been like the only black woman in the classroom, the only one in the honors classes and stuff like that.

Debra expressed her meaning-making of society and her academic environment as those individuals who are different should be more open-minded to the lived experiences of what she and other African American women go through daily. Debra stated:

> I feel like people look at African American Community as if we are based on our parents and their experiences. Society has kind of figured out or mapped out, their opinions of our whole life experiences. And I feel like they just need to be more open minded in more. They kind of considered, really they concluded that maybe I'm not good at science. Maybe I should think about going into another program or leaving the institution all together. Maybe I should go to a community college and learn fundamental biology. I did go to a community college, graduated from there, and returned to finish my STEM degree.

Participants who were single parents or dual parents had the same experiences of being African American women and mothers while trying to persist in STEM. Tamara's stated:

> I would get up early like maybe 4:45 a.m. if I hadn't started or finished homework. I did that till about six. I have a son, so I would get him ready about 6:30 a.m. to leave and drop him off and go to my classes that started at 9 a.m.

Meanwhile Claudia described her challenges as a dual-parent and an African American woman in an undergraduate STEM degree program. She concluded:

> I would say trying to go to school and still handle my responsibilities as a wife and mother were challenges for me. I took a break for a while when I had my second child and went back when she started kindergarten. Most of the time I just handled everything myself and did what I had to because society thinks I'm going to be on welfare or continue to have babies and had no means to support them.

Nikki who is also a dual-parent shared her experiences saying it was almost as if she was a single parent because of her husband's belief that the woman takes care of the home and kids. In her homeland, it was traditionally the woman who cleaned, cook, took care of the kids as well as provided for her husband. Nikki stated:

> I usually wake up at 4 am in the morning, try to study a little bit maybe one hour one hour 30 minutes I have two little ones have five-year-old and a three-year-old and I needed to get ready for school and daycare. Then, my commute from home to work is about one hour. After work, and sometimes during lunch, I get to look at school work and see what I can get done. I can study after work before my family and kids get home and for a couple of hours before going to bed. My husband did not give me much support.

Debra went on to express her experiences with being left behind by her parents and as an adult, still dealing with personal emotional issues from abandonment by her father. Debra wanted to break the ideology that African American women are statistically lower than everyone else. Debra understands that she needed to come to grips with her mental shortcomings her interpersonal and social interactions while in academics to cope with disadvantages in her STEM profession as she concluded:

> I used to struggle with abandonment issues. Kind of felt like that even after they got back from overseas. I had hoped they would take me back or at least my dad

> would take me back. But I was always felt abandoned because he never came back to get me. I was always angry and my mouth got me into trouble at all levels of school because people did not understand me. My experiences made me feel like a victim.

Claudia addressed experiences that enabled her to persist in STEM despite negative connotations directed at her from society of being an African American mother, probably on welfare, and looking for a free ride by foreign professors within her learning environment. Claudia concluded:

> What enabled me to persist in the undergraduate STEM degree program when the system thought that I should not be there was the fact that my mom, aunt, sister, and other relatives had made it in the STEM industry. Also, African American professors were nurturing, especially the older faculty members and advisors.

Lekeisha's experiences were understood to be very similar to Claudia's. There were interpersonal and outreach programs that enhanced Lakiesha's skills as well as her participation in grounded outreach programs. She faced microaggressions from younger white males during her time in STEM and during her early years of academics. Lekeisha stated:

> My mom, grandma, auntie, sister were all in the medical field what we call biomedicine now. I participated in STEM programs starting in middle school I believe. My African American professors were relatable. Understanding, helpful. But you know there were those who treated me like I was in a males'-only club. I had some choice words for them and after that, we were able to understand where each other was coming from. As long as I stayed Black, I wasn't leaving and they needed to understand how not to treat African American females. I felt in the

> academic environment there were assumptions like maybe related to their upbringing or culture. They never considered what you had gone through in your life.

Brianna's understanding of society and her STEM academic environment elevated an awareness as well as heightened her defensive mechanisms. Brianna stated:

> I went through a lot! I feel the way I feel is because they kind of already systematically set it up that black people are dumb and blacks are failures so it's like I'm had to constantly try to prove myself at school and work and it is so annoying. You are seeing microaggressions from people who are not the same color are asking, or they have assumptions that all black women are angry and it causes you to feel a certain way, which isn't necessarily anger; it's more frustration and that amps it up a little bit and that is not anger.

Theme 2: Persistence Despite Family Context - Understanding Family Makeup and its Role in Sustaining Motivation to Remain in STEM

Five out of eight participants shared their persistence and attainment of their undergraduate STEM degrees despite family contextual changes during their childhood years. The participants identified that there were traumatic experiences due to parental circumstances that were detrimental to their emotional well-being, yet motivational influences from childhood to their present life in STEM. Claudia stated:

> My parents got divorced when I was in middle school so I didn't have them to provide everyday moral support. I had a hard time adjusting to the new arrangements due to my age and not being mature enough to handle it. My mom kind of told me what to expect in school and told me to get a nurse's aide certification rather than a degree. My dad told me I could do anything I set my

mind to. I normally talked to him about my goals rather than my mom.

Despite Claudia's early childhood adjustments of being separated from a father who supported her aspirations of being in STEM, she focused on her academics and accomplished her goals to go to college and complete her education. Claudia reflected during her interview what graduating from the undergraduate STEM degree program meant to her by stating:

> This has been very eye-opening for me. I never took the time to reflect on what I had gone through during my undergraduate time. It was kind of sentimental, emotional, and sometimes overwhelming to think about the friendships and professors who helped me.

Brianna had similar experiences as Claudia did and expressed how changing the dynamics of her family context through her parent's separation and ultimate divorce had affected her mentally and as a student in STEM by stating:

> I'm just going to be honest, it's kind of hard to tell people first of all. Trying to come from a divorced family, it was a lot of like back and forth, you know moving around. You know, some summers, half of the summer; half of the year I lived in SC in the country. I was more than happy to be here in Virginia.

Brianna confessed that her meaning-making of her journey through life as well as how it molded her helped her to be strong and persist in STEM. Brianna explained that her past still affects her present, and although she has had small victories, it's a struggle to appreciate them at the moment. Brianna expressed her dream of graduating from the undergraduate STEM program by stating:

> I can actually see myself back then--going through that in my head right now. Thinking about what I accomplished, it gave me a chance to look at myself from a

> different perspective than I ever had. I can move forward because I made it through all of that. I may have been dirty when I went in, but I feel clean after coming out on the other side.

Debra's parental experiences echoed Claudia and Brianna's as she stated:

> My parents went overseas to Iraq and Kuwait. I was probably four or five when they got a divorce and my dad had full custody. When my mom had custodial parental rights or whatever, it was half and half. My mother was not happy that I chose a historically black college but supported me with completing things administratively like the FAFSA. I stayed with my dad until he got assigned overseas and then he took me to his mom's house to live with my grandmother, who raised me. Living with my grandmother was very toxic.

