THE FIRST-YEAR EXPERIENCES OF AFRICAN AMERICAN WOMEN IN ENGINEERING AND COMPUTER SCIENCE MAJORS

by

Tiffany Mary Ann Wilson

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Approved by:

_____
Dr. Cathy D. Howell

_____
Dr. Mark D'Amico

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Dr. Jae Hoon Lim

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Dr. Harish Cherukuri

ABSTRACT

TIFFANY MARY ANN WILSON. The First-Year Experiences of African American Women in Engineering and Computer Science Majors. (Under the direction of Dr. CATHY D. HOWELL and Dr. MARK D'AMICO)

National efforts have been made to increase STEM participation among racially marginalized individuals (Ro & Loya, 2015). However, women, especially African American women, remain underrepresented in STEM fields, particularly in engineering and computer science disciplines. The purpose of this basic interpretive qualitative study was to understand the first-year experiences of African American women in engineering and computer science majors at a predominantly White institution (PWI). This study was guided by Strayhorn's (2019) model of college students' sense of belonging. Semi-structured interviews were used to gather in-depth insights into the participants' experiences. The sample consisted of 8 African American women at a PWI in the Southeastern part of the United States. A thematic analysis approach was used for this study. Four major themes were identified: (1) intentionality in decision-making processes: identification of early experiences for STEM access, (2) messaging: parental "college-going expectations" vs. family "STEM major selection" influence, (3) psychosocial influencers of belonging in STEM, and (4) interpersonal agency toward socialization and engagement in STEM majors. The findings of this study provided insights into the unique challenges African American women face in their first year in engineering and computer science majors. The findings of this study suggest that institutions can significantly improve the experiences of African American women in STEM by implementing targeted strategies that address their unique challenges.

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DEDICATION

This dissertation is dedicated to my mother, Gina Wilson. From a young age, you instilled in me the value of education and always stood by my side, supporting my dreams. Your unwavering strength, encouragement, and wisdom have been the guiding force in my life. I would not be the woman I am today without your love and sacrifices. For all you have done and continue to do, I am forever grateful and blessed to call you my mother. I love you so much.

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LIST OF ABBREVIATIONS

HBCU	Historically Black Colleges and Universities
PWI	Predominately White Institution
STEM	Science, Technology, Engineering and Mathematics
URM	Underrepresented Minority

CHAPTER 1: INTRODUCTION

Introduction

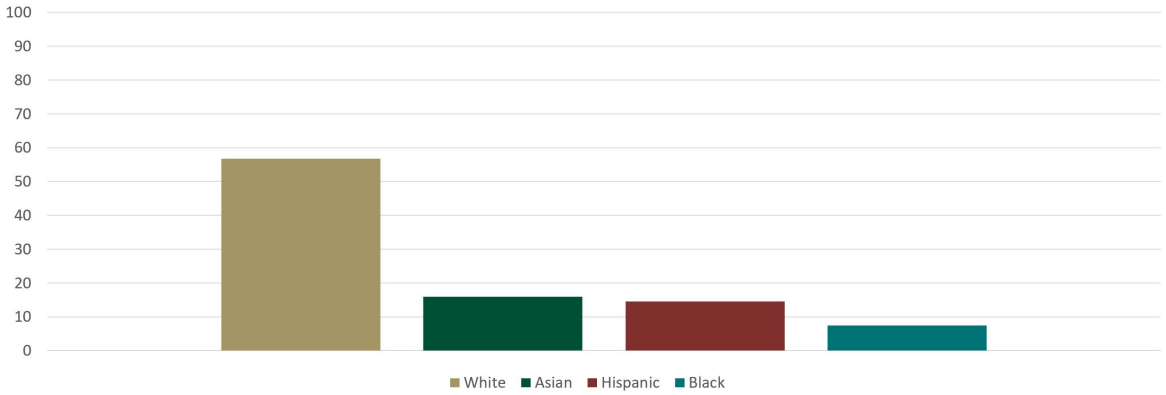
The underrepresentation of women, particularly African American women, in science, technology, engineering, and mathematics (STEM) fields is a major issue across the United States. Racially minoritized students make up 30% of the overall population in the United States, and only a small proportion of them earn STEM undergraduate degrees (Bottia et al., 2021). African Americans, specifically, comprise 12.1% of the United States population (U.S. Census Bureau, 2021). To further contextualize the scope of the problem, from 2021 to 2022, the percentage of STEM bachelor's degrees awarded by race/ethnicity was 56.8% White, 7.5% Black, 14.6% Hispanic, and 16% Asian (Figure 1, National Center for Education Statistics [NCES], 2023b). The National Science Foundation [NSF] (2021) contends that capable talent is underutilized due to the lower representation of some demographic groups. Early education preparation and workforce demands are key concerns in exploring the scant domestic diversification in STEM disciplines.

STEM Workforce and Economic Demands

National efforts have been made to increase STEM participation among racially minoritized people to keep up with the STEM workforce demands in the United States (Ro & Loya, 2015). In 2019, the STEM workforce represented 23% of the total U.S. workforce (NSF, 2021). A substantial portion of the U.S. workforce depends upon well-trained STEM workers. Technological advancements have played a vital role in the United States' growth, and engineering has been at the forefront of these advancements (Thursby, 2014). Engineering is critical to the success of industrial innovation in the United States. Students with engineering

Figure 1

Percentage Distribution of STEM Bachelor's Degrees Conferred to U.S. Citizens and Permanent Residents: Academic Year 2021-2022



Note. National Center for Education Statistics. (2023). Table 318.45. Number and percentage distribution of science, technology, engineering, and mathematics (STEM) degrees/certificates conferred by postsecondary institutions, by race/ethnicity, level of degree/certificate, and sex of student: Academic years 2012–13 through 2021–22 [Data table]. In the Digest of Education Statistics. U.S. Department of Education, Institute of Education Sciences.

degrees can pursue industries such as manufacturing, construction and design, research, and healthcare. Computer science is one of the fastest-growing professions in the United States; however, the demand for professionals is outpacing graduates in the field (Ross et al., 2020). These industries are essential to the continued growth and prosperity of American society.

The United States remains an undisputed leader in applied research and innovation, with approximately six percent of the global population producing more than 20% of doctoral degrees in science and engineering (National Academy of Sciences [NAS], 2007). However, the minimization of gendered and racialized perspectives in STEM majors threatens to weaken national and global competitiveness. The United States continues to have difficulty achieving a diverse STEM workforce due to the failure to maintain underrepresented minorities (URM) in the academic pipeline (Estrada et al., 2016). The lack of a diversified STEM workforce limits innovation and technological opportunities. The low enrollment and retention of students

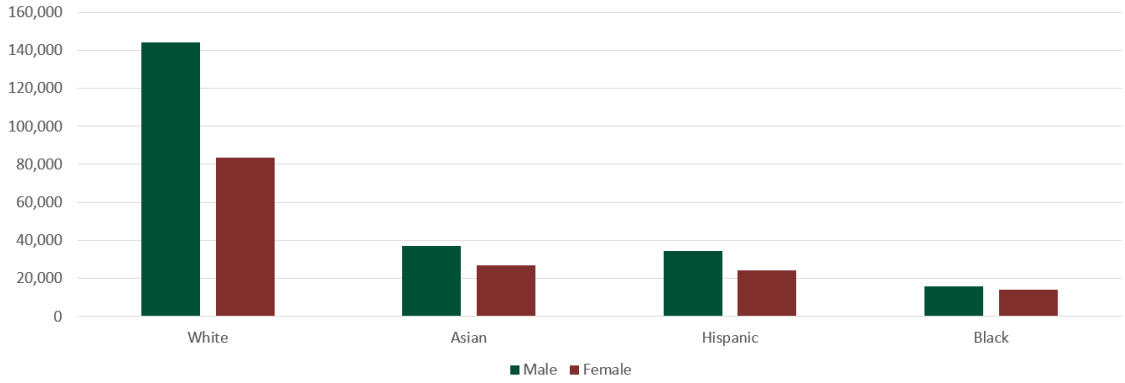
graduating with baccalaureate degrees in STEM majors have been associated with a reduction in competitiveness within the workforce in the United States (Witteveen & Attewell, 2020). For example, Morrison et al. (2011) reported an estimated 600,000 technical positions in manufacturing remained unfilled due to the shortage of skilled STEM candidates. This contributes to "offshoring" or a dependency on a non-domestic STEM workforce that is cause for concern to protect the national workforce (NAS, 2007). Efforts to begin understanding the academic pipeline must first begin with early educational preparation.

Representation of African American Women in Higher Education

According to the NCES (2024), the percentage of bachelor's degrees conferred by males in 2021-2022 was 61.0% White, 8.8% Black, 15.6% Hispanic, and 9.7% Asian. Additionally, bachelor's degrees conferred by females in 2021-2022 were 57.3% White, 11.5% Black, 17.9% Hispanic, and 8.3% Asian (NCES, 2024). For the 2021-2022 academic year, the number of STEM bachelor's degrees awarded by race/ethnicity and gender was White males received 144,295, the majority of STEM bachelor's degrees, followed by 83,457 White females; 15, 807 Black males; 14,110 Black females; 34,465 Hispanic males, 24,151 Hispanic females; 37,245 Asian males, and 27,044 Asian females (Figure 2, NCES, 2023b). These data begin to demonstrate that although progress has been made, African American women still face significant challenges with persistence and degree completion.

Figure 2

Number of STEM Bachelor's Degrees Conferred to U.S. Citizens, Permanent Residents, and Nonresidents: Academic Year 2021-2022



Note. National Center for Education Statistics. (2023). Table 318.45. Number and percentage distribution of science, technology, engineering, and mathematics (STEM) degrees/certificates conferred by postsecondary institutions, by race/ethnicity, level of degree/certificate, and sex of student: Academic years 2012–13 through 2021–22 [Data table]. In the Digest of Education Statistics. U.S. Department of Education, Institute of Education Sciences.

Previous studies have highlighted African American women's representation and success in higher education (Charleston, Adserias, et al., 2014; Porter et al., 2018; Winkle-Wagner, 2015). In higher education, student success is typically defined as degree attainment (Kuh et al., 2006). However, Winkle-Wagner (2015) conducted an interdisciplinary review to address the state of African American women's college success and found that the literature is limited by an emphasis on individual factors instead of institutional or larger sociostructural issues. African American students' definition of success can impact how they navigate college (Porter et al., 2018). For example, Porter et al. (2018) identified that African American women's definition of success included accomplishing their short-term and long-term academic goals. Additionally, Charleston, Adserias, et al. (2014) explored ways in which race and gender impact African American women's achievement in STEM educational goals and pursuits.

African American Women's Experiences and Campus Climate

Previous literature discussed African American women's experiences and campus climate (Dortch & Chirag, 2017; Fletcher et al., 2021; Lee Williams & Nicholas, 2012). African American women regularly encounter microaggressions around college campuses that are unique

to them being African American women (Lee Williams & Nicholas, 2012). Microaggressions are defined as “brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults toward people of color” (Sue et al., 2007, p. 271). Dortch and Chirag (2017) discussed the effects of racial and gendered microaggressions on African American women in STEM. Additionally, Fletcher et al. (2021) discussed how there had been a slight decrease in the number of African American women completing engineering degrees due to factors such as a lack of mentors, stereotype threats, and lack of belonging. Charleston, George, et al. (2014) found several themes related to African American women's experiences in computing science, such as facing the unique challenges of being an African American woman in computer science, feelings of isolation, and making personal sacrifices to pursue a career in computing.

Campus climate has the ability to shape students' experiences, especially within the first year of college. Early research by Hurtado et al. (1999) suggested that campus climate could be improved by understanding the perspectives of students from different racial and ethnic backgrounds. This study focuses on campus climate as a whole, not just within the context of the engineering and computer science academic programs. Academic programs have some STEM courses, but not all first-year courses are STEM-specific. For example, a student could enroll as a first-year student in classes such as calculus, liberal studies, or general studies that are not specific to engineering or computer science. A limitation of engineering and computer science academic programs is the mistaken notion that the entirety of the curriculum is singularly focused on engineering or computer science courses during the first year. The reality is that first-year students may only enroll in one engineering or computer science course; thus, that is a limitation and does not provide a sufficient scope of what I am studying holistically. When first-

year engineering and computer science students will not begin to enroll in core disciplines classes until their sophomore year. These students are engaging with the larger institutional campus through tutoring support or other academic support services. Therefore, the inclusion of institutional campus climate is salient to understanding engineering and computer science academic climate.

STEM Pipeline and Early Educational Preparation

According to Russell and Atwater (2005), students must show competency in mathematics and science to navigate the STEM pipeline from high school to college successfully. Early success in mathematics and science has been correlated with students wanting to major in STEM (Thompson, 2021) and matriculation in STEM majors (Bottia et al., 2021; Maltese & Tai, 2011). Students from culturally diverse backgrounds, such as African American students and other underrepresented students of color, have historically lacked adequate STEM preparation (Bottia et al., 2021; Museus et al., 2011; Young et al., 2019). Inadequate pre-college STEM preparation can negatively impact graduation outcomes for African American women. Inadequate STEM preparation for racially minoritized students can be attributed to a lack of school resources, less qualified instructors, and a lack of rigor within the curriculum (Bottia et al., 2021). Racially minoritized students may face additional challenges due to the limited access to high-quality STEM education prior to attending college. This can also make them feel less confident in their ability to succeed in STEM courses.

Discussions of academic preparation in STEM majors invariably connect to the metaphorical STEM pipeline. According to Allen-Ramdial and Campbell (2014), the STEM pipeline refers to “how trainees advance through the scientific education and training process, with success measured by movement from the pre-college levels to more advanced postgraduate

levels" (p. 612). Prior studies have associated the lack of minoritized students in STEM disciplines with the leaky pipeline.

The leaky STEM pipeline refers to the unintentional loss of individuals in STEM disciplines ranging from K-12 education, postsecondary education, and STEM career fields (Allen-Ramdial & Campbell, 2014; Witteveen & Attewell, 2020). Students can "leak out" from the STEM pipeline anywhere between K-12 and postsecondary education (Maltese & Tai, 2011; Witteveen & Attewell, 2020). Speer (2023) contended that women are "…lost from the STEM pipeline before college, during college, and after college" (p. 1). That contention aligns with studies that similarly position the loss of women in STEM disciplines as occurring at varying stages in their academic and career preparation (Ong et al., 2011).

Critics of the pipeline suggest that the metaphor is too linear or narrow and raises questions about who, when, and where the leaking out applies differently across disciplines (Cannady et al., 2014). Increasing African American student access to and participation in STEM can help diversify the STEM pipeline in the United States (Allen-Ramdial & Campbell, 2014; Young et al., 2019). Institutions should seek to understand how STEM pipeline barriers influence the success of URM students in STEM disciplines, specifically African American women in engineering and computer science majors.

African American Women's Participation in Engineering and Computer Science

According to Beasley and Fischer (2012), the number of people of color in STEM remains notably lower than their White counterparts. Higher education has made efforts to increase participation in engineering among African American students (Fletcher et al., 2021); however, African American women still face substantial challenges with degree attainment in engineering. For example, undergraduate enrollment for engineering programs increased in

2016; however, African American women comprised less than 1% of the undergraduate engineering student population (Richardson et al., 2020). African American women contend with being within the complex intersection of race and gender, but also within an educational system situated in whiteness and masculinity that may be "congruent or incongruent to their identities as a Black person, a woman and that of an engineer" (Ross et al., 2021, p. 93).

Additionally, efforts have not been successful in increasing the participation of African American women in computing (Ireland et al., 2018; Thomas et al., 2018; Yamaguchi & Burge, 2019). Only 1% of bachelor's degrees in computing were awarded to African American women in 2018 (Rankin & Thomas, 2020). In regard to gender comparison in computer science, women often perform just as well or better than male students in programming courses; however, they struggle more with a sense of belonging in computer science (Solomon et al., 2018). Essentially, the racial and gender challenges that African American women face impact their persistence and degree attainment in engineering and computer science. Broadly, "disaggregating STEM fields provides an analytical lens" to address the underrepresentation of women (Cheryan et al., 2017, p. 1).

First-Year Experience

Previous research studies have addressed the importance of first-year experiences in higher education (Battey et al., 2022; Everett, 2017; Lancaster & Xu, 2017; Montag et al., 2012; Walton & Cohen, 2011). Everett (2017) discussed the transition challenges for first-year students and how first-year experiences play a critical role in student success. Additionally, pre-calculus and calculus have been identified as gatekeeper courses in STEM majors (Battery et al., 2022), and gatekeeper courses can impact attrition in STEM majors. Other studies discussed the importance of academic advising on students' grades (Lancaster, 2017) and how academic

advising can be a barrier to African American students in STEM majors (Montag et al., 2012). Student support services play a critical role in student success and degree attainment. Also, social belonging among first-year racially minoritized students can improve long-term academic and health outcomes (Walton & Cohen, 2011). These factors can potentially impact the first-year experiences of African American women in higher education, especially in engineering and computer science majors.

Statement of the Problem

A considerable amount of research focuses on the experiences of underrepresented minorities in STEM (Estrada et al., 2016; Lisberg & Woods, 2018; Secules et al., 2018; Skvoretz et al., 2020). However, limited research primarily focuses on the first-year experiences of African American women in engineering and computer science majors. Research is needed to identify factors influencing student success for this student population. According to Tevis and Britton (2020), the first year of college is a difficult transition and can impact degree attainment for many students. Factors influencing first-year STEM students' overall performance can be difficult to identify because they are just starting their academic careers (Chambers et al., 2019). The first year is critical for engineering students since attrition typically occurs within the first two years (Fleming et al., 2005). Sense of belonging and intersectionality are critical components in understanding African American women's first-year experiences in engineering and computer science majors. Retention and graduation efforts may be enhanced when there is a better understanding of how African American women in engineering and computer science engage in first-year experiences. Therefore, the study will address African American women's first-year experiences in undergraduate engineering and computer science programs.

In summary, efforts have been made to increase STEM participation among racially minoritized groups. The STEM workforce has been critical to the success of American society. Specifically, engineering and computer science careers have been imperative to our society's continuous growth and innovation. Efforts have been made to increase participation among African American students in engineering and computer science; however, African American women continue to face challenges with degree completion. The first year of college can be difficult for many students and can impact their ability to complete their degree. Specifically, focusing on the first-year experiences of African American women in engineering and computer science is important to improve degree completion rates.

Purpose

Sense of belonging has been identified as a critical component of student success in higher education (Strayhorn, 2019). It is also considered essential for individuals who perceive themselves as being marginalized in mainstream society (Hurtado & Carter, 1997). Strayhorn (2019) contends that a sense of belonging is not only a critical basic human need, but the concept also contributes to our optimal functioning consciously and subconsciously by questioning how and in what ways are students matched or aligned to the campus and classroom environments. The purpose of this basic interpretive qualitative research study is to understand the first-year experiences of African American women in engineering and computer science majors at a predominantly White institution (PWI). This study specifically focuses on engineering and computer science majors and not the totality of STEM disciplines. Moreover, the study will help faculty, staff, and administrators identify important factors contributing to the success of African American women in engineering and computer science and contribute to the literature related to underrepresented minorities in engineering and computer science majors. Lastly, it will address

the gap in the literature associated with the first-year experiences of African American women in engineering and computer science majors.

Research Questions

The two research questions that will guide this dissertation study are:

1. What influences African American women's first-year academic major choices in engineering and computer science?
2. How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework?

Theoretical Framework Overview

In order to examine the first-year experiences of African American women in engineering, Strayhorn's (2019) model of college students' sense of belonging will be used as the theoretical framework. Seminal works have focused on college adjustment and student attrition research. For example, Vincent Tinto's Model of Institutional Departure identifies several key sources of student attrition such as academic performance, faculty and staff interactions, and peer interactions (Tinto, 1987). However, the model did not address student attrition among racially minoritized student populations. In later research, Strayhorn (2019) focused on conceptualizing sense of belonging for racially minoritized students and how it can affect if a student stays enrolled in post-secondary education. Strayhorn (2019) identified seven core elements of college students' sense of belonging:

1. Sense of belonging is a basic human need;
2. Sense of belonging is a fundamental motive, sufficient to drive human behavior;
3. Sense of belonging takes on heightened importance: (a) in certain contexts, (b)

at certain times, and (c) among certain populations;

4. Sense of belonging is related to, and seemingly a consequence of, mattering;
5. Social identities intersect and affect college students' sense of belonging;
6. Sense of belonging engenders other positive outcomes; and
7. Sense of belonging must be satisfied on a continual basis and likely changes as circumstances, conditions, and contexts change. (Strayhorn, 2019, p. 31- 39)

Strayhorn's model is an appropriate framework for this study because it explores how belonging impacts the first-year experiences of African American women in engineering majors. The interview protocol (see Appendix) aligns with Strayhorn's framework. Sense of belonging does not denote an underlying assumption or relationship with campus climate. Campus climate should not be denoted as an underlying assumption or relationship with sense of belonging.

Overview of Research Methodology

This study used a basic interpretive qualitative research design. This approach was appropriate because it allowed participants to share their first-hand experiences as African American women in engineering and computer science majors at a PWI. The study occurred at a predominantly White public research institution in the Southeastern part of the United States. The total enrollment at the institution for fall 2023 was approximately 30,000 students, including an estimated 23,000 undergraduate students.

Purposeful sampling was used for this study. Researchers selected this sampling strategy because it can inform the research problem and be central to the phenomenon in the study (Creswell, 2007). Eight participants who are engineering science, engineering technology, or computer science majors were selected for the study. Selected participants were academically classified as sophomores, juniors, or seniors.

The data collection method was in-depth semi-structured interviews. “In semi-structured interviews, the researcher uses the interview instrument to organize and guide the interview but can also include specific, tailored follow-up questions within and across interviews” (Ravitch & Carl, 2019, p. 134). The interview included open-ended questions and was grounded in theoretical questions. The interview was recorded, and a thematic analysis approach was used. A thematic analysis seeks to summarize, identify, and interpret key features in the data (Kiger & Varpio, 2020).

Significance of the Study

The gap in the literature about African American women in undergraduate engineering and computer science majors remains a concern. This study intends to expand the literature on first-year experiences of African American women in engineering and computer science at PWIs. Increasing this population’s retention and degree completion can assist with the STEM workforce demands in the United States. Also, it helps faculty, staff, and administrators understand the specific needs of African American women engineering and computer science students. Results from this study may assist institutions with implementing effective strategies to increase retention and degree completion rates. It can also help facilitate positive change on college campuses to improve the experiences of African American women. Institutions must understand the importance of campus climate perceptions and how this can contribute to student success among African American women. Additionally, previous research has focused on the experiences of underrepresented minorities in STEM. This study focused on the first-year experiences of African American women in engineering and computer science majors.

Furthermore, Strayhorn’s (2019) sense of belonging model was utilized to understand the first-year experiences of African American women in engineering and computer science majors.

Using this theoretical framework will enhance the significance and potential implications of the study. Sense of belonging will analyze the impact of formal and informal integration into the college campus community and will explore the nuances of being a woman and African American in engineering and computer science majors. The findings from this study can improve institutional strategies for improving major persistence among this particular student population. If this issue is not addressed, it will widen the disparity gap among African American women earning engineering and computer science bachelor's degrees.

Delimitations and Assumptions

The study focused on understanding the first-year experiences of African American women in engineering and computer science majors. The first delimitation pertains to the study being conducted at a PWI. This study can help faculty and staff at PWIs identify areas for improvement to increase degree completion among African American women in engineering and computer science. The second delimitation was that the research participants must be enrolled full-time and admitted into the university as first-time in college students. Individuals are considered first-time in college students if they have not taken any college courses after graduating high school. These students typically experience challenges with navigating and adjusting to the academic and social environment on college campuses. The study was not intended to focus on all underrepresented minorities' first-year experiences in engineering and computer science majors. However, this study focused on African American women's first-year experiences in engineering and computer science programs to address the gap in the literature. This study will increase awareness about African American women’s challenges when pursuing an engineering or computer science degree.

Multiple assumptions were associated with this study. First, participants would provide open and honest responses about their experiences. Second, participants would be able to recall their first-year experiences accurately because the sample for the study included participants with sophomore, junior, and senior academic standing. Third, participant perceptions of their experiences remained the same over time. Another assumption was that the sample was representative of the population. Finally, I assumed that my participants would have difficulty establishing a sense of belonging due to racism and sexism, which would have negatively impacted their persistence in engineering and computer science. I was open to alternative perspectives throughout the study, even if the perspectives did not align with my assumptions.

Definitions of Terms

The following terms have been defined for this study and will be used throughout the chapters.

African American/Black. A person having origins in any of the black racial groups of Africa. (NCES, n.d.). For the purpose of this study, the terms will be used interchangeably. The populations include but are not limited to those of the African diaspora: African Americans, Afro-Caribbean, Afro-Latin Americans.

Underrepresented Minorities (URM). URM students are students of African, Chicano/Latino, and Native American heritage (Syed et al., 2011).

Predominately White Institutions (PWI). Used to identify colleges or universities where 50% or more of the student population is White (Lomotey, 2010).

Historically Black Colleges and Universities (HBCUs). Institutions that have a principal mission to educate African Americans (NCES, n.d.).

Science, Technology, Engineering, and Mathematics (STEM). Disciplinary variations across science, technology, engineering, and mathematics. (Erduran, 2020).

Sense of Belonging. A theoretical framework undergirding "…students' perceived social support on campus, a feeling or sensation of connectedness, and the experience of mattering or feeling cared about, accepted, respected, valued by, and important to the campus community or others on campus such as faculty, staff, and peers" (Strayhorn, 2019, p. 4).

Organization of the Study

Chapter 1 provided an overview of the research problem, research purpose, research questions, theoretical/conceptual framework, the significance of the study, delimitations, assumptions, and key terms. Chapter 2 will provide a more in-depth review of the literature related to this topic. The primary literature themes include: (a) representation of African American women in higher education, (b) African American women in STEM, (c) African American women's experiences and campus climate, (d) first-year experience, (e) contextual access and impact to STEM, and (f) theoretical framework. Chapter 3 will provide a detailed description of the research methodology and design. Chapter 4 will present the findings by the research questions, and Chapter 5 will present the summary of the findings and implications for future research.

CHAPTER 2: REVIEW OF LITERATURE

National efforts have been made to increase STEM participation among URM to keep up with the STEM workforce demands in the United States (Ro & Loya, 2015). However, African American women still face substantial challenges with degree attainment in engineering and computer science. Therefore, this study aims to understand the first-year experiences of African American women in engineering and computer science and help administrators identify important factors that contribute to their success. The two research questions guiding this study are: (1) What influences African American women's first-year academic major choices in engineering and computer science? and (2) How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework?

A significant amount of research focuses on the experiences of all women of color or URM in STEM (Charleston, Adserias, et al., 2014; Porter & Byrd, 2021; Samuelson et al., 2016); however, there is limited research that primarily focuses on African American women in STEM. The literature tends to homogenize STEM experiences rather than acknowledge differences among the majors, such as engineering and computer science. The literature has focused on the experiences of all students in engineering and computer science majors (Cintron et al., 2019; Dringenber et al., 2022; Hutchison-Green et al., 2008; Mathis, 2008; Meyers et al., 2010). However, fewer studies focused exclusively on the experiences of undergraduate African American women in engineering and computer science majors. The minimal studies that focus on engineering provide a rationale for this study that offers an intersectional lens of engineering and computer science majors, first-year experiences, and African American women.

Another key distinction is among first-year experiences from programming that differentiates this study from previous scholarship. The goal of the first-year experience is to improve academic performance, persistence, and degree completion, which is essential to student success in higher education (Bowman, 2010; Goodman & Pascarella, 2006; Upcraft et al., 2005). First-year experiences are referenced as students' perspectives of their first year of college (Everett, 2019). That differs from programming that typically addresses college campus academic and social integration issues. Varying terminology is used within the literature to refer to programming such as first-year seminar courses, learning communities, summer bridge programs, and mentoring programs (Cole et al., 2020; Johnson, 2016; Miller & Lesik, 2014). There has been greater emphasis within the literature on addressing singular academic areas of concern, such as transitioning and adjustment into the discipline, rather than the holistic experiences of African American women in engineering and computer science majors, which offers another rationale for this study. Examining all aspects of the first-year experience that positively or negatively impact degree persistence and completion for African American women in engineering and computer science is critical due to the leaky STEM pipeline. There is a need to strengthen the STEM workforce that is inclusive of engineering and computer science majors. Therefore, as part of this literature review, I position engineering and computer science programming as inclusive to the first-year experience to demonstrate the complexity of student experiences rather than suggesting that they occur disparately. The limited literature on this particular area warrants the basis for this study.

This chapter will provide context related to African American women in higher education. The preliminary literature themes that I have identified as being relevant to this topic include: (a) representation of African American women in higher education, (b) African

American women in STEM, (c) first-year experience, (d) African American women's experiences and campus climate, and (e) theoretical framework. Table 1 outlines how this literature will be presented:

Table 1

The First-Year Experiences of African American Women in Engineering and Computer Science Majors: Relevant Literature

Literature Themes	Subthemes/Sources
Representation of African American Women in Higher Education	(Charleston, Adserias, et al., 2014; Porter et al. 2018; NCES, 2022; Thomas & Jackson, 2007; Winkle-Wagner, 2015)
African American Women in STEM	(Alexander & Hermann, 2016; Charleston, George, et al., 2014; Dortch & Patel, 2017; McGee & Bentley, 2017; Morton & Parsons, 2018; NSF, 2020; Russell & Russell, 2015)
African American Women's Experiences and Campus Climate	Challenges (Apugo, 2019; Beasley & Fischer 2012; Hannon et al., 2016; Haynes, 2019a; Haynes, 2019b; Kelly et al., 2021; McGee & Bentley, 2017; Lee Williams & Nicholas, 2012; Lewis et al., 2013; Morales, 2014; Neal-Jackson, 2020; Szymanski & Lewis, 2016; Winkle-Wagner, 2009) Perceptions of Campus Climate (Brown et al., 2005; Leath & Chavous, 2018; Locks et al., 2008; Sims, 2008; Soria, 2018) URM Persistence and Completion in STEM (Alexander & Hermann, 2016; Beasley & Fischer, 2012; Chang et al., 2014; Green et al., 2019; Huang et al., 2021; Martin, Stefl, et al., 2020; Nguyen et al., 2021; NSF, 2015; Oseguera et al., 2019; Porter & Byrd, 2021; Samuelson et al., 2016; Skvoretz et al., 2020; Smith et al., 2019; Syed et al., 2011) Marginalization of URM Women in Engineering (Blosser, 2020; Booker, 2016; Cross et al., 2017; Dortch & Chirag, 2017; Fletcher et al., 2021; Frillman et al., 2010; Litzler et al., 2011; Malcolm & Malcolm, 2011; NSF, 2019; Ong et al., 2011; Ong et al., 2020; Ro & Loya, 2015; Stitt & Happel-Perkins, 2019; Tate & Linn, 2005; Verdín, 2021; Watkins & Mensah, 2019)

Table 1 Continued

	URM in Computer Science (Charleston, 2012; Ong, 2011; Rankin & Thomas, 2020; Rodriquez & Lehman, 2017; Ross et al., 2020; Solomon et al., 2018; Verma, 2010; Walton & Cohen, 2007
First-Year Experience (FYE)	History (Connolly et al., 2017; Everett, 2017; Freer, 2016; Krumrei-Mancuso et al., 2013; Upcraft & Gardner, 1989; Upcraft et al., 2005) Seminars and Programs (Bettinger et al., 2013; Budny & Newborg, 2010; Cabrera et al., 2013; Cole et al., 2020; Everett, 2017; Everett, 2019; Goodman & Parcacella, 2006; Johnson, 2016; Koch et al., 2018; Lane, 2020; Lang, 2006; Sanchez et al., 2006; Sharp, 2021; Stolle-McAllister, 2011) Academic Advising (Drake, 2011; Kitchen et al., 2021; Lancaster & Xu, 2017; Montag et al., 2012; Museus & Ravello, 2021; Pascarella & Terenzini, 2005; Tsui, 2007) Mentorship (Atkins et al., 2020; Booker & Brevard, 2017; Budny et al., 2010; Dahlvig, 2010; Domingo et al., 2019; Estrada et al., 2018; Freeman, 1999; Lane, 2020; Lee, 1999; Lim et al., 2017; Sanchez et al., 2006; Sharp, 2021; Tsui, 2007; Yomtov et al., 2017) Student-Faculty Interactions (Cox & Orehovec, 2007; Guzzardo et al., 2020; Komarraju et al., 2010; Lambert et al., 2007; Lundberg & Schreiner, 2004; Newman, 2015; Pascarella & Terenzini, 2005; Umbach & Wawrzynski, 2005) Gatekeeper Courses in STEM (Battey et al., 2022; Ellis et al., 2016; Harris et al., 2020; Hatfield et al., 2022; Leyva et al., 2021; Meaders et al., 2020; Sax et al., 2018; Suresh, 2006; Wilkins et al., 2021) FYE in Engineering (Cancado et al., 2018; Doolen & Biddlecombe, 2014; Flynn et al., 2016; Godwin & Kirn, 2020; Hutchison-Green et al., 2008; Lakin et al., 2020; Meyers et al., 2010; Verdín et al., 2018) FYE Computer Science (Barker et al., 2009; Blaney & Stout, 2017; Cabo & Satyanarayana, 2018; Cintron et al., 2019; LeBlanc, 2020; Mathis, 2008; Ragusa et al., 2020; Woods, 2023)

Table 1 Continued

Contextual Access and Impact to STEM	(AACC, n.d.; Bahr et al., 2013; Bahr et al., 2023; Gray et al., 2022; Holmlund et al., 2018; Laanan et al., 2010; London et al., 2021; Mulvey et al., 2023; Schudde & Goldrick-Rab, 2015; Zuckerman & Lo, 2021)
Theoretical Framework	Sense of Belonging (Booker, 2016; Dasgupta & Stout, 2014; Dortch & Chirag, 2017; Johnson, 2012; Lewis et al., 2021; Litzler & Samuelson, 2013; Maslow, 1943; Miyake et al., 2010; Ong et al., 2018; Strayhorn, 2011; Strayhorn, 2019) FYE Sense of Belonging (Freeman et al., 2007, Hausmann et al., 2007; Hoffman et al., 2003; Hurtado et al., 2007; Johnson et al., 2007; Means & Pyne, 2017; Miller & Servaty-Seib, 2016; Morrow & Akermann, 2012; Sax et al., 2018; Vaccaro & Newman, 2016; Walton & Cohen, 2011)

Representation of African American Women in Higher Education

Before understanding African American women's experiences in STEM or specifically engineering and computer science fields, we consider their enrollment patterns and access to higher education. African American girls and women have historically experienced educational struggles in the United States. Landmark legislation, such as Title VII of the Civil Rights Act of 1964 and Title IX of the Education Amendments of 1972, significantly impacted high school and college completion rates for African American men and women in the late 20th century (Thomas & Jackson, 2007). However, such factors as racism and sexism continue to impact African American women on college campuses today. For example, Hannon et al. (2016) found that race and gender significantly impact African American women's overall adjustment, engagement, and degree completion.