Debra conveyed that her experiences while growing up made her feel like a victim and abandoned. While she has admitted to still struggling with experiences during her childhood and early adult life, she feels she is still a work in progress and has learned to count her accomplishments of obtaining her undergraduate STEM degree and checking off progress milestones in her life. Debra concluded:

> I made almost perfect grades. I went to a four-year university for two years, then went to community college student status, then back to a four-year institution. I feel like I had a long road and it's kind of disheartening to know that I had to take all those steps just to get a bachelor's degree. Just to get to where I am now. But it's also motivational because I'm passing milestones, even if I have issues with struggling with success due to feeling abandoned.

Jasmine reiterated the importance of having a single parent who is supportive and, as well, has a STEM background. Jasmine stated, "Having a mom that was great in

science and math made it imperative that we excelled in those areas. My mother is an industrial engineer."

Nikki understood the limitations of her parent's abilities as they struggled to accept her dreams of getting a degree in the STEM field and to support her and her family financially or provide moral support as she tried to persist in the undergraduate STEM degree program in a foreign country. Nikki further stated:

> The lack of familial support was due to distance and then they wouldn't understand what I'm doing. Even if they wanted to support me, there's really no means of doing that given the time difference too. So, there's nothing they can do from a distance. Not much support from my spouse either.

Nikki conveyed that despite her lack of family support and her experiences of being in a foreign, strange country with no help from her husband, still she persists in STEM. Nikki stated:

> My desire to maintain focus on taking care of my children and having a mentor who understands my heritage and traditions has allowed me to obtain a job as a network engineer. This is like a learning phase and a new beginning for me and also an opportunity for me to quickly go up the ladder if I continue to put my best foot forward.

Some participants did not have parental contextual changes or their parental contextual changes did not affect their persistence in STEM. Three out of eight were able to participate in outreach programs or camps, received mentorship from parents or grandparents, and had access to major scholarship opportunities. The participants were able to excel in STEM due to positive experiences and continued support from parents or grandparents, which encouraged them to persist and obtain their undergraduate STEM

degree.

Maya expressed that she had access to resources that other black girls did not because her parents were engaged in her education, especially her father who held an advanced degree in engineering. Maya recalls being one of only a select few African American girls to attend her private school. Maya stated:

> I went to a Catholic private school, it seemed like a regular public school, minus you know the religion, and I'm not even Catholic, by the way. I get a lot of support from my family, especially my dad. He graduated from the same university in Virginia and he encouraged me to keep pushing. I would just add that it is really hard to persevere through all these classes (STEM), especially if you get a bad grade on something. But for myself, I feel like I've kind of been training for this since high school.

Lekeisha's parents encouraged her to pursue her academic dreams and provided all of the resources and support she needed to persist in STEM programs from an early age. Lekeisha's positive experiences in STEM started early in her childhood. Lekeisha stated:

> Reflecting on my experiences in STEM, I would say it is bittersweet and it was fun. I learned a lot and I would do it all over again. I never happened to consider how insane this journey would be and how much you have to love what you do to make it through and graduate. It was a great journey but I'm glad it's over.

Theme 3: Expectations and Misconceptions in the Academic Environment

Six out of eight participants expressed their experiences with professors as either perceived lower expectations and/or misconceptions of African American female students by white and foreign professors (non-African American professors) to be

microaggressions and hindrances to their persistence in the STEM learning environment. Some participants experienced moments of embarrassment in class, which caused anxiety and made them feel awkward when approaching their professors. The participants had fluctuations in their voices, displayed frustration, and sometimes anger as they mentally relived their experiences with non-African American professors. Claudia shared that her experiences with her Black undergraduate STEM program professors who were not American were not comforting and often caused her to have anxiety and feel mistreated as she stated:

> Most of my STEM classes had professors from other countries. They seemed to have lower expectations of me than the African American professors I had in other courses and expected me to try harder or read more. As if I was lazy, or not applying myself. It made me feel like I was valued less than the students that were White males or male and female Black students who looked like those professors or who came from the same home country. Like those students were supposed to be in the class and I wasn't on the same level as those students.

Lekeisha reiterated the experiences described by Claudia in recalling the pedagogy of her foreign professors as unbending and causing her to experience anxiety due to language barriers and stringent expectations in her rigorous classes. Lekeisha stated:

> I don't feel like I had the traditional college experience. I had trouble with maybe understanding some professor's accents. I found that some of my foreign teachers taught a certain way that was, kind of like, they weren't changing their way of teaching if you didn't understand. I wouldn't encourage STEM if a person is not committed to their studies because they won't put all of their energy into it when

> professors make you feel like just asking questions is making them have to do more than their job. Typically, I had professors that are, way more structured. they have something for everything. I didn't work well with structure, lack of inflexibility, and no patience. That workflow didn't work for me but I passed my classes.

Maya shared the same experiences of Claudia and Lekeisha's verbal interactions with professors who were from other countries. Maya stated, "Sometimes there's like an accent but that's something easy to get over. I feel like I, I would probably connect a little better with somebody that was African American and female, like myself, and understood what African American women go through daily in academics and life. Brianna's feelings echoed the others as she described her experiences concluding:

> Sometimes the professors who looked like me but were from another country that had too many expectations and didn't get African American women. I'm just like, do you even understand somebody that looks like me. I was always feeling isolated and ignored in her STEM classes. I never expected anything to be like that but it's just, again this is just a part of my experiences in society as an African American women well as part of my HBCU STEM academic experience.

All of Debra's professors were White and of European descent. She described her experiences with her professors as being treated as if she was out of place because she was usually the only African American female student in her class. Debra stated:

> On occasion, they stereotyped Americans and African American females saying I'm lazy and weren't meant to be here (at the school in a STEM degree program). In staying home due to the pandemic and getting my work done, that was perceived differently. Like I was getting help or cheating. I'm always paranoid

> about what someone might be saying about me and you know and it caused me to have anxiety, have low self-esteem, and be angry at times. I need to get up at five o'clock in the morning to read or finish homework from the night before and it's eight o'clock at night and I am at my job thinking about school and I don't get off until midnight okay. I've always been like, I have to prove myself to my professors show them that I'm trying harder than everyone else, even though I'm performing better than all of the White males in the class. I know English, first of all, isn't their second language. So, they don't understand my casual behavior for the most part. They're more so strict and serious all the time. As far as when it comes to the academic setting, I don't necessarily know if they're not being more relaxed in conversation is due to their culture, or is it because of who I am as an African American female in their class.

Tamara shared different experiences from the others. She expressed that her experiences with faculty and STEM professors at her university made her feel they were microaggressions and caused her to be overwhelmed. She was thrust into leading younger African American female students in her STEM courses and experienced pressure to set the example for her peers in undergraduate STEM courses. Tamara stated:

> I definitely wanted to quit more days than then finish um, but the opportunities that I had at school, the mentors that I had met at school, you know, they knew it was difficult for me as an older student. I was told to be a leader and keep the other female students on track because of my age, not my academics. It was like I was supposed to be smarter just because I was older. I had been out of school for over a decade and the younger girls and I spoke a different language and most were smarter than me in certain STEM subjects as I struggled to keep up. The

> pressure caused me to have anxiety and worry about how I would do so many things at once. For instance, you know I'm going to school like everybody else but I'm also you know the kids don't talk to me the same. You know, they don't want to do the same type or be in a study group with me because I'm an older student, you know, and I have a specific time that I need to be here and there any time that I need to leave due to responsibilities of a single mother and working a full-time job.