Previous research studies have highlighted African American women's representation and success in higher education. According to Winkle-Wagner (2015), African American women have doubled their enrollment rates over the last thirty years, but their graduation rates remain

lower than White and Asian women. Winkle-Wagner (2015) used an interdisciplinary review of student and institutional factors that support student success among African American women. The author found sub-themes related to student success that include: (a) individual factors in college success, (b) lack of analysis among the differences of African American women, and (c) framing of success as persistence or degree completion.

Additionally, researchers have highlighted how African American women define success in higher education. For example, Porter et al. (2018) utilized a qualitative study to examine how African American women defined success in achieving their long-term higher education goals. The study was conducted at a PWI research and land grant institution. The authors conducted two focus groups with 13 African American undergraduate women. They found that multiple factors, such as pre-college socialization, identity, self-awareness, and support systems, contribute to their definition of success.

African American Women in STEM

The data highlights the disparity in degree completion between non-science fields and STEM-related fields for African American women during the 2021-2022 academic year. According to the National Center for Education Statistics (NCES, 2023a), a significantly higher number of African American women completed degrees in professions such as education, health professions, and the humanities compared to STEM disciplines. In 2021-2022, only 1,666 engineering degrees and 2,710 computer and information science degrees were earned by African American women, reflecting a notable underrepresentation in these fields (NCES, 2023a). African American women complete significantly fewer STEM degrees than their counterparts, and studies have indicated STEM persistence challenges for them. For example, McGee and Bentley (2017) examined the experiences of high-achieving African American

women in STEM and found that racism, sexism, and gender bias impacted African American women in STEM. The authors extracted data from two larger studies, and the data consisted of three African American women in engineering majors from three universities. The sample included two graduate students and one undergraduate student. Also, two participants attended HBCUs, and one participant attended a PWI. Institutions must help mitigate environmental challenges to improve success among African American women in higher education, specifically at PWIs.

To further contextualize, African American women are disproportionately underrepresented in STEM compared to population representation in the United States, and they experience multifaceted marginalization while obtaining STEM degrees (Charleston, George, et al., 2014; Dortch & Patel, 2017). The inability to persist has been linked to microaggressions, low self-confidence, and insufficient institutional support (Alexander & Hermann, 2016). Their qualitative study of African American women in STEM graduate programs was at a PWI and included eight African American women. Additionally, Russell and Russell (2015) conducted a phenomenological case study to understand African American women's decisions to switch their major to STEM. The authors found that three major factors impacted their lack of persistence in their original STEM majors such as (a) lack of early success in science at the PWI, (b)lack of adequate career counseling and advisement, and (c) feelings of lack of adequate preparation for science in the college classroom based on their pre-college science and math course experiences.

Other studies have focused on African American women's experiences with STEM identity development and how it impacts degree completion. For example, Morton and Parsons (2018) conducted a qualitative study to explore how race and gender identities influence African American undergraduate women’s engagement in STEM fields. The study was conducted at an

HBCU and a PWI. The sample included five participants from the HBCU and the other five from the PWI. The findings emphasized the importance of African American women developing their own perspectives about their identities in STEM as a means for retention and matriculation.

African American Women's Experiences and Campus Climate

Interactions with faculty or peers can influence African American women's experiences in higher education positively or negatively. The following sections begin to address their experiences related to campus climate, including challenges, perceptions, and how the sense of belonging may magnify marginalization.

Challenges

Researchers have highlighted the challenges that African American women face on college campuses. First, there are institutional challenges. For example, Haynes (2019a) examined how colleges and universities can be uncomfortable spaces for high-achieving African American women, who often deal with intense feelings of isolation and frustration. This qualitative study was conducted at a PWI, and the sample included 20 undergraduate African American women. A second institutional challenge was that women participants' sense of academic achievement was often undermined by the marginalization they experienced on campus (Haynes, 2019a). This study suggested that institutional problems negatively impacted African American women. A third institutional challenge was the effect of an oppressive environment on academic success. This was underscored in the work of Kelly et al. (2021), who noted that African American women often feel like "space invaders" at PWIs and that their voices do not matter when they experience gendered racism, which can lead to feelings of isolation (p. 203). Lastly, the institutional system presented as a maze that African American women had to carefully navigate, such as in social interaction within residence halls on college

campuses where African American women often self-segregated due to racial and gender tensions in general (Haynes, 2019b). The overall navigation within institutions for African American college students was described as social traps while sharing living spaces with White students, making daily life stressful (Haynes, 2019b).

African American students are the most marginalized racial group on college campuses and experience more negative stereotypes, such as poor academic performance (Beasley & Fischer, 2012). Apugo (2019) examined the relationship between intellectual, cultural, and racial stereotypes and how they perpetuate psychological anguish among African American women students and found that psychological distress can hurt their ability to persist and complete their degrees. Typically, PWIs are designed to accommodate the majority, leaving students of color to feel "devoid of cultural, social, and academic connections with the university" (Apugo, 2019, p. 60). Additionally, Neal-Jackson (2020) examined how stereotyping emerged for undergraduate African American women in academic spaces, and the author found that these women encountered gendered racial stereotyping, which impacted their success. Neal-Jackson's study was conducted at a public PWI, and the sample included 30 female African American undergraduate students.

Regarding a different inhibitor to college success, Winkle-Wagner (2009) highlighted that African American students are more likely to withdraw from their college pathways than their White peers due to negative experiences. Specifically, negative experiences can disparage African American women on college campuses, particularly at PWIs (Apugo, 2019; Blosser, 2020; Winkle-Wagner, 2009). Racial microaggressions affect student success and the overall student experience. Racial microaggressions are "subtle racialized insults students encounter in higher education" (Morales, 2014, p. 48). Racial microaggressions can negatively affect African

American women academically, physically, and psychologically (Lewis et al., 2013; Szymanski & Lewis, 2016). Examples of the effects on African American women were denoted within the literature. Lee Williams and Nicholas (2012) found that African American women students regularly encounter microaggressions unique to being African American and woman. Szymanski and Lewis (2016) found that African American women experience gendered racism on college campuses through their learning environment and relationships with faculty, administrators, staff, and other students, which can influence psychological distress.

Navigating through the intersection of gendered and racialized microaggressions requires developing coping strategies to succeed in higher education. Lewis et al. (2013) highlighted how African American college women cope with gendered racial microaggressions that included resistance (i.e., using one's voice as power), collective coping (i.e., leaning on one's support network), and self-protection (i.e., becoming a Black Superwoman). African American women used multiple coping strategies in addition to picking and choosing their battles (Lewis et al., 2013). Institutions must create more inclusive environments to increase college persistence and success among African American women.

Perceptions of Campus Climate

According to Brown et al. (2005), more favorable perceptions of campus climate are associated with positive academic outcomes. Brown et al. (2005) found that African American engineering students' positive perceptions of personal/social campus climate can influence academic performance and increase their commitment to the institution. Sims (2008) also examined the social experiences of undergraduate African American women students at a PWI. The author found that developing connections to campus environments is essential for African American female students; furthermore, the college experience includes successfully integrating

into social spaces on college campuses and having positive social relationships with faculty and peers (Sims, 2008). Campus climate can affect academic achievement and persistence in higher education (Locks et al., 2008; Soria, 2018).

Leath and Chavous (2018) conducted a study examining the campus racial climate experiences of African American women compared to other women of color and White women. The sample included 100 African American women, 143 women of color, and 102 White women from a public PWI. The authors found that African American women encountered more hostile racial climates and less academic satisfaction than their White counterparts. African American women are achieving educational success at high rates; however, "…this success in degree attainment may draw conceptual and empirical attention away from unique challenges that some Black women face in their college contexts as they pursue these degrees" (Leath & Chavous, 2018, p. 125). It is essential to continue addressing African American women's challenges in higher education to improve persistence and degree completion.

Overall, individual experiences and campus climate can shape students' academic adjustment and college experience. When students do not feel a part of the campus community, "they can feel excluded, which negatively affects their performance in the course and subsequently influences degree completion (Booker, 2016, p. 225). Specifically, perceptions of campus climate can influence degree completion for African American women. Campus climate is linked to positive or negative student outcomes. It is imperative to identify how college environments promote student success among African American women in engineering and computer science at PWIs.

URM Persistence and Completion in STEM

In the United States, URM students are defined as students of African, Chicano/Latino, and Native American heritages (Syed et al., 2011). African American and Latino students are less likely to persist in STEM majors than their White and Asian counterparts. The STEM workforce will benefit from the increased success of URM in STEM disciplines.

African American women discontinue educational enrollment for many reasons. First, pre-college factors and college experiences are correlated with URM students' completion rates (Chang et al., 2014). Chang et al. (2014) explained that academic experiences could enhance undergraduate URM students' STEM persistence. Second, community cultural wealth was identified as a key persistence strategy for URM undergraduate students in engineering (Samuelson et al., 2016). This concept allows students to utilize their cultural background to effectively navigate and succeed within educational institutions (Samuelson et al., 2016). The authors interviewed 11 African American undergraduate students and 20 Latino undergraduate students from 11 universities for this mixed methods study. Third, social capital has influenced the persistence and retention of URM students in engineering. Social capital refers to social connections, networks, and resources (Martin, Stefl, et al., 2020; Samuelson et al., 2016; Skvoretz et al., 2020). Skvoretz et al. (2020) found that various levels of social capital could affect the persistence and retention of undergraduate URM students in STEM. Lastly, stereotype threats can impact attrition rates for undergraduate URM students (Fischer, 2010) and can specifically cause women and minorities to leave STEM majors (Beasley & Fischer, 2012). Racial stereotypes, such as African American students being perceived as underqualified, can threaten their attrition rates in STEM (Torres & Charles, 2004).

Persistence for African American women in higher education was supported through various strategies in the literature. Literature related to persistence was framed as structural, psychosocial, and identity development. The structural factors of persistence were both institutional and personal. Nguyen et al. (2021) noted, in their work with African American women who attended 10 HBCUs, that multiple factors influenced their achievements, such as parental engagement, positive interactions with teachers, the affirming nature of their college campuses, and STEM pipeline programs. Their qualitative study explored opportunities to facilitate the achievement of undergraduate African American women in STEM majors. From a personal perspective, Morton (2021) used composite counter-storytelling to understand the experiences of four participants at a PWI and asserted that African American women were self-reliant in identifying and participating in support programs to persist in STEM and in navigating marginalizing environments.

A second persistence strategy was explored by Huang et al. (2021), who conducted a mixed methods study to examine the psychosocial and structural factors that influence African American undergraduate STEM students' experiences. The study included six HBCUs, and the sample included 91 African American women and 27 African American men. The authors identify factors that influence their experience in STEM, such as people, programs and resources, institutional standards, academic self-efficacy, academic motivation, social support, and social challenges.

The third persistence strategy of identity development was first centered on scientific identity, as exemplified by Oseguera et al. (2019), who noted an association between a high scientific identity with fewer instances of discrimination that increased the likelihood of participants remaining in their program. Osequera et al. (2019) quantitative study focused on

undergraduate students' early retention within a STEM scholar program at a PWI. This study specifically examined the retention patterns of 48 African American students alongside 44 students from other URM backgrounds. Identity development extended into situating the layered implications of racial and gender intersectionality on STEM identity for African American women undergraduate students' academic achievement (Smith et al., 2019). The scholars noted that participants were highly committed to achieving their undergraduate degrees to prove to others that they were able to persist.

For every story of an African American student who successfully persists in the academy, there are accounts of those who are unable to do so. Non-matriculating or "nonpersistence" factors such as professor interactions, peers, the institution, and society were found to be deterrents (Green et al., 2019, p. 249). Their study sought to understand factors contributing to the nonpersistence of African American students in STEM majors at a PWI, and the sample included eight African American women and five African American men.

Overall, African American women have made significant strides in higher education. However, they continue to face challenges that impede their academic success. Increasing representation is essential, but it is also critical to focus on persistence. Furthermore, engineering and computer science degree completion is another issue for African American women in higher education. African American women's "experiences are valid in and of themselves, and their unique definitions of success warrant further investigation" (Porter & Byrd, 2021, p. 804). It is essential to differentiate African American women's challenges from other underrepresented minority groups. When examining the experiences of African American women in higher education, administrators must view them holistically. Understanding the different aspects of

representation and success identifies the need to support African American women in engineering and computer science majors at predominately White institutions (PWIs).

Marginalization of URM Women in Engineering

Engineering degrees awarded to African American women have slightly decreased in the last five years compared to women of all other races (Fletcher et al., 2021). Data from the NSF (2019) noted that 7.6% of undergraduate engineering degrees were awarded to women of color, 12.7% to White women, and 79.1% to men of any race/ethnicity. Studies have identified factors related to the experiences of URM women in engineering and their participation in higher education. Ong et al. (2020) found that women of color implement various strategies to cope with the challenges of race and gender inequity in engineering education. Similarly, Tate and Linn (2005) examined how interactions between academic, intellectual, and social identities influence persistence and perceptions of educational experiences for URM women in engineering. The study was conducted at a large public university, and the sample consisted of five women of color. The authors determined that academic, social, and intellectual identities help URM women persist in engineering. In a related study, Verdín (2021) explored how persistence toward degree completion for URM women is related to their interest in engineering and their confidence in their academic abilities, and the author found that URM women's persistence toward degree completion in engineering is associated with their academic confidence.

Additionally, recruiting and retaining African American women in engineering is critical in increasing the degree completion rates for URMs in engineering. Studies have explored how African American women described their marginalization in engineering. For example, Blosser (2020) found that African American women experienced isolation, difficulties forming study

groups, and microaggressions. In their study, Litzler et al. (2011) discussed how women are represented by different cultures, races, ethnicities, and experiences and the need for women to be recognized as a non-monolithic group in undergraduate engineering academic environments. The authors found that African American women reported more comfort in asking questions in class but had lower opinions about professors. However, Hispanic, Native American, Asian American, and White women reported feeling less comfortable asking their professors for help, but they had higher opinions about professors (Litzler et al., 2011).

However, the number of African American women obtaining engineering degrees has increased compared to the general African American engineering population, and challenges for African American students in engineering have led to stagnant degree conferrals (Fletcher et al., 2021). Frillman et al. (2010) found that staying focused and maintaining confidence were significant themes related to African American women's positive progress in engineering. Furthermore, Ro and Loya (2015) found that African American women in engineering majors may be at a disadvantage due to the double effect of their gender and race. Stitt and Happel-Perkins (2019) examined how African American women engineering students are often unwelcomed in spaces such as White male-dominated fields. The authors used an intersectional lens to understand African American women's experiences in engineering majors. They found that matriculation toward degree completion is impacted by "racism, sexism, and prejudice that result from the intersection of their race and gender" (Stitt & Happel-Perkins, 2019, p. 62). Therefore, race and gender and their intersectionality contribute to African American women's educational experiences in engineering.

Watkins and Mensah (2019) used counter-storytelling to examine the undergraduate, master's, and doctoral STEM experience of one African American female PhD engineer. The

participant attended an HBCU for her undergraduate degree and PWIs for her master's and doctoral degrees. The authors noted positive and negative peer support influenced her success and persistence in attaining her engineering doctoral degree. The participant received positive same-race peer support in her undergraduate and doctoral programs. However, the participants received a lack of peer support and experienced isolation in the master's program.

A sense of belonging and marginalization can be considered aspects of the "double bind," a concept highlighted by Cross et al. (2017), describing the challenges women of color often face when navigating STEM majors. The "double bind" refers to the challenges that African American women face in STEM based on gender and race (Dortch & Chirag, 2017; Malcolm & Malcolm, 2011; Ong et al., 2011). Cross et al. (2017) used a mixed-methods study to understand how race and gender impacted the experiences of color in engineering. The sample for this study consisted of ten African American women and seventeen Hispanic American women. The authors found that race and gender can positively or negatively impact engineering identity and sense of belonging.

Marginalization of URM in Computer Science

Empirical research studies have addressed the lack of degree attainment for women and URM in computer science (Charleston, 2012; Rankin & Thomas, 2020; Verma, 2010; Walton & Cohen, 2007). As Rodriquez and Lehman (2017) highlighted, the computing industry is under urgent pressure to recruit and retain more diverse students in computer science, including women and underrepresented minorities. Women of color often face social challenges in computer science. Particularly at PWIs, they may experience being the only women or minority in their classes (Ong, 2011). Varma (2010) conducted a mixed-method study to examine why so few women enroll in computer science and computer engineering. The author found that early

socialization and anxiety toward technology are the two primary factors that cause women to be underrepresented in computer science and computer engineering education.

Additionally, prior studies have focused on African American students in computer science. For example, Charleston (2012) conducted a qualitative study that revealed the complex factors influencing African Americans' successful pursuit of computer science degrees. The study found that key themes were early exposure and engagement with computers, positive interactions, and computing socialization. Importantly, the study suggested that the decision to pursue computer science among African Americans was heavily socially constructed, adding a layer of complexity to the issue. Moreover, Rankin and Thomas (2020) conducted a mixed-method study to understand how intersectionality influences African American women's ability to persist in computing. The sample consisted of 14 African American women in various stages of the computing pipeline, such as undergraduate students, graduate students, and career professionals. The findings suggested that “interlocking systems of oppression (i.e., gendered racism) play out in computing education and negatively impact the recruitment and retention of Black women in the field of computing” (Rankin & Thomas, 2020, p. 199).

Sense of belonging has been associated with African American students' ability to persist in computer science. For example, Walton and Cohen (2007) examined race, social fit, and achievement for African American students in computer science. The study was conducted at a private university, and the sample consisted of 36 African American and 34 White undergraduate students. The authors found that African American students may feel discouraged from pursuing computer science if they do not feel like they belong. Additionally, Solomon et al. (2018) discussed the importance of a sense of belonging for African American women who pursue and persist in computing. The authors highlighted the intersectionality of race and gender as key

components of their experience in computing. Ross et al. (2020) conducted a quantitative study to understand the difference in experiences between African American women, African American men, and non-African American women in computer science programs. 118 colleges and universities were selected from two-year and four-year institutions. The sample consisted of 10,203 students, and 7% of the sample was identified as African American. The findings suggest that African American women had different social experiences from African American men and non-African American women. The two groups had more friends in computer science in comparison to African American women.

First-Year Experience (FYE)

First-year experiences can offer an opportunity to acclimate and acculturate engineering students into a discipline that has key foundational courses in advanced math and science that may be the key to academic success. First-year engineering students are oriented to learning skills related to team-building and problem-solving experiences (Dringenberg & Purzer, 2018). There are opportunities to engage in class and lab support groups while building social capital through comradery (Martin, Stefl, et al., 2020). Research often lacked a comprehensive understanding of the multiple aspects of the first-year experience. A pattern noted in the literature was a tendency to consolidate information related to the first-year experience into one aspect that needed a holistic view. For example, literature may focus on one particular aspect, such as summer bridge programs; however, it does not focus on student-faculty interactions. The current study is more comprehensive, not isolated to one component of a student's experience. These interconnected experiences play an important role in shaping a student's overall experience and success in college. In order to understand the first-year experience, I highlight multiple aspects of a student's experience, which include seminars, mentorship, student-faculty

interactions, and gatekeeper courses. A holistic understanding of the first-year experience requires a comprehensive examination of various aspects.

History

The first-year experience movement in higher education began in the 1960s and early 1970s during the Civil Rights Era (Freer, 2016). In particular, Upcraft and Gardner (1989) noted that first-year experiences are intended to help students transition from high school to college and help with academic, social, and personal adjustment challenges (as cited in Freer, 2016). Transitioning to college can be difficult for many students (Connolly et al., 2017; Everett, 2017; Upcraft et al., 2005), and universities face challenges with first-year student success and retention (Everett, 2017; Krumrei-Mancuso et al., 2013). First-year experience programming includes first-year seminars, summer bridge programs, orientation programs, advising, early-alert systems, learning communities, service-learning, and support services (Everett, 2017; Upcraft et al., 2005).

Seminars and Programs

Institutions have focused on first-year experiences by developing programming to support students transitioning from high school to college. A key retention strategy universities employ is first-year seminar courses, which can play a meaningful role in the learning experiences that help first-year students transition to college (Everett, 2017). Several studies have shown the positive impact of first-year seminar courses. According to Goodman and Pascarella (2006), students who participate in first-year seminars report more meaningful interactions with peers and faculty and more positive perceptions about themselves as learners and achieve higher grades. Additionally, Lang (2006) found that first-year experience courses have been associated with academic performance, persistence, and graduation rates for students

who complete first-year experience courses and achieve higher GPAs in their first semester. Everett (2019) found that students experience a range of emotions during their first semester in college. These studies demonstrate that the first year of college is critical to student success in higher education.

Targeted first-year academic transitional programs, such as summer bridge programs, have been associated with retention and college persistence (Ghazzawi et al., 2021; Koch et al., 2018). Unfortunately, many students enter college underprepared for college-level coursework (Bettinger et al., 2013; Mulvey, 2008). College transition programs can assist with this issue. Summer bridge programs have been associated with helping incoming first-year students with remediation (Stolle-McAllister, 2011). For example, Johnson (2016) examined how a STEM summer bridge program can increase academic self-efficacy and self-confidence and found that summer bridge programs assist with retention efforts for first-year students. Cabrera et al. (2013) found that summer bridge programs can positively impact academic performance and persistence. Cole et al. (2020) found that a comprehensive college transition program increased first-year students' sense of belonging and mattering. This quantitative study was conducted across three large public colleges.

Academic Advising

Effective academic advising can reduce student attrition (Tsui, 2007). Academic advising is the cornerstone of student retention, and quality advising can positively impact retention and persistence rates and students' overall satisfaction with the institution (Drake, 2011; Pascarella & Terenzini, 2005). Academic advisors help students to (a) navigate higher education, (b) make choices regarding their futures, (c) align talents with academics, and (d) encourage academic success based on their abilities (Drake, 2011). Previous research has examined the impact of

academic advising on student success. For example, Lancaster and Xu (2017) utilized a qualitative case study to explore the experiences of African American students in STEM majors. The authors found that frustration with academic advising was a barrier to degree completion. Advisor interactions can contribute to African American students transferring to different departments and leaving the STEM pipeline (Lancaster & Xu, 2017).

Previous studies have identified areas for improvement in academic advising. For example, Museus and Ravello (2021) examined the role academic advisors play in contributing to the success of students of color at predominantly White institutions. The study was conducted at a PWI, and the sample consisted of 14 academic advisors, 9 Asian Americans, 9 African Americans, and 13 Latina/o students. The authors found three themes that contribute to success which included: (a) advisors humanizing the practice of academic advising, (b) the impact of a multifaceted advising approach, and (c) the importance of proactive academic advising. Academic advising can impact students' grades and major gratification, indirectly impacting student retention (Montag et al., 2012). Kitchen et al. (2021) also found that proactive advising strategies positively impacted URM students' academic self-efficacy. Academic advising is a critical factor that contributes to academic success.

Mentorship

Mentoring is one strategy that is used to retain students and promote timely degree completion (Atkins et al., 2020). Mentorship has been associated with improving academic outcomes in STEM (Domingo et al., 2019; Tsui, 2007) and can be formal or informal (Atkins et al., 2020; Dahlvig, 2010). Booker and Brevard (2017) examined the first-year experiences of African American students in a year-long mentoring program. The study was conducted at a mid-size liberal arts college, and the sample consisted of 47 women and 11 men. The authors

found that the mentoring program positively impacted first-year African American students' transition to college. Mentoring can be essential to African American students' degree persistence and completion (Freeman, 1999).

Atkins et al. (2020) examined the relationship between mentoring and scientific identity for STEM students. The study occurred at a PWI; the sample consisted of six White women, six White males, and thirteen URM women. The authors found that mentorship helped shape scientific identity, which can increase retention and persistence in STEM majors. A longitudinal study conducted by Estrada et al. (2018) found that mentoring can contribute to integrating undergraduate students into STEM fields. The study's sample consisted of 1,450 minority science undergraduate and graduate students from 50 universities across the United States. Other studies have focused on mentoring, specifically in engineering (Budny et al., 2010; Lim et al., 2017).

Peer mentoring is another strategy to assist with first-year experiences. "Peer mentoring has emerged as a viable retention strategy to aid higher education institutions in their efforts to ensure freshmen students make it through that crucial first year and beyond and obtain that degree" (Lane, 2020, p. 481). Prior research has highlighted the significance of peer mentoring during the first year of college. Peer mentoring has been associated with overall satisfaction with the university and creates positive experiences for first-year students (Budny et al., 2010; Sanchez et al., 2006). Sharp (2021) found that participation in an FYE peer mentor program was a vital support for first-year students. Participating in an FYE peer mentor program can positively impact student retention as they feel more connected and integrated into their institutions, which can impact their persistence toward graduation (Yomtov et al., 2017). Lim et al. (2017) found that peer mentoring programs could be used to integrate first-year engineering

majors into the engineering community and help them develop positive interpersonal relationships. This qualitative study was conducted at a PWI, and the sample consisted of 26 undergraduate engineering student mentors and mentees.

Student-Faculty Interactions

The importance of student-faculty interactions has been well-documented in previous research. Interactions inside and outside the classroom can positively impact students' self-concept and increase academic achievement (Cox & Orehovec, 2007; Komarraju et al., 2010). Formal and informal classroom interactions are beneficial to student success. Informal student-faculty interactions influence college students' attitudes and interests (Lambert et al., 2007; Pascarella & Terenzini, 2005). Prior research has shown a strong correlation between student-faculty interactions and college success. For example, Komarraju et al. (2010) found that students' relationships with faculty members are associated with their psychosocial and academic outcomes. This quantitative study was conducted at a mid-sized public university. The sample consisted of 242 undergraduate students, and 54% of the participants were women, and African American students were the largest minority in the sample. Students reported feeling more confident in their academic skills and abilities when interacting more frequently with faculty members. Umbach and Wawrzynski (2005) found that student engagement increased when faculty members interacted with students more. Student-faculty interaction is essential to a student's college experience inside and outside the classroom (Cox & Orehovec, 2007; Lambert et al., 2007). A significant amount of research has focused on student-faculty interactions with all college students. However, limited research has focused on African American women's student-faculty interactions in STEM.

According to Guzzardo et al. (2020), student-faculty interactions can reduce underrepresented students' retention and graduation gap in higher education. Guzzardo et al. (2020) conducted a qualitative study examining student-faculty relationship perspectives. The authors found that being inclusive and engaging students leads to supportive relationships between students and faculty, leading to student success. Lundberg and Schreiner (2004) examined student-faculty interactions as predictors of learning by race/ethnicity. The authors found that more frequent high-quality student-faculty interactions significantly impacted student learning for all racial groups.

However, research has demonstrated that African American students do not always interact positively with faculty. For example, Newman (2015) examined the role of race in the interactions between African American engineering and computer science students and faculty members. The study was conducted at two predominantly White public research universities, and the sample consisted of 37 African American college students. Twenty-nine participants were undergraduate students, and eight had received a bachelor's degree within 3-5 years. The author found that African American students experienced discrimination from some faculty members, which led to them receiving less academic support than their White counterparts. Negative student-faculty interactions during the first year of college can impact student retention and success.

Gatekeeper Courses in STEM

According to Meaders et al. (2020), “introductory STEM courses represent entry points into a major, and student experiences in these courses can affect both their persistence and success in STEM disciplines” (p. 195). Studies have shown that academic performance in introductory courses, including URMs, is associated with degree completion. For example,

Hatfield et al. (2022) found that low performance in introductory courses was associated with URM students' failure to obtain a STEM degree. Introductory STEM courses have been associated with being challenging and can weed out students (Mervis, 2011; Sax et al., 2018; Suresh, 2006). If a course has been identified to weed students out, it impacts their academic performance in the course (Suresh, 2006). Harris et al. (2020) also found that poor performance in critical introductory courses significantly affects students' interest in STEM majors. Other studies have focused explicitly on barrier courses in engineering. For example, Suresh (2006) examined the correlation between student performance in barrier courses and persistence in engineering and found that motivation impacted student success with barrier courses.

Ellis et al. (2016) examined the factors of students who persist in STEM or switch out of STEM after completing Calculus I and found that all women switched out 1.5 times greater than men. Recent studies have examined the relationship between first-year mathematics courses and graduation rates in engineering programs. Wilkins et al. (2021) found that students who are more successful in their first mathematics course are more likely to complete their engineering degree. Other studies have identified how students' perceptions of instruction in introductory math courses contribute to attrition in STEM. For example, Leyva et al. (2021) found that marginalized students' perceptions about introductory math courses influence their ideas about who belongs in STEM fields. The study was conducted at a large public research university. The sample consisted of four African American women, four African American men, four Latina women, four Latino men, and four White women. Overall, gatekeeper courses can influence first-year academic outcomes.

According to Battey et al. (2022), precalculus and calculus are gatekeeper courses in STEM due to their academic rigor and requirements for STEM majors. The authors found that

URM and women encountered unfortunate events during precalculus and calculus. These events can ultimately lead to students not persisting in STEM majors. Harris et al. (2020) also examined reducing the achievement gap among URM in their first course of a general chemistry series. The authors found that achievement gaps are based on gender, race, socioeconomic status, and family educational background. Poor performance in first-year STEM courses can determine if students persist in STEM (Harris et al., 2020; Maltese & Tai, 2011).

FYE in Engineering

Examining all aspects of the first-year experience of African American women in engineering majors can assist with degree completion efforts and understanding their sense of belonging. The first-year experiences of engineering majors are critical for increasing retention and students' interest in engineering (Meyers et al., 2010). Many first-year engineering students are overwhelmed with the rigorous engineering coursework and the new college environment (Flynn et al., 2016). Studies have identified programming that assists first-year engineering students. For example, Doolen and Biddlecombe (2014) examined the effects of first-year engineering students participating in a learning community. The authors found that students who participated had more positive attitudes toward engineering and overall satisfaction. Flynn et al. (2016) found that students who participated in an engineering living and learning community had stronger feelings about being a part of an engineering community and had a more positive relationship with their peers. This quantitative study was conducted at a medium-sized public institution, and the sample consisted of 18 White students, two Asian/Pacific Islander students, and two Hispanic/Latino students.

Establishing an engineering identity has been identified as a critical factor in the first-year experience of engineering students. Engineering identity can be defined as “the ways in

which students describe themselves and are positioned by others in the role of being an engineer" (Godwin & Kirn, 2020, p. 364). Developing an engineering identity has been associated with student persistence in engineering (Geisinger & Raman, 2013; Godwin & Kirn, 2020). Identity and motivation were essential to predicting if first-year engineering students will have continuous interest in the major (Godwin & Kirn, 2020).