Theme 4: Support Mechanisms While in the STEM Program

All participants expressed in their meaning-making the importance of having a strong relationship with a mentor or support available for them to make it through their undergraduate STEM degree programs. Six out of eight participants described that they had mentors or shared experiences where the mentor was also a support mechanism that enabled them to mentally maintain balanced perspectives regarding their set goals whenever they went through struggles with school, finances, or their lives.

A professor, who was also a collegiate coach, served as a mentor as well as a support mechanism while tutoring one participant in math. Women in the STEM industry were also seen as mentors as they allowed some participants to shadow them in their STEM work environments. One participant described a women's group in STEM that supported each other's mental stress caused by a lack of spousal support as her support mechanism. Three participants expressed that their parents or grandparents who were or are currently in the STEM arena were their mentors and support mechanism. Claudia shared how her relationship with an older African American female faculty member bloomed into a quasi-grandmother relationship even after college. Claudia stated that:

> One particular advisor was an older black lady in her 60s or 70s and often would

> check on me. She kind of took me under her wings and made me feel more comfortable about my STEM degree program and school. She was very nurturing and reminded me of my grandmother. She would tell me that many students went through the program successfully and so would I. We kept in touch even after I graduated. She passed away recently and it saddened me.

Brianna communicated that it was meaningful to see a STEM mentor who looked like her and who understood the life of an African American woman as well as an African American woman in STEM. Brianna stated:

> If I needed help with school, like you know, a coach who was also a math teacher, he would help me, you know with lessons, so I had a lot of support. It just encouraged me (to keep going on) to never give up.

Jasmine shared her experience while shadowing her STEM mentor as being a privilege to be able to access the STEM industry in real-time as well as see how women are treated in STEM. Jasmine stated:

> I have a mentor that is a renowned Surgeon. She is a straight shooter and challenges me. She also inspires me. I can shadow her during surgeries and talk to her about what it's like to be in a male-dominated area of medicine.

Debra shared her understanding of how she got along with older faculty due to her connectedness with her grandparents. This was comparable to the experiences of Claudia and Brianna. Debra stated:

> I had an older faculty member who was kind of like a mentor and my support. Probably in his 70s. I never really had a grandfather, and there were thoughts about what it would be like to have one so yeah, I guess you could say that he filled that void. I think the majority of the case the older faculty member checked

> on me and helped with my academics because I was still working those two to three jobs despite being in school and I had gone through all of those different institutions. I just always work with the elderly better than I do with everyone else. I kind of understand them better and they understand me.

Tamara shared her experiences with a female mentor who was also a single parent. Tamara expressed how much more comfortable she felt having a mentor who was a woman who could understand what she was going through as a woman in academics. Tamara stated:

> Having a mentor who looked like me made me more comfortable because I felt like she could relate to some of the stuff that I went through or some of the stuff that I struggle with. My mentor was not only a single mother, but she was also a mother; she also went to school while having children so she was more relatable to me.

Theme 5: Identifying Needs for Sameness of Professors and Financial Resources to Support African American Women in STEM

Establishing relationships and gaining support from African American women professors was identified as important to all of the participants. None of the participants had African American women professors during their degree programs who could relate to them as well as understand the day and life of African American female students. Six of the eight participants expressed that having a professor who looked like them would have helped them, while only two stated it really did not matter. Claudia shared the following:

> Hiring more professors who look like African American females is a start. They are the first line of African American women in STEM we see at the university. It

> would be good because it levels the field between those African American women in STEM who face challenges trying to run a household as a wife or single parent and it will give them exposure to real-world experience.

Lakeisha expressed that she did not take structure, lack of patience, and inflexibility from her foreign professors in STEM well. She went on to say that having African American women professors would have allowed her to have a better HBCU experience. Lakeisha recommends, "some of us need to be mentored by faculty or maybe somebody in the industry. Preferably by professors and others who look like us and the same gender in the same field so we can get firsthand knowledge."

Meanwhile, Maya described her experience in her undergraduate STEM degree program as lacking in African American women when she recommended, "I would like it if they were more diversity in my STEM classes. Add way more culturally diverse African American women students and faculty, I guess." Brianna believed that if she had African American female professors she would not have experienced microaggressions in her undergraduate STEM degree classes. She recommended that her university hire more African American women professors as she shared:

> Having African American women professors would encourage more African American female students to enroll in STEM because African American women professors shared the same inequalities in society and STEM. Seeing African American women in STEM, I felt like I had a chance at life right. I felt like well they did it, so can I.

Debra recommended that her university hire a balanced demographic of women professors who reflect the student population. She stated STEM is a male-dominated industry and seeing African American women in STEM would set a great example for

younger generations. Debra expressed:

> I lose self-esteem for the most part because male professors make me feel like I am not contributing to a tier or level that I should be performing. But I did today and every day. I wouldn't feel like this with an African American woman professor. I think as long as African American women professors have the same opportunities to teach, have the proper training, professional development, and the confidence in themselves, they should be allowed to teach and be in the same jobs as men. Society seems to think we need men to interpret our data and be able to explain what it means.

Seven of the eight participants shared that they knew of the common scholarship opportunities. However, they expressed that their university does not do a good job of equally sharing what scholarships and other financial aid resources are available for socioeconomically or displaced African American women students. It was stated that scholarships created by the National Science Foundation or Presidential STEM scholarships were not publicized to make them aware of these specialized STEM financial support programs designed for African American women pursuing STEM degrees. Claudia shared, "I knew there were grants and the commonly known scholarship foundations, but I was not made aware of any programs being available to me as an African American woman by my professors or advisors."

Tamara shared that as a single parent trying to hold down a job and support her kids, it would have been nice to know she had scholarship resources available for her. She expressed that it is hidden from some African American female students and given to a select few who are well-liked by professors. Tamara stated, "I think that National Science Foundation, Presidential scholarships, and other programs would be helpful to all

African American women pursuing STEM. People need to know that there's another option for funding your education."

Nikki recommends that her university do a better job of informing African American women students in undergraduate STEM degree programs what options are available to them as well as aid in applying for those programs. Nikki shared that she applied for financial aid and searched for scholarships so she would not incur a lot of debt. She mentioned that she was not aware of specialized programs that benefitted African American women in STEM, specifically as she described having a hard time financially obtaining funds for her education due to her bad credit and low income. Nikki stated:

> I was not aware of any federal scholarship programs available to African American women in STEM. One of my goals was to complete my education with little to no student loan debt. I received some financial aid and I paid a little out of pocket each month. I thought that if I had a lot of out-of-pocket expenses I would have to say no to enrolling in classes. So, when I saw the scholarship email from my advisor, I applied for the scholarship, put in a couple of my stories a little bit here and there, and prayed I received a scholarship.