Developing engineering identity is vital for the persistence of first-year engineering students. The impact of first-year grades related to engineering identity has been explored in literature. For example, perceptions of engineering identity influence retention and are more influential than the grade point average among first-year engineering students (Lakin et al., 2020). A second example relates to how self-efficacy influences students' academic performance in first-year engineering courses. Hutchison-Green et al. (2008) conducted a qualitative study to explore engineering students' self-efficacy beliefs. The sample included seven men and five women from an ENGR 106, Engineering Problem Solving and Computer Tools course that was required of all first-year engineering students. The findings revealed that performance comparisons influence students' self-efficacy and shape their confidence in engineering.

Verdín et al. (2018) examined how engineering identity and sense of belonging predict the persistence and grit of first-generation college students. The study was conducted at three land-grant institutions and one Hispanic-serving institution. The sample of 24% female and 76% male was racially/ethnically identified as "…9% Asian, 7% African American/Black, 30% Latino/a or Hispanic, 1% Native American or Alaska Native, 1% Native Hawaiian or other Pacific Islander, 7% multiple race/ethnicities, and 45% White" (Verdín et al., 2018, p. 7). The authors revealed that engineering identity positively affects students' sense of belonging. Additionally, other studies have suggested that first-year study groups can impact engineering

students' sense of community and belonging. For example, Cancado et al. (2018) examined the impact of first-year mathematics study groups on retention and graduation rates for engineering students. The authors found that students who participated in the study groups had a higher association with being retained in engineering. Study groups can help increase the sense of belonging among first-year engineering majors, thus improving retention and degree completion rates. The first-year experience must be inclusive of key elements such as faculty and staff interactions, mentorship, and academic advising.

FYE in Computer Science

Previous studies have highlighted the significant impact of introductory courses in computer science as well as major-specific FYE courses in computer science (Mathis, 2008; Woods, 2023). For example, Mathis (2008) explored how first-year computer science introductory courses can support women planning to major in computer science. Mathis (2008) noted that these courses can enhance students' computer skills and foster mentoring relationships with instructors. Woods (2023) examined the implementation of an information technology (IT) specific FYE course and its ability to help students better understand the IT curriculum and career paths, thereby increasing the retention rates of computer science majors. These factors help to increase persistence in the major. Introductory courses serve as gateway courses into many disciplines and provide the essential support to help students matriculate through their degree programs.

Other empirical studies have highlighted the significance of sense of belonging and motivation for students in introductory computer science courses. For example, Blaney and Stout (2017) conducted a quantitative study to examine the relationship between introductory computing courses and sense of belonging among first-generation college women. The study

included 704 women from 65 universities. The results indicated that both self-efficacy and sense of belonging are important factors to retention, persistence, and success in computing. Additionally, Cintron et al. (2019) conducted a quantitative study to analyze the perceptions and motivation differences between URMs and non-URMs in introductory computer science courses. The results suggest that URM students in computer science are perceived to have less instructor support and less positive perceptions of collaborative coursework with peers. The authors strongly suggested that instructors should provide individualized support to provide a more inclusive learning environment for students.

Previous studies have also discussed the importance of prior experience in computing and peer-to-peer interactions as a key to success for first-year computer science students. For example, LeBlanc (2020) conducted a mixed-methods study at a public university to understand first-year computer science students' pathways and perceptions in introductory computer science courses. The study found that students with prior computing experience were more successful than those without such experience. Additionally, these students were more likely to develop positive connections with faculty and peers. Barker et al. (2009) conducted a quantitative study to identify which environmental and student factors influence persistence in computer science. The sample included first-year and second-year students enrolled in an introductory computer science course. The sample racial demographic consisted of 49% White, 19 % Asian, 14% Hispanic, 9% Other, 5% African American, 4% Native American/Pacific Islander. The authors found that student-student interactions were the strongest predictor of students' persistence in the major beyond the introductory course.

Other studies have highlighted the significance of Learning Communities (LC) and intervention programs on first-year student retention in computer science. For example, Cabo

and Satyanarayana (2018) discussed the impact of LCs on student retention and class performance in first-year computing courses. The study suggested that students who participated in LCs had higher retention rates, and significantly better performance compared to those who did not participate. Additionally, Ragusa et al. (2020) conducted a quantitative study to understand the impact of large-scale intervention programs on first-year engineering and computer science majors at a large public Minority-Serving Institution, where the dominant ethnicity was Hispanic. The results indicated that students' parental education was positively related to their success in these majors. Additionally, social capital was a significant predictor of their academic success and degree progression.

Contextual Access and Impact to STEM

The gendered differences in educational pursuits in STEM fields is most notable for women who are “more concentrated in biology, chemistry, and mathematics than in computer science, engineering, and physics” (Cheryan et al., 2017, p. 3). Understanding more about the gendered and racialized gaps may be linked to educational access and agents, e.g., family, peers, and mentors, which can function as potential influencers to degree-seeking behaviors. Early educational experiences that provide access to more women role models may counter masculine normative culture and stereotypes in computer science, engineering, and physics (Cheryan et al., 2017). The authors explained masculine culture in STEM as providing a greater sense of belonging to men than women.

Access to STEM majors begins before enrollment as a first-year student. King et al. (2021) suggested that understanding the educational decision-making of African American parents “underscores their agency and activism, thus reinforcing their value of education” and has “the potential to inform research and practice designed to increase Black student

participation and success in STEM" (p. 1102). Education preparation in out-of-school, e.g., afterschool programs, which are inclusive of developing a STEM identity and core skills in math, technology, and problem-solving, is key to developing STEM professionals (Mulvey et al., 2023). The authors further contend that success in addressing the workforce demands in the STEM fields requires preparation of adolescents focused on developing "STEM motivation and interpersonal competence concurrently" (Mulvey et al., 2023, p. 1211). Holmlund et al. (2018) suggested that early educational access and engagement in STEM learning experiences that are pragmatic and linked to partnerships between problem-solving of real-work needs and careers are key attributes of STEM education. The saliency of belonging as part of participation in STEM learning for youth was noted as being critical for URM in STEM fields (Cheryan et al., 2017). Mulvey et al. (2023) asserted that a sense of belonging for adolescents could act to "promote a sense that STEM is "for you" as part of encouraging developing competence in STEM fields early in while also cultivating the STEM identity for traditionally underrepresented students (p. 1220). Recruitment and interest in specific fields of computer science, engineering, and physics required interventions to "counter the masculine culture of the fields so that girls feel a sense of belonging" (Cheryan et al., 2017, p.16). In addition, Ong (2011) contended that interventions to improve the STEM experience required attention to the multiple barriers that exist for students of color.

The potential educational pathways for students enable an understanding of academic and sociocultural backgrounds that may influence undergraduate education (Zuckerman & Lo, 2021). For example, African American students reported a lack of access to requisite courses that are foundational to a pathway into engineering and computer science degrees, thus requiring nontraditional means of exposure to the fields (London et al., 2021). Another example centered

on key influences on early STEM education and participation is family members and teachers (London et al., 2021). Parental input and encouragement to engage in STEM activities aided students in increasing their interest and identity as scientists (Showers, 2015). Community colleges provide one pathway to broaden educational access to STEM baccalaureate degrees (Bahr et al., 2023; Schudde & Goldrick-Rab, 2015). Community colleges also provide another mechanism to further increase and diversify the STEM workforce (Bahr et al., 2023; Gray et al., 2022). Those students who transfer from community college to four-year institutions to complete STEM baccalaureate degrees have comparable degree completion rates as those who initiated their studies at a four-year institution (Bahr et al., 2013; Schudde & Brown, 2019). Community college enrollment includes students who are 43% White, 28% Hispanic, 12% Black, and 6% Asian/Pacific Islander (AACC, n.d.). The majority of community college students are 58% women and 42% men (AACC, n.d.). However, Yap et al. (2024), posited that while community colleges serve as a strategic pathway for students of color into STEM majors, there is a gap in the research about the role of social networks as an influencer to the STEM pathway. The more positive perceptions of being a transfer student coupled with academic adjustment yield positive learning experiences at a four-year university (Laanan et al., 2010). However, Ong et al. (2011) posited that while two-year institutions and community colleges are of import to STEM educational pathways and for women of color, there is limited literature to understand their postsecondary experiences within those environments, transfer process to four-year schools, and the role of articulation agreements.

COVID-19

The World Health Organization (WHO) declared a global pandemic of an infectious disease, the coronavirus disease 2019 (COVID-19) U.S. (WHO, 2024). The impact of COVID-

19 was not only on the health and well-being of people but was experienced in academic communities. Broadly, education shifted from classroom to emergency remote teaching (ERT), which centered on online instruction (Toti & Alipour, 2021). The use of ERT allows for the "continuation of courses initially designed to be delivered completely or partially face to face" (Toti & Alipour, 2021, p. 377). Due to the scope of COVID-19, ERT was used on a global scale (Toti & Alipour, 2021). In a study of students enrolled in at least one computer science course at the end of spring 2020, participants expressed favorable experiences of ERT including (1) having more time to focus on their studies since commuting time was eliminated with online courses, (2) there was a noticeable improvement in communications with professors that reduced ambiguity, and (3) the flexibility in going back to review recorded lectures when needed (Toti & Alipour, 2021). However, there were unfavorable experiences such as (1) access to faculty via email, (2) time management of attending classes, and (3) reduction in motivation and concentration to classes (Toti & Alipour, 2021).

Understanding the educational contexts of students in STEM learning is essential because learning preferences and cultural values significantly influence their educational experiences and outcomes. For example, King et al. (2021) described how leveraging STEM education that is integrated as part of secondary education along with the decision-making input and perspectives of African American parents can increase African American student participation in STEM. Similarly, understanding the role of family members as influencers or promoters of STEM majors was denoted as aspirational capital focused on those who encourage curiosity, whereas knowledge brokers described the familial capital and influence of older siblings (Yap et al., 2024).

Theoretical Framework

Sense of Belonging

The sense of belonging model developed by Strayhorn (2019) contributes to understanding how students develop a sense of belonging and how certain concepts of belonging help students thrive in college. Strayhorn's sense of belonging model demonstrates how the key elements of belonging are related to student success. Sense of belonging is identified as a basic human need, and the framework was developed from Maslow's (1943) hierarchy of needs which is used to understand motivation for human behavior. Maslow's model includes the following categories: (1) psychological needs, (2) safety and security, (3) love and belongingness, (4) esteem, and (5) self-actualization. Strayhorn's revised model of college students' sense of belonging emphasizes the love and belongingness category.

Strayhorn's model includes seven core elements, which are discussed in the following section of the literature. Strayhorn's model, like Maslow's, uses a triangular shape to conceptualize key elements or dimensions that may suggest a linear pathway to student success or happiness; however, the identified literature suggests there is fluidity in the concepts. Therefore, the following section serves as an exemplar of how selected literature related to the experiences of African American women, particularly those in their first year as engineering or computer science students, aligns with Strayhorn's model. I use the "love and belongingness" category of Strayhorn's model as a framework for my study.

Sense of Belonging is a Primitive Need

According to Booker (2016), safe spaces are needed to help students engage and participate fully on college campuses. Negative experiences can have a long-term impact on minority students' motivation to complete their degrees. Students who do not feel like they

belong rarely stay in college (Strayhorn, 2019). Booker (2016) found that African American women's ability to persist was determined by faculty interactions, such as being approachable and accessible. The study was conducted at a public institution, and the sample included six African American female undergraduate students.

Sense of Belonging Drives Behavior

An important factor contributing to URM women in STEM is their experience with sense of belonging with faculty members and their peers (Johnson, 2012; Ong et al., 2018). The contributions of campus racial climate perceptions can impact a sense of belonging for URM women in STEM majors. Negative academic stereotypes that women in STEM encounter can impede their academic performance (Dasgupta & Stout, 2014; Johnson, 2012; Miyake et al., 2010). According to Litzler and Samuelson (2013), URM undergraduate engineering students face more challenges with college integration than their White counterparts. The authors identified that campus integration plays a significant role in feelings of belonging and impacts a student's decision to persist at the institution. Additionally, co-curricular/extracurricular involvement, peer support, faculty, department support, and residence programs help URM students develop a sense of belonging (Litzler & Samuelson, 2013; Ong et al., 2018). When students can successfully integrate into the campus community, it positively impacts academic outcomes, thus increasing retention and persistence.

Sense of Belonging is Impacted by Intersecting Social Identities

Additionally, Lewis et al. (2021) found that African American students experienced more racial microaggressions than their Asian American and Latinx counterparts, which significantly impacted their sense of belonging. Similarly, Dortch and Chirag (2017) used a phenomenological research approach to examine how racial and gendered microaggressions influence African

American women's sense of being in STEM at a PWI. The study focused on the participants' undergraduate experience; however, the participants were doctoral students. Literature has highlighted that a lack of belonging can result from racial and gender discrimination, isolation, and marginalization (Booker, 2016; Dortch & Chirag, 2017; Lewis et al., 2021; Litzler & Samuelson, 2013). Racial and gendered microaggressions profoundly impact the sense of belonging for African American women in higher education, specifically in STEM.

According to Strayhorn (2011), sense of belonging influences student success outcomes for African American students in STEM majors. The author utilized a mixed methods study to examine this topic. The author found multiple factors related to sense of belonging, which included: (a) African American students reported a lower sense of belonging than their White and Asian counterparts, (b) African American students whose educational backgrounds were similar to their White and Asian counterparts still reported a lower sense of belonging, and (c) African American males reported a higher sense of belonging than African American women. This study highlights that African American women face challenges in terms of belonging at higher rates than their counterparts in STEM fields.

FYE Sense of Belonging

Sense of Belonging Creates Positive Outcomes

In higher education, sense of belonging is associated with student success and persistence (Freeman et al., 2007; Hausmann et al., 2007). According to Morrow and Akermann (2012), 35% of students leave a university for academic reasons, and 65% leave for non-academic reasons. The authors found that sense of belonging and motivation are significant predictors of persistence and retention. Sense of belonging is associated with retention and academic self-efficacy among first-year students (Freeman et al., 2007; Hoffman et al., 2003).

Sense of Belonging is Connected to Mattering

Hausmann et al. (2007) conducted a study at a large public PWI and found that undergraduate students who reported interactions with peers and faculty reported greater belonging. However, other studies have examined how institutional support structures such as programming, student organizations, residence hall communities, and academic support services can impact first-year students. Institutional structures can have a positive effect but can also undermine students' sense of belonging (Means & Pyne, 2017). A lack of institutional integration can make students feel less committed to the institution and drive their decision to leave college (Miller & Servaty-Seib, 2016; Morrow & Ackermann, 2012).

Sense of Belonging is Essential in Certain Context

Johnson et al. (2007) reported that first-year African American, Hispanic/Latino, and Asian Pacific American students reported less sense of belonging than first-year White/Caucasian students. Student success is often associated with students feeling welcomed by the institution (Hausmann et al., 2007; Johnson et al., 2007; Morrow & Ackermann, 2012). Hurtado et al. (2007) examined racially minoritized students in biomedical and behavioral sciences transition to college compared to White, Asian, and non-science minority students. The authors found that campus racial dynamics were a factor that affected first-year adjustment and campus integration. Additionally, Walton and Cohen (2011) examined a brief sense of belonging intervention and its connection to freshman students' psychological well-being. The authors found that increasing African American students' sense of belonging leads to positive outcomes such as higher grade-point averages.

Sense of Belonging Must be Fulfilled on a Consistent Basis

Vaccaro and Newman (2016) implemented a qualitative study to explore students' definitions and development of a sense of belonging during their first year in college. The study was conducted at a PWI, and the sample was comprised of 51 first-year undergraduate students, including five African American students. The authors found that the following themes shaped belonging: (a) environmental perceptions, (b) involvement, and (c) relationships. Additionally, Sax et al. (2018) conducted a quantitative study to examine changes in sense of belonging for women in URM undergraduate students in introductory computing courses. The study utilized data from 15 universities, and the sample included 42.1% women; of that percentage, 25.5% were URM women. The findings revealed that women experienced declines in their sense of belonging over time in the introductory computing courses.

Summary

African American women have made positive progress in higher education; however, they face challenges with degree completion in STEM majors, specifically engineering and computer science. The literature identifies challenges with campus climate, sense of belonging, and persistence in STEM among underrepresented minority students. Additionally, the literature identifies experiences related to the first-year experience of all college students. Still, there is limited research on the first-year experiences of African American women in engineering and computer science. Research is needed to help higher education administrators identify the needs of first-year African American women in engineering and computer science to create supportive environments and increase degree completion.

CHAPTER 3: METHODS

The number of people of color in engineering, computer science, and other STEM disciplines remains lower than that of their White counterparts. Specifically, African American women face challenges with degree attainment in engineering and computer science. Therefore, this qualitative study aims to understand the first-year experiences of African American undergraduate women in engineering and computer science majors at a PWI. This chapter outlines the methods that guided the data analysis for the research questions and findings. Chapter 3 will present the research design and methodological approach for this study. The following topics will be addressed in this chapter: (a) epistemology and methodology, (b) research design, (c) positionality/subjectivity, (d) ethics, (e) research site and participants, (f) data collection, (g) pilot study, (h) data analysis, (i) trustworthiness, and (j) limitations.

Research Questions

The two research questions guided this study: (1) What influences African American women's first-year academic major choices in engineering and computer science? and (2) How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework?

Research Epistemology and Methodology

According to Ravitch and Carl (2019), qualitative research is descriptive and analytic. It allows researchers to understand how individuals make meaning of their experiences. Qualitative research focuses on the depth of inquiry, and researchers use this method to gain a deeper understanding of a phenomenon in a particular setting (Neuman, 2014). Qualitative research seeks to "achieve an understanding of how people make sense out of their lives, delineate the process of meaning-making, and describe how people interpret what they experience" (Merriam

& Tisdell, 2016, p. 15). This type of research allows participants to understand their reality through subjective meanings and experiences (Creswell, 2013).

By conducting this qualitative study, I gained an in-depth understanding of the participants' first-year experiences as undergraduate engineering and computer science majors at a PWI. A key component of qualitative research is that the researcher is considered the primary instrument throughout the research process (Ravitch & Carl, 2019). As the primary instrument, my social identity and positionality may conflate or contour the research as it relates to processes and methods (Ravitch & Carl, 2019). Additionally, qualitative research is inductive in nature and builds concepts and theories rather than coming from a predisposed perspective like quantitative research (Ravitch & Carl, 2019).

Moreover, qualitative research is commonly associated with a constructivist paradigm. A research paradigm includes philosophical assumptions that impact how individuals view the world (Mertens, 2019). According to Mertens (2019), the constructivist paradigm assumes that people's realities are socially constructed. Also, constructivists seek to implement a more personal data collection method, such as interviews, to understand participants' experiences (Mertens, 2019). For this study, the data was co-constructed with the participants and me. The research paradigm for this study aligns with a constructivist perspective because the study aims to explore participants' lived experiences in engineering and computer science majors.

Research Design

A basic interpretive qualitative research design was used for this study which is commonly used in qualitative research (Merriam & Tisdell, 2016). Researchers who use this methodological approach are interested in (1) participants' interpretations of their experiences, (2) participants' construction of their worlds, and (3) participants' meaning attributed to their

experience (Merriam & Tisdell, 2016). Basic interpretive qualitative studies are not guided by philosophical assumptions found in other qualitative designs and do not have prescribed methods and analysis techniques (Caelli & Mill, 2003). Additionally, it gives researchers more flexibility, and data analysis concepts can come from theoretical frameworks (Caelli & Mill, 2003). This study will use sense of belonging as the theoretical framework in the data analysis process. Moreover, a basic interpretive qualitative research design was appropriate for this study because it allowed participants to describe and interpret their lived experiences as an African American woman in an engineering or computer science major at a PWI.

Positionality/Subjectivity

My previous experiences have shaped my desire to address the disparity gap among African American women completing engineering and computer science degrees. I have a parallel existence as a co-constructor of knowledge and as an observer seeking to understand the experiences of African American women. According to Jones et al. (2021), positionality refers to "what a researcher brings of themselves to the research process and how the researcher situates themselves in the research process" (p. 83). I acknowledge insider and outsider positionality for this study. As an insider, I identify as an African American woman and attended a PWI for my bachelor's and master's degrees. Also, I am currently enrolled at a PWI for my doctorate. Although I share similar identities with the participants, I do not intend to project my experiences onto them.

I previously worked as an undergraduate academic advisor in the college of engineering at a four-year public institution. As an advisor, I noticed that the number of African American women enrolled in engineering programs was minimal. Also, I noticed limited support resources specifically for African American women in the major. My personal experiences shape my

perceptions. I may bring certain biases to this study; however, I tried to ensure objectivity. I cannot take away or minimize my own experiences. As an outsider, I did not major in engineering or other STEM disciplines. I did not have to learn to navigate the STEM academic and social culture. For example, I did not have to take STEM foundational courses such as calculus and physics for my undergraduate major. My undergraduate experience did not include being in a male-dominated major. Also, the geographical location of the institution that I attended for my undergraduate degree was not in the Southeastern part of the United States.

Furthermore, I obtained a master's degree in clinical mental health counseling, so I understand the importance of students receiving support to be successful in college. Also, my background in counseling aligns with my desire to do qualitative research because it allows me to obtain in-depth information about participants' lived experiences. My counseling background helped me establish rapport with my participants so they could be comfortable sharing their experiences during the interviews. I used a self-reflective journal and implemented member checking to manage my own perspective and potential biases throughout the research process. Also, I debriefed with my dissertation committee co-chair throughout the research process to reflect on and manage my subjectivity.

Ethics/Protection of Human Participants

The protection of human participants is essential in all research studies. For this study, multiple procedures were implemented to minimize ethical risks. I obtained Institutional Review Board (IRB) approval before conducting the study. The IRB approval process provides a safeguard to participants through guiding principles such as confidentiality, anonymity, and informed consent (Jones et al., 2022). Additionally, each participant completed an informed consent form to participate in the study. The informed consent form included language that

informs the participant that their participation is voluntary and that they can withdraw from the study at any time without ramifications. Also, pseudonyms were used for all participants and the institution. These procedures helped reduce ethical risks and maintain confidentiality.

Research Site and Participants

Research Site

The study took place at a predominantly White, public research university in the Southeastern part of the United States. Rosen University, institutional pseudonym, was selected because a larger PWI was needed with a sufficient number of engineering and computer science students to be able to recruit African American women in the majors. Limited information about the institution will be provided to protect participants' privacy. Estimates of data provided from institutional data analytics included roughly 150 engineering faculty members, fewer than 40 women (26%), and fewer than ten African American women (6%). Comparatively, the total number of computer science faculty was roughly 80. The number of women faculty was approximately 25 (31%), and the number of African American faculty was less than five (6%). Computer science has a greater representation of women faculty members compared to engineering.

The institution offers a variety of engineering baccalaureate degree programs. The six undergraduate engineering majors included (a) civil engineering, (b) computer engineering, (c) electrical engineering, (d) mechanical engineering, (e) systems engineering, and (f) engineering technology. Also, they offer seven concentrations within their computer science baccalaureate degree program.

Sample Population and Sampling Technique

The institution has a diverse student population, even though it is considered a PWI. African American students make up 16% of the student body. Total undergraduate enrollment for Fall 2023 was slightly over 23,0000. Enrollment for undergraduates in the college of engineering was slightly over 2,700 for Fall 2023. The total undergraduate enrollment for the college of engineering based on race and gender for Fall 2023 was slightly over 200 women and slightly under 200 African American students. The number of African American students included slightly over 40 women. Enrollment for the undergraduates in computer science was slightly over 3,000 for Fall 2023. The total undergraduate enrollment for computer science based on race and gender for Fall 2023 was slightly under 600 women and slightly over 400 African American students. The number of African American students included slightly over 100 women. The institutional research analytics enrollment data included information on physical sex, though this study will focus on participants' experiences related to their gender.

This study used purposeful sampling. Researchers selected this sampling strategy because it can inform the research problem and be central to the phenomenon in the study (Creswell, 2007). According to Patton (2015), qualitative research does not have specific rules for sample sizes, and the sample size depends on the purpose of the study.

Participant Recruitment

To gain access to the research participants, I elicited help from two gatekeepers at the university. Usually, gatekeepers have some form of authority and can grant access to enter a research setting (Glesne, 2016). I contacted the assessment director in the college of engineering, and I contacted the graduate program director in the college of computing and informatics. These individuals served as my key contacts for this study. I requested that they distribute my

recruitment materials to individuals who met the participation criteria. The threat of a privacy breach to this study was minimal as the selected participants were deidentified with the use of pseudonyms.

An initial recruitment email was sent to potential participants' university email accounts, which are the official mode of communication. The email briefly described the study participation criteria and eligibility criteria. Data obtained from the institution's website suggest that approximately 120 students met the criteria to participate in the study. Participants replied to the initial email to express their interest in participating in the research study. Eligibility was determined based on a review of the demographic survey and its alignment with the study's purpose. To increase participation, a $25 Amazon gift card was provided to each participant as an incentive for participating in the study. A study conducted by Kelly et al. (2017) showed that monetary incentives showed greater willingness to participate in qualitative research than no incentive or nonmonetary incentive.

Participant Selection

For my primary participant selection, I initially sought to recruit ten to twelve participants who were engineering science or engineering technology majors, and their admission status into the university would be first-year college students, i.e., no prior college enrollment. The participants were of sophomore, junior, or senior academic standing, and self-identified as an African American woman. Initial participant recruitment did not secure ten to twelve participants who met these criteria, so I expanded my recruitment efforts to include transfer students and computer science majors with the same demographic and academic requirements. Three of my participants were engineering majors, and the other five were computer science majors. I used pseudonyms for all participants for confidentiality purposes.

Data Collection Procedures

Demographic Survey

The participants completed a demographic questionnaire to verify that they met the study's eligibility criteria. I distributed the demographic questionnaire to potential participants via Google Forms. The form gathered information about their race, academic major, age, and gender. Once their information was verified, they received a digital copy of an informed consent form to sign. Also, they received a Doodle poll link to provide their availability to meet. Once their availability was provided, their interview was scheduled.

Semi-Structured Interviews

The data collection method included one semi-structured interview. "In semi-structured interviews, the researcher uses the interview instrument to organize and guide the interview but can also include specific, tailored follow-up questions within and across interviews" (Ravitch & Carl, 2019, p. 134). An interview protocol was established with fifteen open-ended questions (see Appendix). Qualitative interviews can bring forth participants' lived experiences and help researchers understand similarities and differences within a cultural group (Tracy, 2013). Interviews provide depth to the participants' experiences and allow them to share their experiences in their own words.

All interviews took place via Zoom, and the audio recording function was used. Using a virtual platform, such as Zoom, can increase participation because it allows participants to complete their interviews from anywhere versus requiring them to come in for a face-to-face interview. The interviews lasted from 50 minutes to 60 minutes. I began the interview by reiterating the purpose of the study and discussing how the study was voluntary and that they could opt-out at any time without repercussions. I reassured the participant that a pseudonym

would be used to ensure confidentiality. I requested that they give verbal consent to continue with the interview. The Zoom audio recording was turned on once I received their verbal consent, following a signed informed consent. Zoom video conferencing was used to capture audio and video. Immediately after the interview, the video recording was deleted, and only the audio was retained for transcription. The audio recordings were saved on the cloud and were deleted once participants verified the transcription. For data recording keeping purposes, each recording was labeled with a unique identifier, for example, ENGR 01, CS 01, to protect the identity of the participants. The participants' names and identifiers were maintained in separate Microsoft Word documents to protect their identities. An interview protocol was established (see Appendix). The interview had four warm-up questions to build rapport with the participant. The next twelve questions were related to the participant's first-year experience. The main topic areas that the questions explored were: (a) first-year experience, (b) sense of belonging, (c) campus climate, and (d) personal connectedness. Following the interview, I used Otter transcription service to upload and transcribe the interview verbatim. Once I had the transcript, I listened to the interview audio recording while simultaneously reading the transcript line-by-line to verify accuracy. Once I had the completed transcript, I emailed it to the participants to allow them to verify the accuracy of the transcript. The responses I received from the member-checking process confirmed that the transcripts were accurate.

Pilot Study

The pilot study took place at a predominantly White four-year public research institution in the Fall of 2022. The pilot study focused on the first-year experience of one African American undergraduate female civil engineering student. Two interviews were conducted. The first interview was approximately 50 minutes, and the second was 25 minutes. The questions in the

first interview focused on success and challenges during the first year, and the second interview questions focused on campus climate. The themes that emerged included pre-college experiences, peer interactions, and faculty and staff interactions. The pilot study helped to inform the methodological approach for this study. IRB approval was not obtained for the pilot study, so the data from the pilot study was not used in the current study. The current study examines the first-year experiences of African American women students majoring in engineering and computer science at PWI, building on and differing from the findings of a pilot study.

Data Analysis Procedures

The interview recordings were transcribed verbatim using Otter transcription service. I used NVivo computer software to assist with organizing and analyzing the data. A thematic analysis approach was used for this study. According to Patton (2015), themes serve as interpretations of a pattern, and themes evoke the meaning of a pattern. A thematic analysis approach includes six steps: (1) become familiar with the data, (2) generate initial codes, (4) search for themes, (4) review themes, (5) define and name themes, (6) produce a report (Kiger & Varpio, 2020). First, I conducted a thorough, line-by-line reading of each interview transcript. This process was completed multiple times before starting the coding process to ensure I understood the data. In the first phase of coding, I used in vivo coding. In vivo coding is an inductive approach that emphasizes analyzing data based on participants' own words and phrases (Saldaña, 2021). This method allows researchers to uncover “what is not already known and how the problem/issue is understood through data analysis” (Jones et al., 2022, p. 210). Although in vivo coding is often associated with grounded theory, it was appropriate for this study because this method identifies codes directly from the participants' own words.

After establishing broad codes and categories through in vivo coding, I transitioned to focused coding to identify codes and categories specifically related to Research Question 1 (RQ1). Examples of codes identified during this phase include "advanced placement courses" and "familial influence." The categories derived from these codes included "K-12 education" and "parental expectations." Similarly, focused coding was employed to address Research Question 2 (RQ2), with codes such as "interpersonal relationships" and "departmental support" emerging. Corresponding categories included "multifaceted peer interactions" and "academic discipline impact." Focused coding, as Saldaña (2021) notes, involves categorizing “coded data based on thematic, categorical, or conceptual similarity” (p. 302).

Following the coding process, I identified patterns within the data by examining similarities across the content to uncover recurring themes. According to Jones et al. (2022), researchers look for themes that frequently appear in the data. These themes were then reviewed, defined, and named based on their respective content categories. This process was conducted in close consultation with my dissertation co-chair to ensure cohesiveness and accuracy. A thematic analysis approach was chosen for this study because it allows researchers to “summarize, highlight key features of, and interpret a wide range of data sets” (Kinger & Varpio, 2020, p. 8). This method was particularly appropriate for this study because it allowed me to analyze the data comprehensively.

Trustworthiness

Qualitative researchers seek to obtain trustworthiness (Lincoln & Guba, 1985), and trustworthiness provides credibility and rigor to qualitative research (Ravitch & Carl, 2016). For this study, I implemented three strategies to achieve trustworthiness. The first strategy was member checking, which describes how researchers check in with participants (Ravitch & Carl,

2016). Each participant reviewed their interview transcript and verified if it was accurate or if changes needed to be made. The second strategy was self-reflection. Self-reflexivity allows researchers to understand how their past experiences and points of view can impact their research (Tracy, 2013). I used a self-reflective journal to reflect on my personal experiences and potential biases throughout the research process. Also, I elicited feedback from my co-chair for the third strategy. These strategies enhanced the data quality for this basic interpretive qualitative research study.

Limitations

There are multiple limitations to this study. The first limitation was related to the research participants. Participants are self-selected for this study, so the study results will not include information about other individuals' first-year experiences who do not volunteer to participate. The second limitation pertains to the participants' self-reporting of their experiences and their being open and transparent about their experiences. Also, if the participants had junior or senior academic standing, accurately remembering their first-year experiences could be challenging. Another limitation was that individuals were not eligible to participate because they had changed majors. Individuals had to be current engineering, engineering technology, and computer science majors to be eligible to participate. Lastly, I will share the limitations during the data collection and analysis process in Chapter 5.

Summary

Chapter 3 focused on the methodology for this study. A rationale was provided for using a constructivist paradigm. A basic interpretive qualitative research study will be used to understand the first-year experiences of African American women in undergraduate engineering and computer science majors at a PWI. Chapter 3 provided an overview of the research site,

sample, data collection, and data analysis techniques. The study took place at a four-year public research institution, and eight participants were secured for this study. Each participant participated in one semi-structured interview. A thematic analysis approach was implemented to analyze the data. Additionally, ethical considerations, trustworthiness, and limitations were addressed in Chapter 3. IRB approval occurred before recruiting participants, and trustworthiness was established through member checking, self-reflection, and peer debriefing. Lastly, Chapter 3 addressed this study's limitations, including data collection methods and generalizability.

CHAPTER 4: FINDINGS

The purpose of this basic interpretive qualitative research study is to understand the first-year experiences of African American women in engineering and computer science majors at a PWI. The study is guided by Strayhorn's (2019) sense of belonging framework. This chapter will include participant summaries and findings of the salient themes and subthemes from the participants' interviews.