Debra shared her experiences of receiving financial support from her community through a program called Trio, established for socioeconomically disadvantaged communities. She expressed that her university had specialized programs for African Americans as a whole, not generally for African American women. Debra recommended that her university disclose federal programs created for African American women and partner with industry to collectively create scholarships for African American women in STEM. Debra concluded that although she welcomed the financial assistance provided by

her community, there was a stigma attached that you were poor or some charity case because of your upbringing or current situation. Nikki stated the following:

> So, you have to understand what the treatment programs are and what it's like being in a program for disadvantaged communities. They basically supply support for those who are disadvantaged and struggling in their coursework. They provide help in tutoring and things like that. You take what you can get but there's this self-consciousness thing you get for accepting it.

Chapter Summary

Chapter 4 synthesized the data collected in Chapter 3 and provided the results of the study. An interpretive phenomenological analysis was used to provide detailed understandings of the lived experiences of eight African American women as they recalled their sense-making in their undergraduate STEM degree programs. It produced a detailed account of each participant in turn, before moving to more common assertions. The IPA analysis was helpful due to the painstaking attention to detail that it allows the participants to recall the meaning-making of their experiences. The data captured were analyzed against this study's research questions and found a shared connection between the experiences of the participants that contributed to their persistence and attainment in their undergraduate STEM degree programs. The data reflected emotion-laden, ambiguous, and complex experiences, which were identified as both motivations to persist, as well as hindrances that required mentors and/or support groups that encourage the participants.

Chapter 5: Discussion

The purpose of this phenomenological study was to provide an understanding of the lived experiences of eight African American women who were either beginning their senior year of college or were recent graduates with a bachelor's degree from a STEM degree program. In addition, this study illustrated the everyday challenges of being an African American woman as well as an African American woman in STEM where such women represent less than 3% of the STEM industry. The sample population consisted of eight African American women, seven of whom had recently graduated with a bachelor's degree in an undergraduate STEM degree program within the past 3 years. An analysis of the data revealed five themes: (a) Living in my skin and bringing emotions in the STEM program; (b) Persistence despite family context: Understanding family makeup and its role in sustaining motivation to remain in STEM; (c) Expectations and misconceptions in the academic environment; (d) Support mechanisms while in the STEM program; and (e) Identifying needs for the sameness of professors and financial resources to support African American women in STEM. In this final chapter, the researcher discusses the key findings of this interpretative phenomenological analysis study and offers some transparency to the significance of this study.

In essence, the researcher highlights the importance of how disproportionately underrepresented African American women persist in STEM. This research may be used for future practices by K-12 administrators who create policies to engage African American female students in STEM curricula; higher education policymakers who want to improve the lived experiences of African American women in STEM; and legislative and industry leaders who are advocates for implementing STEM diversity policies to increase African American women in the STEM workforce. Lastly, this research was

intended to elevate the conversation of the lived experiences of African American women shared by the heightened expressions of the participants regarding the intersectionality of being both an African American woman and an African American woman in STEM.

Currently, there is a lack of research exploring the lived experiences of African American women in STEM and the causes for enrolling, persisting, or leaving undergraduate STEM degree programs. Furthermore, the literature fails to weigh in the sense-making by which African American women give meaning to their collective experiences during their undergraduate STEM degree journey (Blackburn, 2017). African American women in this research study expressed that their unique experiences while enrolled in their undergraduate STEM degree journey were shaped by their social, interpersonal, familial, and academic interactions.

Based on the interviews conducted, the African American women acknowledged that they navigated social, interpersonal, academic, and familial experiences during their undergraduate STEM degree program as they persisted and attained their degrees despite intersectionality due to gender and race, microaggressions and being discounted in their academic environments. This contradicts the literature in chapter 2 regarding the social cognitive career theory as discussed by Fouad and Santana (2017, p. 27), which states "perceived racism may serve as a psychological barrier for people of color, whereas sexism can be a barrier for women. Women of color may encounter both racism and sexism as challenges to persistence." The African American women in the study conceded that they all struggled with math and science classes as early as middle school, and this contributed to their anxiety toward the misconceptions of being an African American female in STEM academic undergraduate courses. Furthermore, Lindsey-Dennis and Burns (2020) stated that "despite early interest in science and math, three-

fourths of women of color working in STEM field indicated that they were never identified or encouraged to pursue STEM studies, and 40% reported being actively discouraged" (p. 1). This was prevalent in the research as the participants identified their successes despite the many negative experiences that they endured at various points in their journey from their youth through their undergraduate STEM degree programs.

Kricorian et al. (2020), stated:

> Increasing representation of women and people of color in STEM fields can help increase diversity, creativity, and innovation in STEM . . . Several factors may influence participation of underrepresented students in STEM. These may include both intrinsic psychological factors and external environmental variables, such as their mentorship experiences and preferences, their academic mindsets, STEM attitudes, and family background characteristics. (p. 2)

Hill et al. (2010) identified that gender inequalities in the STEM industry are predominantly caused by socio-cultural behaviors and influences rather than a lack of ability or intelligence among women of color. Educators must understand that subjects, such as mathematics and science, are not culture-free. Farinde and Lewis (2012) stated, "Few researchers have examined how the dual presence of race and gender affect the educational experiences of these marginalized women. Rather, the issue of race and gender is often addressed in isolation" (p. 421).

Themes and Findings

In Chapter 4, there were five themes identified in the research study: (a) Living in my skin and bringing emotions in the STEM program; (b) Persistence despite family context: Understanding family make-up and its role in sustaining motivation to remain in STEM; (c) Expectations and misconceptions in the academic environment: (d) Support

mechanisms while in the STEM program; and (e) Identifying needs for the sameness of professors and financial resources to support African American women in STEM. The themes were generated by evaluating the participant's subjective lived experiences and meaning-making. The researcher analyzed the qualitative data in the interview transcripts to closely examine common topics, patterns of meaning, ideas, and behaviors that surfaced.

Living in My Skin and Bringing Emotions in the STEM Program

Farinde and Lewis (2012) identified that race and gender were societally characterized biases and hindrances within STEM fields. Institutional racism and inequalities still exist in some occupations that are predominantly White and male-oriented affording privileges that other races and genders do not receive. Moreover, African American women are treated at the opposite end of the spectrum and have been prejudged to be of lesser intelligence and ability when compared to other races and genders (Wilkins, 2016). Whether intentionally or unintentionally, these stigmas, perceptions, and prejudices toward African American women, both past and present, have caused countless African American women's contributions and capabilities in STEM to either be disregarded or discounted (Wilkins, 2016).