The two research questions guiding this study were: (1) What influences African American women's first-year academic major choices in engineering and computer science? and (2) How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework?

Participant Summaries

The data were collected at Rosen University during the Fall of 2023. The pseudonym Rosen University is used for confidentiality purposes. All the participants self-identify as being African American women. The participants' ages ranged from 20 years old to 22 years old, with the average age being 21. The participants were relatively high-achieving students based on their cumulative GPAs at Rosen University, ranging from 3.19 to 3.7, with an average cumulative GPA of 3.485. The participants' GPA calculations only included the grades from courses they completed at Rosen University. Three out of eight (37%) participants indicated they were first-generation college students. Five out of eight (62%) participants transferred from another institution. Two participants (25%) transferred from a 4-year institution, and three (37%) transferred from a community college. There were three engineering students and five computer science students. The majors, i.e., engineering or computer science, are denoted rather specific tracks or specializations, e.g., engineering science or engineering technology, to protect the

participants' privacy. A demographic summary of participants is shown in Table 2, followed by a contextual description of the participants, which briefly provides a mini vignette of each woman.

Table 2
Participant Demographic Summary

Pseudonym	Age	High School	Class Standing	Major	Transfer Type	Semesters at prior institution	Admit Type	Started at Rosen University	GPA	First-Generation
Katrina	21	STEM	Junior	Engineering	Public 4-Year	One	Transfer	Spring 2022	3.2	No
Tessa	21	Private	Senior	Engineering	Non-transfer	n/a	First-year	Fall 2020	3.48	No
Whitley	21	Dual Enrollment	Senior	Engineering	Non-transfer	n/a	First-year	Fall 2020	3.64	No
Crystal	20	STEM	Junior	Computer Science	Non-transfer	n/a	First-year	Fall 2021	3.7	Yes
Destiny	21	Public	Sophomore	Computer Science	Community College	unknown	Transfer	Spring 2023	3.5	Yes
Angela	22	Homeschool	Junior	Computer Science	Community College	Four	Transfer	Fall 2021	3.57	No
Brianna	20	Public	Junior	Computer Science	Community College	Two	Transfer	Fall 2022	3.6	No
Jennifer	21	AP Courses	Junior	Computer Science	Private 4-Year	Two	Transfer	Fall 2021	3.19	Yes

Katrina

Katrina is an undergraduate student in her junior year majoring in engineering. She expressed that she became interested in STEM in middle school. She attended an engineering early college high school. After one semester in college, she transferred from a four-year public institution. She participated in a 2+2 program at her prior institution, which allowed students to spend two years at one four-year institution and then finish their courses at another institution. Katrina seemed eager to share her experiences throughout the interview.

Tessa

Tessa is an undergraduate student in her senior year majoring in engineering. She expressed that she liked math and science in elementary and middle school. She was in a gifted program in middle school and was introduced to STEM. Tessa attended a private high school, and she became interested in engineering during high school. She started college in Fall 2020 during the global pandemic (COVID-19). She was also a student-athlete for her first two years in college; her parents and brothers are engineers. Tessa was relaxed and open to sharing her experiences throughout the interview.

Whitley

Whitley is an undergraduate student in her senior year majoring in engineering. She wanted to be a doctor in high school because of her parents. She mentioned that her parents were not born in the United States (second-generation immigrants). Whitley attended two different high schools simultaneously (dually enrolled). One of the schools was focused on career and technical classes such as engineering. She started college in Fall 2020 during the global pandemic (COVID-19), and received a full academic scholarship. Whitley demonstrated some hesitation in her responses compared to other participants.

Crystal

Crystal is an undergraduate student in her junior year majoring in computer science. She attended a STEM-focused high school where she learned about computer science. She enjoyed playing video games and took advanced placement (AP) classes in high school. Crystal indicated that she is a first-generation college student. She also mentioned that her mother did not get a chance to finish college, and she pushed her to excel academically. Crystal described herself as being shy; however, she demonstrated an upbeat demeanor and was open to sharing her experiences throughout the interview.

Destiny

Destiny is an undergraduate student in her sophomore year majoring in computer science. She expressed that she did not take "tech classes" in high school because they were AP courses, which "scared" her as a high school student. She started college in Fall 2020 during the global pandemic (COVID-19). Destiny transferred from a community college and indicated she is a first-generation college student. She described herself as being a quiet person. Destiny was more reserved in her responses compared to other participants.

Angela

Angela is an undergraduate student in her junior year majoring in computer science. She was homeschooled from 6th to 12th grade and practiced coding before she attended college. She attended a community college for four semesters before transferring. Angela described her first year of college as being "atrocious." She mentioned that she changed her major from biology to computer science two semesters after transferring. Angela seemed eager to share her experiences throughout the interview.

Brianna

Brianna is an undergraduate student in her junior year majoring in computer science. She expressed that she was not encouraged to explore STEM fields in high school. After two semesters, she transferred from a community college and participated in a transfer program that helped students transition to a four-year institution. She mentioned that her brother is a software engineer, and he introduced her to computer science. She changed her major from biology to computer science. Brianna demonstrated a calm demeanor and was open to sharing her experiences throughout the interview.

Jennifer

Jennifer is an undergraduate student in her junior year majoring in computer science. She completed AP computer science classes in high school. She started college in Fall 2020 during the global pandemic (COVID-19). She transferred from a 4-year private institution after two semesters and was a student-athlete during her first year of college. Also, she was a pre-med major prior to transferring. After transferring, she participated in a leadership program for one semester. She changed her major from engineering to computer science. Jennifer was relaxed and open to sharing her experiences throughout the interview.

Findings & Themes

The findings are organized based on two research questions with themes and subthemes. The themes and subthemes provide insight into the first-year experiences of African American women in engineering and computer sciences majors at a PWI.

Table 3
Summary of Themes and Subthemes

RQ 1: What influences African American women's first-year academic major choices in engineering and computer science?	
Themes:	**Subthemes:**
Intentionality in the decision-making process: Identification of early experiences for STEM access	I. Early accessibility to STEM disciplines in K-12 education II. Impact of the transfer process into STEM majors
Messaging: Parental "college-going expectations" vs. Family "STEM major selection" influence	I. Parental expectations foster postsecondary educational pursuits II. Family guidance influences STEM major aspirations
RQ 2 - How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework?	
Themes:	**Subthemes:**
Psychosocial influencers of belonging in STEM	I. Acculturation to STEM as a persistence mechanism II. Environmental impact as being conducive to inclusivity and well-being III. Departmental and/or institutional support systems contribute to integration and positive outcomes IV. Academic discipline impact as a determinant of belonging
Interpersonal agency toward socialization and engagement in STEM majors	I. Meaningful interactions with faculty and staff (positive and negative) II. Navigating multifaceted peer interactions to generate support and connection III. Student involvement as an aspect of social integration IV. Coping via socialization to leverage peer support

RQ1: What influences African American women's first-year academic major choices in engineering and computer science?

The significant themes associated with this research question include intentionality in the decision-making process and parental and family messaging.

Theme I: Intentionality in the Decision-Making Process: Identification of Early Experiences for STEM Access

Access to STEM disciplines at an early age allows women to develop interest and foundational skills that are critical to fostering success in STEM disciplines in the future. This can include STEM educational programs such as STEM-based high schools or taking advanced placement (AP) courses. The data illustrated that first-year experiences were cumulative of early exposure and accessibility to STEM disciplines.

Subtheme I - Early Accessibility to STEM Disciplines in K-12 Education

Introduction. The evidence of early access to STEM was prevalent in most of the participants' responses. The participants discussed liking math and science from an early age, attending STEM-focused high schools, and taking AP courses in high school. For example, Tessa, an engineering major, denoted how, since elementary school, she had always known she "really liked math and science." She specifically gained interest in engineering once she attended a private high school. Whitley, an engineering major, discussed how she wanted to be a "doctor in middle school." Her interest in becoming a doctor also correlates with her interest in STEM fields at an early age. Other participants described how they attended STEM-focused high schools. For example, Crystal, a computer science major, reflected on how she learned about the major in high school because she attended a "STEM-focused high school." Similarly, Katrina, an

engineering major, described how she went to a high school that "was specifically for engineering," and since middle school, she knew she wanted to "pursue something in STEM."

Additionally, some participants discussed their engagement with STEM prior to college. For example, Whitley reflected on how she took three electronic courses in high school. She expressed, "We did a lot of hands-on things, like simple things like building a battery out of lemons and pennies. So, I have always been around it. So I knew I wanted to continue that in college." In contrast, two out of eight participants discussed not taking AP courses or focusing on STEM in high school. For example, Brianna, a computer science major, described how she was not "encouraged to look into the STEM field" in high school, and it "wasn't until college" that she explored different STEM career paths. Similarly, Destiny, a computer science major, reflected on not taking AP courses in high school because they "kind of scared" her.

Career opportunities were another introduction that was beneficial for participants, such as Crystal, who denoted that she was introduced to three different career pathways in high school, which included biomedical engineering, mechanical engineering, and computer science. Crystal discussed how she "started really enjoying AP computer science" and how she could envision herself majoring in computer science in college. Similarly, Jennifer, a computer science major, expressed how she took "AP computer science in high school" and could see herself "doing this in the future." Katrina, an engineering major, denoted that the career outlook for STEM fields was one of the reasons she gained interest in the field. She expressed that "there will always be a need for engineers." Angela, a computer science major, indicated that the "computer science field will have more well-paying jobs because business and communications fields are pretty saturated." Similarly, Brianna indicated that she looked at the salary level for certain positions, such as "software engineers" and "cybersecurity," and she noticed the positions

would “make more money” in comparison to other career fields.” She also expressed that once she started coding, she realized that it would hold her “interest” and “drive” her to work harder in school.

Type of K-12 Education. The K-12 education system represents the participants' educational experiences prior to entering college. Foundational education provides participants with the knowledge and skills they need to succeed in postsecondary education. In many instances, K-12 education acts as a conduit to STEM majors and informed engagement with academic resources such as faculty and peers. Participants in this study tended to perceive first-year experiences from the context of their postsecondary experience. K-12 educational opportunities varied widely, ranging from public to private schools, as well as homeschooling, each providing different foundational experiences and opportunities that could influence pathways into STEM majors. An exemplar of this was denoted by Katrina, who indicated that she attended a “STEM-based” middle school and an engineering early college high school, both of which sparked her interest in pursuing a career in STEM fields. Similarly, Crystal, a non-transfer computer science major, indicated that she attended a STEM-based high school. She recounted being part of the inaugural class of designated STEM-focused students who were identified as “top achieving students.” According to Crystal, she did not want to join because she did not like math or science. She was perplexed as to why she would enroll in a program that focused on a curriculum that she lacked interest in, but her mother “didn’t want me to go to the regular high school” and advocated for the “stem focus[ed] one.” Tessa, an engineering major who attended a private high school, shared that she had started in public school and was in the “gifted program.” However, she transferred to a private school when she was in seventh grade. Tessa revealed that she was “introduced to STEM” at her private school, which she described as

a “step up” from her public school. During high school, Whitley, a non-transfer engineering major, was dually enrolled at a “main school” and a “career and technical” school. She indicated that the technical school offered a variety of programs, including “music, culinary classes, engineering, and coding.” Her K-12 curriculum provided access to courses that may be atypical in public schools, which allowed her to broaden her educational context. In sharp contrast, Angela, a community college transfer, reflected on her homeschooling experience. She was homeschooled from sixth through twelfth grade, but prior to sixth grade, she attended a public school.

Subtheme II - Impact of the Transfer Process into STEM Majors

Transferring in STEM was another prominent subtheme. The transfer function seemed to allow students the opportunity to explore majors of interest while also permitting them time beyond their K-12 experiences to further their education about STEM majors. Transfer students often face unique challenges as they transition from one institution to another. They often have to adapt to new academic standards and expectations while adjusting to a new social environment as well. Five out of eight participants were transfer students. For example, Katrina mentioned that she transferred from another 4-year institution and was part of a “2+2 program.” This program would allow her to spend two years at one 4-year public institution and another two years at a different 4-year public institution. However, she did not complete two years at her previous institution. Instead, she decided to transfer back to Rosen University “to be in a more familiar setting” because she attended Rosen’s engineering early college. Jennifer described how she transferred from a 4-year private institution and how she was a pre-medical major at her previous institution. While at Rosen University, she changed her major from engineering to computer science.

Additionally, three participants, Destiny, Brianna, and Angela, transferred from community colleges to Rosen University to major in computer science. Brianna and Angela were further comparable in that they both changed their majors as pre-transfer students. The rationale for the change of major was highlighted due to frustration and discontent in the initially selected major. For example, Angela expressed that she "really likes a challenge"; however, as "biology became more intense," she began to "dislike it." She recounted:

> I found myself very miserable, pretty much just doing that. It wasn't like your typical frustration, where you feel like, yeah, I could do it. I know, this is annoying, but I could do it, I just got to keep pushing through it. It was nothing like that. It was more of a drain, so I ended up switching to computer science. And the challenges that I faced with that particular field is completely different. I still have moments of frustration, but I'm highly driven, unlike with biology, where my drive just kind of fell off.

Angela did not experience the fulfillment of completing the challenging coursework for the biology major; however, her greater interest in computer science gave her the drive to push through the challenges she faced in computer science. Brianna expressed similar sentiments, noting that she had to "work hard" to remain interested in biology, whereas her interest in computer science was more engaging.

Theme II: Messaging: Parental "College-Going Expectations" vs. Family "STEM Major Selection" Influence

The messaging that the participants received from their parents and family members was a prevalent finding throughout the data. Parent expectations and family influence played a significant role in the participant's decision to attend college and major in STEM. Family influence refers to the degree to which family members support and contribute to an individual's

decision-making. Parental expectations and family influence can enhance an individual's opportunities and access to STEM disciplines.

Subtheme I - Parental Expectations Foster Postsecondary Educational Pursuits

Parental expectations were a noteworthy subtheme. Participants in this study suggested that their parents conveyed consistency in the messaging that a college degree was an expected milestone in their educational, career, and future planning beyond K-12. The expectations set the tone and provided a guidepost for participants to follow. Parental expectations can play a pivotal role in shaping an individual's aspirations and decisions regarding higher education. When parents place a high value on academic achievement, it often fosters a similar desire in their children to excel academically and pursue higher education. Six out of eight participants expressed how their parents' expectations influenced their decision to attend college. The participants identified their parents as being their mother and father. For example, Destiny indicated that her dad "pushed" her to go to college, which is "one of the main reasons" why she attended postsecondary education. Likewise, Jennifer revealed that, while growing up, her parents expressed she had to go to college. Katrina revealed that her parents attended college, and growing up, "that was the expectation" for her. Similarly, Tessa expressed that her "parents went to college," which is why she never questioned if she would attend college after high school. Angela decided to attend college "mainly due" to her "parents' recommendations." She described that her parents "were very adamant about" her attending college or a trade school.

Additionally, Whitley expressed that because she comes from immigrant parents, "the whole point" of them coming to this country was for her to "get an education and go to college." Whitley was a dual-enrolled high school student who came to Rosen University to major in engineering. Crystal, who attended a STEM-focused high school, indicated that she had to attend

college because of her mother, who “always pushed [her] to excel in academics” and acted as a key motivator and advocate of education. Crystal shared that her mother “didn’t get a chance to finish college,” thus early promotion and expectation of education was instilled that you’re “gonna go to school, you’re gonna go to high school, you're gonna go to college, you're gonna need a job.” Crystal extolled that education served as a roadmap for a career and that through her mother’s expectations, there was “already just kind of [a] set path for me.” However, Crystal was clear that she had educational aspirations and was not being pushed into something that she did not want, “I did want to go to college, just myself anyway. Once I really solidified what major I wanted to do, I wanted to go to college.” Similar to parental expectations, Brianna, a community college transfer participant, expressed how her parents’ encouragement influenced her decision to attend college. For example, Brianna denoted that her parents were “kind of old school,” and it “was hard for them to go to college.” She expressed that they “really encouraged” her to get an associate or bachelor’s degree.

Subtheme II - Family Guidance Influences STEM Major Aspirations

The prevalence of family influence among the participants was another relevant subtheme. Family support and encouragement played a key role in the participants' decisions to pursue a STEM major. Many participants acknowledged that their family members' positive influence and guidance significantly impacted their academic choices. Additionally, having family members already working in STEM fields was an additional source of motivation because they provided both inspiration and examples of the opportunities available in STEM careers. Four out of eight participants recounted how their family influenced their decision to major in either engineering or computer science. For example, Tessa denoted that both of her parents are “electrical engineers,” and she has two brothers who are engineers as well. Having early access

and exposure to the STEM fields provides an opportunity for early exploration and role modeling. Tessa shared

> I grew up always liking math and science and having an interest in those types of things. So I saw them do it and obviously, I gravitated towards what they did, seeing what they did for their jobs and stuff like that. So I was like, this is probably the field for me.