The African American women who participated in this study expressed that they experience stereotypes and racism daily within the larger society and from the African American community that portray them as homemakers, working as nurses or in service-oriented occupations, and not motivated in obtaining academic degrees. Ironically, the U.S. Department of Education, National Center for Education Statistics (2018) reported that African American women lead the United States as the highest demographic receiving bachelor's degrees. This is in addition to being the predominant breadwinners

in their households. Tamara described her days as long and exhausting after working 9-10 hours a day, providing for her children and maintaining her home, while working, and achieving her goals of obtaining a STEM undergraduate degree. Tamara stated:

> I picked my son up, then took him to soccer, studied, feed him dinner, and depending on the class, or specifically like chemistry classes, we would then leave soccer, eat dinner and then we would spend as long as it would take me to finish my homework and research in the library, and then we would go home. This was a daily thing as I got my degree as continued into the master's degree I started this year.

Meanwhile, Brianna shared her lived experiences of being an African American in society and the mental anguish it caused her. Brianna stated:

> I just kind of had to have tunnel vision, so that stuff wouldn't bother me because if you think about it you're just like kind of blocked up and so worried about racism that that alone will make you angry and crazy. I still process everything because most of the times I treat this other headspace so I can at least get through the day. My subconscious knows what's going on, but my consciousness don't want to get there until I'm home alone.

Debra expressed her meaning-making of society and the African American community by sharing her experiences of being an individual who is different. She said that her environments should be more open and inclined to accept the lived experiences of what she and other African American women go through on a daily basis. Debra stated:

> I feel that people look at African American women coming out of the African American community as if we are based on our parents' lack of education, jobs,

> or the socioeconomic experiences that they went through. Society has kind of figured out or mapped out their opinions and expectations of African American women and our whole life experiences. I feel like they just need to be more open - minded rather than think that I don't have what it takes to be a good or even great scientist.

The participants collectively expressed that it is hard being an African American woman today as they shared the experiences of their mothers, grandmothers, and aunts from previous decades, who were under different conditions. It was shared that in today's society and within their own communities one would not think that they would be experiencing the same discriminations, marginalization, and objectification in the year 2021.

Persistence Despite Family Context: Understanding Family Make-up and its Role in Sustaining Motivation to Remain in STEM

African American women displayed success during their journey in the undergraduate STEM degree programs despite their traditional familial and community upbringing. Their lack of support by family was used as a motivational mechanism to achieve their STEM undergraduate degrees. Butler-Sweet (2017, p. 372) identified that family dynamics and socioeconomic status were influences on the experiences of African American women in their undergraduate STEM degree programs. African American women students who came from two-parent, middle-class households were treated differently by professors than students who were in a single-parent, blue-collar or low-income household. The expressed experiences of the participants of the study revealed similar associations between their familial and socioeconomic status with the perceived treatment by their undergraduate STEM degree professors. It was discovered during the

data analysis of the participant's transcripts that the support received from middle-income parents and coping with low-income single-parent households was their first introduction to persistence in their STEM learning environments. During this time, parents were either discouraging their choices in degree programs or did not know what STEM was.

Debra stated,

> When you're trying to pursue something and you don't necessarily have all the support that you need to keep going, you have to keep a positive mindset focus on it and so on. My mother was not happy that I chose a historically black college. I think that my mom, she doesn't know how to have a relationship with children. I hate to say it, but I feel like she doesn't have any maternal instincts to an extent. My dad didn't have a good childhood, he was raised neglectfully. So, I felt like they put that on their children to the point where now their children are kind of mirroring our feelings similar to those experiences that they had. My parents don't get me. They don't know how to give because they were never given to themselves.

Meanwhile Brianna went on to state:

> Both of my parents served in the military and I was not given any of their GI Bill money for college or access to any military dependent scholarships. They were never concerned about what I wanted to do and how I was to get there. It was more so, if you want to pursue this dream of yours, or if you want to continue with getting an education, you have to figure it out and how you are going to pay for it because they weren't going to help. They never used the money for themselves either. So that's kind of where I was at as far as family support.

Tamara felt that her parents were encouraging but could not relate to what she

was going through as an African American female in a STEM undergraduate degree program. Tamara stated:

> They helped me as far as living and as far as just general support you know, congratulating me if I was doing research or coming up to see our research posters. But that's kind of where they were. Neither one of my parents knew anything about STEM. My father is a nurse and my mother was a correctional officer.

Nikki shared that coming from a strong traditional African family caused her to struggle with disappointment from her family because of her choice to move to a foreign country as well as to enroll in a STEM degree program. The expectations of her family were for her to study in her home country in banking or finance rather than the STEM field. Nikki stated:

> My parents did not understand what I was doing. I was always helping my father with his cell phone because he did not understand technology. I've always liked technology since I was a child. I've always had this connection with computers and cell phones so I had to pursue my dreams, not what they wanted me to do.

The meaning-making of some of the participants during this theme reflected the importance of family support as well as their role in the family. Some participants felt that their place in the family was based on parent's lack of responsibility and emotional attachment, while others stated feelings of disappointment in their choices due to their parents' lack of education and understanding their passions and goals. In the end, the participants felt that receiving their degrees were defining moments in their lives.

Expectations and Misconceptions in the Academic Environment

Alfred et al. (2019) reflected that regardless of the STEM degree chosen, African

American women and women of color in college STEM programs and within the STEM industry feel alienated and isolated due to the lack of sameness in peers as well as sameness in professors. Academically, participants shared that they felt alienated in their academic environment when they asked for clarity or further instructions from their bioscience and math professors. The participants further detailed that not only did they not do well in science and math, but they also actually had anxiety and fear in those courses as they struggled to get passing grades or had to retake them. Clements and Sarama (2016) shared that preschool children possess a very broad and complex skill to learn high quality academics in math and science. But, if this education does not begin in preschool the student's potential may not be ascertained due to a lack of interest and an inevitable trajectory of failure in future science and math courses (p, 77-78).

Jasmine, although she felt she was not treated any differently than other students, said that the expectations of her professor made her feel like she had to prove she belonged in the course. Jasmine stated, "I hated physics. I still do. It is the only C I ever received in a class. I took it over again and was still only able to earn a B."

Claudia described similar experiences in her academic environment with the exception of perceived microaggressions from professors who were from other countries. When asked what she struggled with as well as the support she received from her professors, Claudia shared:

> I would have to say chemistry and math, I hate math and comprehending research articles in chemistry. The professors I had for classes like biochem 101, science, and math were not the same race as me. Both academically and socially I was told to join what we called the "chosen" student's group. Those professors seemed to have lower expectations of me than the African American professors I had and

expected me to try harder or read more. As if I was lazy or not applying myself.

Debra stated that she loved biomedicine and learning how the body worked so she gravitated toward that STEM degree program. She went on to state that being a little naïve to being isolated and being treated differently because of her upbringing taught her that everyone is alike. So, how could she be treated differently just because her skin color and gender were not the same? As she matured during her collegiate journey, Debra realized that not everyone was treated equal. Debra experienced first-hand a double bind (Dortch & Patel, 2017, p. 202) based on her racial demographics (e.g., African American) and gender (e.g., female). Debra expressed,

> I struggled with comprehension all of my life due to a disability. If I couldn't comprehend what questions were being asked, then my written response was not going to be sufficient enough. Due to the pandemic, I was doing my work from home and it was perceived by my professors differently than other students. My professor made me feel paranoid because I still got my work done on time and sometimes early. If my class started at 8 a.m., I got prepared at 5 a.m. I always felt like I have to prove myself to my professor and show that I'm trying harder than everyone else, even though I'm performing. I was seen as being lazy.

Brianna shared the same experiences as Debra. Brianna expressed betrayal of the teacher-student relationship as she described being cast aside by one of her STEM professors. Brianna stated:

> Some of the professors gave me a hard time. One woman professor displayed she didn't like me and shot down all of my research ideas and was aggressive toward me all the time. I was working with another STEM professor on research and things were going well. I was surprised to be told by this professor that

> biomedicine was not for me and he stopped researching with me. I am an African American woman with a documented disability that affects my comprehension sometimes, but I did well in college. Rather than suggest support mechanisms available, he told me to change my major because I didn't get it and he wanted to focus on his research. I know I need professional help but I thought college was supposed to be a haven for me and other African American female students. Especially those with disabilities.

As a nontraditional student, Tamara always felt out of place and disassociated with her professors and younger students. Tamara shared:

> White professors at my school treated me like I should quit and go back home because financially I did not have the money or the support for school like they did. I was also told that college wasn't for everyone.

The participants identified that they faced perceived microaggressions in their academic environments as African American women in STEM. They felt isolated and ignored while interacting with professors and their peers. Nevertheless, even those who struggled in the STEM courses all proved that their intellect, diligence, and tenacity enabled them to finish their journey. They all reflected that in order to get to where they wanted to be in life, they had to step outside their comfort zone and go through their personal trials and tribulations. The participant's in the study showed an undying commitment to their personal goals as they looked beyond the perceived instructor stereotypes and biases. However, the same challenges and insensitivities experienced from some STEM professors have sometimes evoked an emotional distress that undermined the outcomes of many other African American women pursuing undergraduate STEM degrees (McGee & Bentley, 2017, p. 265).

Identifying Needs for the Sameness of Professors and Financial Resources to Support African American Women in STEM

Blackburn (2017) expressed that women mentors reinforce young women's mathematics outlooks and self-concepts while enhancing women's abilities to think about STEM fields as career aspirations. Meanwhile, African American women professors and role models in STEM classes were recognized by the participants as those who shared their same lived experiences in society and STEM. Identify-safety cue is described as only those share the same racial identity and gender with African American women in STEM and who are seen as allies and value their success in STEM (Johnson et al., 2019). Having a representation of African American women professors and mentors and access to resources such as funding to pay for college were identified by participants in this study as very important to the retention and recruitment of future African American women in STEM. Brianna expressed:

> I think that there should be more African American professors in STEM. It would help to increase the number of African American female students enrolling and staying in STEM programs. Nobody knows how black women feel and it kind of, takes a toll on me mentally; It does. But I got my degree despite not having women professors. I would have felt better having someone who looked like me teaching my classes and understanding what I go through. It's hard being an African American woman in general and society's expectations are low of us attaining a certain level academically or in industry.

Maya described her experiences with her predominantly White male professor-led courses as challenging being in a classroom with all White male students. Maya stated:

> African American females were pretty much ignored, and I felt isolated in the

> STEM classes even though I did better than most of the White males in my class. Not having a mentor in the classroom who looked like me and feeling isolated in my STEM classes felt like it was going to kind of be a challenge because I know things are a lot easier when there's something or somebody who has something in common with you and who you can go to and ask questions.

Tamara, who had an African American female mentor teach one of her STEM classes, had a different experience than Brianna and Maya. Tamara shared:

> For my undergraduate degree program, it made me more comfortable to have an African American female professor because I felt like they can relate to some of the stuff that I went through or some of the stuff that I struggle with. I know my mentor, although she wasn't a single mother, she was a mother who also went to school while having to take care of children. So, she was more relatable to me than White professors or professors who weren't black.

Jasmine, meanwhile, shared that she was motivated to attaining her degree and reaching her dream of being in the STEM industry despite not having an African American woman professor at any point in her STEM program. Jasmine stated:

> I would certainly like to see more African American female instructors at my university. During my time there, I did not have a single African American instructor. There were not many African American women in relationship to the overall population of the school. Most of my instructors were either of Indian descent or white men. About 20% were women instructors.

The majority of the participants identified financial hardships and the lack of knowing what funding resources were available to them as mental stressors. Some participants identified that they were not told of financial resources available to African

Americans in STEM. If they were notified, it was only because their university was not a financial resource according to the federal government. It seemed as if the programs were in place for those who did not need financial help. Claudia shared:

> There were grants available and scholarships if you qualified. According to the government, my parents made too much money for me to get scholarships. They really didn't make that much money but somehow, I was excluded while there were students who were from wealthy families who got scholarships, room and board and the best dorms. I was never informed of financial aid or scholarship programs specifically designed to increase the number of African American women in STEM.

Tamara, unemployed off and on during her undergraduate degree program, did not want to take on the burden of student loans, especially as a single parent already overwhelmed by her financial hardships. Tamara shared:

> Near graduation, I didn't have enough money to graduate. The STEM Department collected money from faculty to pay for the rest of my bill so that I could graduate. I don't think my institution participated in federally funded programs to support African American women such as affirmative action or the National Science Foundation Scholarship for Underrepresented Minority Women. I think those programs would be helpful, so that people know that there's another option for funding your education.

Debra, similar to Claudia and Tamara, identified a financial need to support her tuition and textbooks. Debra was a walk-on college athlete who had no means of support to accommodate her expenses during her STEM undergraduate degree program. Debra stated:

> I was on the collegiate track team but didn't get a scholarship. I was a walk-on. I didn't really know how to apply for academic scholarships so I just applied for financial aid and student loans. I thought what I was receiving was enough so I didn't really look any further. I wasn't really experienced or mature enough to figure out how to actually get free funding.

Brianna had similar aspirations as Debra, to receive an athletic scholarship to pay for college. Brianna's parents declined to offer any financial assistance toward her goals. Brianna shared:

> I was one of those kids that was hoping to get a scholarship to play softball and then move on, so I wasn't really thinking about like you know academic or financial resources. I only thought about playing sports. My university offered many scholarships but they were generalized, not specifically geared toward African American women in STEM. The STEM and Journal club helped me to research and apply for scholarship money as well. I used my skills as an athlete to get what little financial resources and support that I needed.

All participants identified a need for academic institutions to make STEM academic financial support mechanisms known to all students rather than just to students who excelled at STEM, had wealthy parents, or those who some professors thought could enhance their research. Some hoped that their athletic skills would allow them to be accepted to their university. Although they did not receive student-athlete scholarships, these students were committed to finding financial support on their own to achieve their dreams of graduating college.

The significance of this study is that the lived experiences of eight African American women in undergraduate STEM degree programs affect their acceptance,

belonging, and struggles to persist in their STEM academic settings. The study captured the meaning-making of hinderances, which were used as motivational methods by the African American women to obtain their STEM degrees. Their feelings of isolation, disrespect, and implications of lower intellectual capabilities expressed during the study could have an association with their small representation (only 2.9%) in STEM undergraduate degree programs. The African American women in this study identified that the most important stressors affecting their attainment in the STEM degree programs were: (a) mental stress, (b) financial hardships, (c) being an African American woman in society as well as being an African American woman in STEM academics, (d) the lack of African American women professors and mentors during their journey, and (e) absence of strong support mechanisms. These needs were described as the tipping point between persisting in their undergraduate STEM degree programs, changing majors, or dropping out of school altogether.

The participants of this study shared that even though they felt isolated and suppressed in their STEM academic environment, they held their own when compared with the White male students in the classroom. Some even stated they were in the top-tier academically in their programs. Each participant shared that the study enabled them to appreciate their accomplishment after enduring such a turbulent journey. Overall, the study was seen as a much-needed release of emotional anguish that the participants had not felt comfortable sharing previously. The consensus was that they could not speak of the mental strain they experienced due to the beliefs of the African American community that nothing is wrong other than a stronger commitment to try harder. However, during the study the eight participants expressed their comfort with speaking freely about sensitive experiences because they felt respected, heard, and genuinely cared about. The

participants expressed that they were inspired during the study that someone took the time to listen to what they had to say. It was recommended by the participants that the study should be continued every year as a part of an exit program of some sort to evaluate how institutions are meeting the needs of African American women in undergraduate STEM degree programs. The findings of this research may be used by individuals who are in higher education administration, the STEM industry, and government agencies to create policies, practices, and mechanisms to remove negative stimuli, which affect the experiences of African American women and their enrollment, retention, and attainment in undergraduate STEM degree programs.

Limitations

Due to COVID-19, there were challenges in getting a higher number of participants and their availability due to end-of-year finals and graduations. To counter this, the researcher conducted interviews via virtual web applications which also introduced new opportunities to question the validity of the study. Using live streaming videos there were background noises and connectivity latency due to interviewees' lack of technical skills using Zoom. The researcher proposed conducting interviews during low network peak times and when the interviewee had adequate time to become familiar with the web application as well as fewer distractions.

There were challenges due to the dynamics between the interviewer and interviewee's use of language and maturity. Creswell and Poth (2018) noted when using interview protocols that, "…some forms lack visual communication, and most require individuals who are not hesitant to speak and share ideas or who are technology-savvy" (p. 164). There were limitations in conducting interviews due to some students acknowledging that the pandemic had caused them to lose track of days and time.

Participants had issues identifying what day they were in. The researcher also turned off the video recording due to the interviewees feeling moments of anxiety and under pressure because they identified themselves as introverts. Unexpected frustrations and passive aggressive emotions occurred in some of the interviewees due to the recall of their lived experiences during initial questioning and probing as discussed in previous literature (Creswell & Poth, 2018). Due to the participants having diverse intellects as well as various academic backgrounds and experiences, some participants were not as articulate as others, and the interviewer had to provide examples for some of the less mature interviewees. There were moments when it was hard to understand and interpret the interviewees when using audio recordings due to the pitch and tone of participants' voices and other noises such as televisions, cell phones, and individuals talking in the background. Further, the researcher refined the interview questions and procedures as the interview process continued due to some interviewees struggling to capture their thoughts, similar to the pilot testing that had been conducted (Creswell & Poth, 2018).

Recommendations

The researcher proposes several recommendations based on the heartfelt experiences described by the African American participants in the study. These recommendations could help higher education leadership, the STEM industry, and governmental agencies who write policies to better understand the needs of African American women in undergraduate STEM degree programs. The participants were encouraged that their voices may provide the necessary support and resources to increase enrollment and retention of African American women in undergraduate STEM degree programs. Firstly, the researcher recommends that higher education leadership and administrators assess their current policies and procedures regarding the recruitment and

retention of African American women's professorship as well as increasing the number of African American female students in undergraduate STEM programs. The lack of formal processes to include diversity, equity, and inclusion of this demographic of women has hindered the enrollment, retention, and diversity of African American women in STEM academics. Grubbs (2020) stated:

> My belief that the institutional and systemic racism so obvious to me would never be fully acknowledged, much less addressed. This belief was formed after several experiences that left me — a Black woman — feeling stifled, unheard, unvalidated, unsupported, and concerned for my health. (p. 1)

Secondly, institutions should incorporate annual diversity, equity, inclusion and emotional intelligence, and engagement training so that professors can better relate to the experiences and stereotypes hindering African American women in academia, society, and industry. The participants of this study are a microcosm of the world in which we live. They have many traits, traditions, and cultural beliefs that shape their lived experiences. Institutional leadership, as well as faculty, have an obligation to investigate, believe, confirm, and respond to discrimination and the suppression that African Americans face as microaggressions in the classroom in order to support their students (Grubbs, 2020; Paradies et al., 2015). Grubbs (2020) stated, "The fact that someone denies that a racially biased act wasn't intentional doesn't mean it didn't happen" (p. e25(1)-e26(2)).

Thirdly, it is recommended that institutions implement or evaluate existing mentorship and role model programs to include more professors and mentors who are of the same gender and ethnicity as African American women in undergraduate STEM degree programs. African American women in STEM have been shown to enroll and

persist in STEM when they are partnered with mentors and role models who understand their lived experiences and cultural beliefs (Kricorian et al., 2020). Each participant of this study stated that they would have benefitted more from having a mentor or role model who looked like them and who understood the experiences of African American women in STEM. Having someone who understood the mental anguish and hardships of being an African American in their communities and society was seen as valuable to their persistence in STEM.

Lastly, it is recommended that senior academic administrators, the STEM industry, and governmental agencies create policies that address mental health access due to the mental health struggles that the participants of the study stated they had experienced while in their STEM academic programs. Participants who identified the need for mental health relief stated that they did not feel comfortable showing their emotions or allowing their professors or peers to think that they were weak and could not handle their rigorous courses. The participants either held it in or broke down emotionally in a confined space at home. White (2019), a specialist in stress management, community-based intervention strategies, and mental health shared:

> Seeking mental health is often viewed as a weakness, running counter to the survivalist mentality born from systemic oppression and chronic racism. Much of the pushback against seeking treatment stems from ideas along the lines of: We have survived so much adversity and now someone is going to say that there's something wrong with us. (p. 2)

Participants in the study expressed that they were taught not to bring up anxiety or mental stress. They stated that they just dealt with whatever came up in their way, whether that be lashing out, crying alone in their rooms, or seeking refuge in faculty who

were senior citizens.

African American women are unique and bring many experiences and traits to the STEM industry. The participants of this study revealed that there is a level of stress that was caused by oppression, lower expectations, and disrespect by society and their communities, which extend to their contribution in STEM programs. Not providing the necessary resources that allow them to succeed will continue to widen the gap between African American women and other races and genders in STEM. Society and academia must end this trend of inequality and undervaluing of African American women. Not implementing policies and practices to increase the number of African American women could be detrimental to the STEM industry moving forward.

Future Research

The researcher highly recommends continuing further study on the lived experiences of African American women in undergraduate STEM degree programs. Currently, there is limited research in this area of concentration. The expressed desires of the participants of this study identified that more studies of this kind are needed to understand their experiences, meaning-making, and resources needed for their persistence and attainment in STEM academics and society. Specifically, there needs to be a better understanding of the mental anguish and its effects on African American women in STEM. The study found that when African American women were suppressed and ignored as they demonstrated intellectual skills and cultural experiences in their STEM environments, it made many of the participants consider dropping out of their programs. Furthermore, conducting research on the impact of having professors who are the same gender and race as African American women could provide invaluable data regarding enrollment, retention, and attainment in the STEM field.

Additionally, it is recommended to conduct research to see if there is an association among academics, the STEM industry, the larger U.S. societal norms and specifically within the African American community of traditional beliefs and the value of African American women in STEM. It is recommended to continue research to understand why this deep-rooted view of African American women in STEM still exists in academics and industry during an era when STEM professionals are highly sought, especially when African American women are a critical shortage in the industry. Finally, it is recommended that future research include a more expanded population of participants to include the experiences of African American women in undergraduate STEM degree programs in different localities across the United States.

Conclusion

Chapter 5 summarized the exhaustive study of the lived experiences of eight African American women in undergraduate STEM degree programs. This study served as a platform for the eight African American women who, through courage and trust, shared their lived experiences from childhood through their recent graduation from their respective undergraduate STEM degree programs. Their experiences and sense-making resonate with many African American women in STEM academics who preceded them and held their heads high after their academic journey. The findings in this research identified how eight determined African American women with differing backgrounds, but very similar life experiences, used inequalities, racism, and traumatic and emotional hardships while participating in STEM as motivational catalysts to attain their undergraduate degrees.

The implications of this research and understanding the challenges and obstacles that African American women in STEM face daily could allow senior academic

administrators, industry, and those who are governmental policymakers to create policies, procedures, and programs that make the enrollment and retention of African American women in STEM a national priority. Implementing transformational practices such as (a) increasing funding for the marketing and recruitment of African American female students in STEM; (b) increasing sameness of African American women professors and mentors in STEM courses; and (c) providing mental health and wellness support mechanisms, necessary measures that could address the critical shortage of African American women in STEM.

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Appendix

Semi-Structured Interview Protocol

Time of Interview:

Date:

Interviewer:

Interviewee:

Hello [participant]. I appreciate your willingness to participate in this study. As you know, I am researching to obtain an understanding of the lived experiences of African American women such as yourself, who are currently in or graduated from an undergraduate science, technology, engineering, and math (STEM) degree program. My goal is to describe the factors that influence African American women's decisions for enrollment/non-enrollment, their persistence, social interactions, and retention/non-retention in the field. I have invited you to participate in this study because I believe your responses and feedback could prove to be valuable to this understanding. Interviews are scheduled to last approximately 1 hour. In the case that we risk running overtime, we can coordinate a follow-up interview via [zoom] at a day and time of your convenience. Keeping this in mind, please let me know if you are or become uncomfortable with any aspect of this interview process. I may pose a question that triggers an emotional recall of an experience, or one that takes additional time to discuss. If necessary, we can move on to the next question. As discussed, and in accord with your consent, your confidentiality will be respected and assured during and after the interview process. Thank you again for participating.

To ensure that my questions for you stay organized, I have categorized them under thematic motifs. These motifs are prominent in the literature that I have reviewed regarding studies of this type. They are as follows: (a) African American women's introduction to STEM, (b) familial influences, (c) institutional environment's acceptance and support mechanisms, (d) programs to recruit African American women in STEM, (e) community, and cultural influences. However, let's begin with some personal demographic information.

SECTION 1: PERSONAL DEMOGRAPHIC INFORMATION

1. What is your current age?
2. Name and describe your hometown and state? Are there any prominent STEM businesses or jobs that you are aware of in this area?
3. Could you describe any African American women you knew in STEM?
4. Describe a typical day in your STEM undergraduate academic life.

SECTION 2: AFRICAN AMERICAN WOMEN'S ACADEMIC, SOCIAL, AND INTERPERSONAL EXPERIENCES IN STEM UNDERGRADUATE PROGRAMS

1. Describe how you became aware of STEM education and careers?
2. How would you describe the overall demographics and experiences you had with

your instructors in the STEM undergraduate program?
3. Describe any academic skills or knowledge that you have or lacked for entry into STEM (e.g., advanced classes in math, science, chemistry, or technology in K-12 or outside of school time programs).

SECTION 3: AFRICAN AMERICAN FEMALE EXPERIENCES AS THEY PERSISTED IN THEIR STEM UNDERGRADUATE COURSES

1. Describe any familial support or encouragement that helped you persist in the STEM undergraduate program.
2. Describe any institutional experiences that enabled you to persist in the STEM undergraduate program (e.g., scholarships, tutors, mentoring programs, STEM outreach programs, academic/career advisors).
3. Describe any relationships you had with role models or peers that enabled you to persist in the undergraduate STEM program.
4. Please express the impact, if any, of having faculty and mentors who had the sameness as you. How did this affect your persistence in the STEM undergraduate program?
5. What courses or clubs would you recommend African American girls in K-12 participate in to enhance their chances to persist in STEM undergraduate degree programs?

SECTION 4: SUCCESSES AND CHALLENGES AFRICAN AMERICAN FEMALES FACE IN A STEM UNDERGRADUATE PROGRAMS

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1. How would you describe the atmosphere and culture toward African American women in the STEM undergraduate program you are/were in?
2. Would you encourage African American women to pursue a STEM undergraduate degree program? Why or why not?
3. Describe any experiences regarding differences of treatment between African American women and their peers in the STEM learning environment.
4. Describe what success or challenges within your STEM courses impacted your ability to persist in a STEM undergraduate program?
5. Explain your workload in the STEM courses compared to other courses in your degree program. Did this affect your enrollment or retention in future STEM courses or the program?

SECTION 5: ADVICE AND/OR RECOMMENDATIONS THAT AFRICAN AMERICAN FEMALES PROVIDE TO FACULTY AND PROGRAM ADMINISTRATORS

1. Describe what mechanisms you would recommend that faculty or program administrators implement to encourage African American females to enroll or stay in STEM undergraduate programs at your university.
2. Explain your thoughts regarding your institution applying for federally funded programs such as affirmative action or the National Science Foundation Scholarship for Underrepresented Minority Women to increase their budget for

marketing and enrollment of African American women in STEM?

3. Could you describe any recommendations for any specialized outreach programs or partnerships with the STEM industry to enhance the persistence of African American females in the STEM undergraduate programs at your institution? Why would they be good or bad?
4. Describe any recommendations for mentoring programs regarding African American women in STEM at your institution.
5. Please describe any recommendations to institutional administrators regarding the demographics of instructors who teach STEM courses at your institution (e.g., ethnicity and gender).
6. Is there anything else that you would like to share with me?