Similarly, Brianna shared that her brother influenced her decision to switch her major from biology to computer science. She indicated that her brother is very "active in academic life," and he is a "software engineer." Brianna expressed her dislike for biology to her brother, and he suggested computer science as an alternative. She revealed

> He got me a Udemy course. He got me into Code Academy. He started me on Leak code. He basically sent me other stuff to do and was like, find interest in something. He was like, even if you don't really find interest in like coding, it can take you a different avenue, you can do bioinformatics or you can just find your niche, but he was like, I think this is a good path for you.

Other participants discussed how their extended family members influenced their decisions to pursue a career path in either engineering or computer science. For example, Jennifer revealed that some of her family members went to college and got degrees in computer science. She expressed that "growing up [and] seeing how they used to make little small games, I was like, oh that's kind of interesting. I wish I could figure out how to do it. So then, I did AP computer science in school. And I was like, okay, maybe I could see myself doing this in the future." Similarly, Destiny expressed how her aunt inspired her to major in computer science. She denoted

> My aunt does a lot of computer science stuff and I went to work with her one day, and I got to see what they did. It looked kind of cool. Just being around her made me want to pursue a degree in tech, and computer science.

The participants expressed a common theme regarding the influence of their immediate or extended family members on their decision to major in engineering or computer science. Parental expectations and family influence played a significant role in shaping their decisions to pursue STEM fields.

RQ 2 - How are African American Women's First-Year Experiences in Engineering and Computer Science at a PWI Understood Within the Sense of Belonging Framework?

The major themes associated with this research question include psychosocial influencers, socialization, and engagement.

Theme III: Psychosocial Influencers of Belonging in STEM

The concept of psychosocial influencers refers to psychological and social factors that shape a person's sense of belonging within STEM fields. Multiple factors are associated with psychosocial influencers, such as environmental conditions and campus support systems. Additionally, belonging can also be influenced by specific academic disciplines. Different academic disciplines often have varying cultures and norms, which can positively or negatively affect belonging.

Subtheme I - Acculturation to STEM as a Persistence Mechanism

Acculturation to STEM describes how individuals adapt to and integrate into the norms and practices of prevalent STEM fields. This study identified the ways in which African American women began to evolve in their meaning-making process of what it meant to be in a STEM major and the strategies used for interactions at the institutional, departmental, and

personal levels. For example, the factors that can facilitate acculturation noted in this study included applied opportunities.

Applied Opportunities. Applied opportunities were valuable to the participant's experience. Applied opportunities provided the participants with practical, hands-on experience, which allowed them to develop skills for success in their academic discipline. Access to multiple experiences where participants could engage in the work of STEM majors was key in demonstrating the varying application and utility of classroom content. Four out of eight participants discussed how applied opportunities assisted with their integration into their academic major and college campus. For example, Angela, a computer science major, indicated that she practiced coding for “three years or so” prior to attending college. This experience provided her with some fundamental concepts of computer science. Similarly, Crystal, a computer science major, discussed how she played video games, which increased her interest in computer science. Video gaming can be closely linked with computer science due to programming languages such as Java and Python. Furthermore, Katrina and Whitley, engineering majors, described their experience with campus integration during their first year at Rosen University. Attending Rosen University’s engineering early college high school significantly aided Katrina’s integration into the campus. This early exposure allowed her to become familiar with the university's environment, resources, and academic expectations. She expressed

> My first year went pretty well. I want to say that I didn't struggle in a lot of areas. I see other students struggling it's just because I have the prior knowledge from high school. Because my junior year of high school, I was already on Rosen's campus, and we took a

> first-year seminar in high school. We were taught how to register for courses. I knew the campus already, I knew the bus routes. So none of that was really different.

Whitley recounted her participation in a STEM scholarship program during her first year, which taught her about leadership and dealing with imposter syndrome. Additionally, she shared her experience with a program geared towards first-year engineering students, which assisted with their integration into the engineering college. This program helped her learn how to "schedule classes" and provided "tips" on how to be a successful college student. She denoted

> They taught me the importance of going to office hours, and even if you don't really have a question, you should go to office hours anyway to connect with professors. They taught me about scholarships that are out there and just how to boost your GPA, [and] things like that.

These applied opportunities allowed the participants to gain a better understanding of their academic major and their college campus. Engaging in these opportunities helped the participants integrate into their academic major and campus community, fostering a deeper connection to their field of study and enhancing their college experience.

Subtheme II - Environmental Impact as Being Conducive to Inclusivity and Well-Being

Environmental impact refers to factors that influence aspects of student experiences. This can include factors such as a worldwide health crisis, departmental and institutional support, and academic major environment. In addition, the environment was noted as being conducive to supporting the first-year experiences; however, there were examples from the participant interviews that demonstrated hindrance to academic outcomes and overall well-being.

COVID-19. COVID-19 is a global health crisis that impacted higher education in the spring of 2020. This health crisis had a profound impact on students' experiences, such as the

transition to online learning, mental and emotional well-being, and cancellation of social and extracurricular activities. Five of eight participants outlined three impacts of COVID-19 on their first-year experience.

Socialization. First, three of the participants described the impact of COVID-19 on their socialization skills, which seemed to diminish. The limited socialization with peers was exemplified by Destiny, a community college transfer, who expressed how she was "locked in the house a lot during the COVID times" and how she did not "socialize with other people." Jennifer expressed similar sentiments, indicating that her social skills "went down very bad because of COVID." She also indicated that her first year of college got off to a "bumpy start" because she was quarantining due to COVID-19. She expressed, "we really didn't get like the transition from high school to college" as a descriptor of preparation that may have been anticipated for post-secondary enrollment. Likewise, Brianna described how it was difficult to participate in events because there were not a lot of events on campus due to COVID-19. She could not recall if she participated in any events during her first year because she did not attend virtual events.

Connection. Second, connection with peers as part of academics and student success was described as being limited with participants. Tessa discussed how COVID-19 significantly impacted her ability to connect with others. The restrictions and social distancing measures limited her exposure to individuals, making it difficult to build relationships. She denoted that "building relationships with people was a lot harder" during this time, which forced her to put extra effort into developing peer relationships in her sophomore and junior years. She understood that those relationships were important to not only her success but theirs as well.

> Because it's hard to not have study partners or not have people that you can depend on when you're going to miss class or things like that. Even with your professors, it's just harder to communicate with them when you never see them face to face, so that was a big thing.

Similarly, Whitley discussed the lack of connectivity with others due to taking classes online and being “behind a screen for a whole semester.” She denoted that it was “difficult to get to know people because you could not see them or talk to them as much.” Whitley expressed that, “it was rough kind of just [my] everyday routine was get up, do homework, go to sleep, because it's COVID, you can't really go anywhere as well. So yeah, it was just depressing for me.”

Academics. Furthermore, three participants described how COVID-19 impacted their academic learning experience. Notably, course content was understood in contrasting ideas of classes being easier, but engagement and retention of content were limited. For example, Tessa mentioned that she did not "retain as much information" with online learning and found the classes to be "a little bit easier online." Destiny, a computer science transfer student who started at a community college in 2020, at the onset of COVID-19 shutdowns in the United States, described online classes as being “pretty easy” and that overall online education “was easy”. However, when she enrolled at “Rosen University, being in in-person classes was kind of tough for me because paying attention was tough because I'm used to looking at a computer screen, doing my online classes, and then doing it by myself, not having lectures.” The level of engagement expected during in-person classes was very different from being online. She described the interactions with lectures and peers as being more communal in comparison to online learning, allowing for greater independence and being “used to learning on [her] own.”

In comparison, Whitley, an engineering major, was able to make the distinction of how being in person her second semester significantly improved her academic learning experience. She indicated that it was still "kind of awkward" when she came on campus because students had to sit "six feet apart" due to social distancing guidelines. However, she indicated that being on campus was positive for her overall academic well-being and enabled hands-on learning opportunities.

> I'll say most of the good parts happened during the second semester of my first year when I was on campus because then I could actually work with things with my hands, and the professor didn't have to do it for me. When I was taking classes online, we kind of had to do the calculations or draw out what we wanted to do, and then the professor would do it for us and test it for us to see if it actually worked. Once I got on campus, I started taking DC circuits and AC circuits as well. It was better [because] I can put things together and see why it works the way it does; I can see what the professor was saying or was teaching us in person.

Transitioning to in-person learning allowed Whitley to better understand her course material by actively engaging in the work herself rather than relying on her professors to do the work for her.

Adjustment to New Academic Life. Another prominent finding that emerged from the data was the adjustment to a new academic life. This adjustment included the need to adapt to new academic expectations and rigor. The participants reflected on their experiences and shared ways in which they had to adjust and adapt. For example, Jennifer highlighted the contrast in academic expectations between high school and college. She noted that there was no gradual transition, making the transition more difficult. Reflecting on her first year, Jennifer shared,

"There was really no transition between high school and college. So we went from doing high school work, like okay, this is easy. To all of a sudden, we have like three essays due tomorrow." This sudden increase in workload and academic demands was overwhelming. Additionally, Jennifer's challenges were heightened when she transferred to Rosen University. The combination of a demanding course load and participation in a leadership program was challenging for her to balance. She shared, “I was trying to juggle with a leadership program and all the other classes. I was taking 18 credits, my first year here, or first semester, horrible decision. So, I was just trying to juggle a leadership program and all my classes.” The pressure and workload caused significant difficulties, which led to her being placed on academic probation at the end of her first semester.

Whitley also shared her experiences adjusting to the academic demands of college coursework, expressing that the material was more strenuous than she had anticipated. She had high expectations for herself and felt pressured to keep up because "other people" seemed to understand the material better. This added to the stress of her academic transition. Angela, on the other hand, found adjusting to the "time demands" of college particularly challenging. She recalled her struggles with precalculus algebra at her community college, noting that she "bombed" her first attempt. Despite taking the course again, she was unsuccessful a second time. However, Angela viewed this experience as a valuable learning opportunity, emphasizing the resiliency and lessons she gained from these setbacks.

> I came out of the experience pretty proud of myself. Because I was like, okay, you bombed this. It kicks you in the shin pretty good. But you put in the effort. You tried, and you didn't just sit there and give up and say, Oh, my grade is at a 70; I need to give up. It's like no, even though it was a downhill losing battle, I still fought it. You know, it may

> have been kind of pointless, perhaps, but it showed me that hey, I don't get shaken up too easily, where I'm like, Oh, I'm just gonna give up. This is a losing battle. It's like no, it was a very helpful experience. I would say that was one of the most shaping experiences for me. It showed me that hey, failure is not the end of the world. You can always try again.

Angela displayed resilience when faced with academic adversity, demonstrating her ability to keep pushing forward despite the challenges.

Furthermore, two out of eight participants discussed their perception of the academic rigor differences between a community college and a four-year institution. Brianna, who attended public school before enrolling in community college and subsequently transferring to Rose University, expressed that she “struggled in a new way” with class difficulty and expectations related to the academic curriculum.

> I think just the overall expectation, and like, I don't want to say adaptability, but how the teachers were enabling students, I feel like [at my community college] , if you struggled with something, or if something was like a miss, teachers would kinda be like, okay, timeout, let's address this, let's hold off on assignments, you know. I feel like that was more geared towards freshmen.

Brianna described that there was a greater onus of responsibility on students for their learning and engagement with institutional resources, along with some level of preparation for this shift due to community college enrollment.

> When I got to Rosen, it was very much like, you're expected to know this. And if you don't, you need to go rely on resources and know it. And that was okay. I feel like it just

took some adjusting, but it was definitely something that I anticipated because there's a big difference between a community college and a four-year university.

Destiny expressed similar sentiments regarding the academic rigor between a community college and a four-year institution. She shared, "My community college was easy, I would say." She implied that Rosen University was "more challenging," initially thinking it would be as easy as her community college experience. Destiny particularly highlighted her struggles with specific courses, indicating that her math and introduction to computer science classes were her "hardest" courses. She acknowledged that she "was not as prepared" for the more rigorous academic environment at Rosen University, finding the transition more difficult than anticipated.

In contrast, two other participants discussed how the academic adjustment was not as challenging for them. For example, Crystal noted that since taking AP Computer Science in high school, she "already kind of knew a lot of the fundamentals" covered in class. She described her experience as being "pretty easy," indicating that her prior knowledge helped her transition smoothly into the college-level coursework. Similarly, Katrina revealed that her academic experience during her first year "went well." She expressed that "it wasn't too challenging" because she had "good homework habits" and would "try not to procrastinate." These effective study habits and a proactive approach to her coursework helped her manage the academic demands without significant difficulty.

Engaging Campus Environment - Feeling Welcomed. An engaging campus environment emerged in the findings. The participants recognized the importance of the campus environment and its impact on their overall experience. For example, Angela noted that it was difficult to engage with the campus environment due to her own personal “mental health issues that went misdiagnosed” during her first year. However, once she transferred to Rosen

University, she described the campus environment as “friendly” and “safe.” Similarly, Brianna also described Rosen University as having a “friendly” environment and expressed that students provide “social support,” contributing to a “community feel.” Crystal indicated that staying on campus and being involved on campus has allowed her to feel like she is “a part of the campus community.” She shared, “Just being involved on campus just kind of helped me feel more as a part of the community just through different relationships and bonds I've made with everyone here.” Another participant had a different perspective on the campus environment. Whitley articulated that it depends on where she is on campus and “who” she is around to feel like part of the community. She expressed

> The whole entire campus, I feel like I belong. But if I can, if I choose where I'm at and who I'm with on campus, and then yeah, depending on the organization or the color, and how diverse those are, then you feel like I belong. But I'd say it's in between, just depends on where you're at and what you're doing.

Jennifer indicated that the environment at Rosen University is “accepting” because students do not care about what you wear to class, contrasting her high school experience. This accepting environment allowed her to feel welcomed on campus. Similarly, Katrina described the Rosen University culture as “really welcoming.” She indicated that she has not “had any problems with feeling kind of out of place” as she did at her previous institution. She expressed, “I feel like it's way more diverse just because Rosen in general is really diverse.” Katrina had attended another PWI 4-year public university before transferring to Rosen University. Additionally, Tessa expressed that she “did not feel a part of the campus community freshman year,” but that “has since changed as time has gone on.” She noted that students can find their

"group of people" because there are opportunities for students to get involved with a "plethora of different clubs" and they can find their "identity in one of them." Tessa shared

> I do feel like it's inclusive. I mean, I know that, like, at this point in time, like the minorities will always be the minority group, in a big PWI, like we have here. But I don't think that should like to deter anyone from trying to come here to Rosen University, or whatever the case may be, because, like, you can always find your group of people, meet new people, start different groups, join different groups, like there's something for everybody.

Even though the participants attended a PWI, the institution provided a welcoming environment, which allowed them to feel more comfortable on campus.

Subtheme III - Departmental and/or Institutional Support Systems Contribute to Integration and Positive Outcomes

Findings from the participants' interviews indicate a clear emphasis on the impact of institutional-level support over departmental-level support. Participants reported greater involvement in programming and resources associated with the broader university campus rather than those specific to their departments. This suggests that institutional-level support played a more prominent role in their first-year experiences. In contrast, the lack of discussion about departmental-level support suggests that it was less impactful on the participants, which can also indicate a potential gap in resources at the departmental level.

Programming. The majority of campus programming focused on student success. During the interview, I provided examples of programming, such as mentoring, seminar courses, and learning communities. I also asked participants to discuss their experiences with

participating in first-year programming. The findings showed that three out of eight participants engaged in programming.

Three out of eight (37%) participants indicated that they participated in campus programming during their first year. Jennifer, a transfer commuter science major, participated in a "mentoring chat" during her first year at a private 4-year institution, which she found to be "somewhat helpful." She received information about the chat sessions as part of a first-year requirement. Destiny, a transfer from a community college in computer science, discussed how she was required to participate in a transfer orientation program at Rosen University, which helped her adjust to the campus. She indicated that orientation made learning about the campus much easier. She described how becoming familiar with campus buildings and learning about various campus resources proved to be very helpful. Similarly, Brianna, a transfer from a community college, described how she participated in a transfer success program that helped her navigate her first year and provided a seamless transition to Rosen University. She explained the benefits of the program that allowed her to "[meet] a lot of people" including faculty and students at different events. Brianna described the engagement and "exploring campus" as "super fun."

In contrast, other participants discussed how they were made aware of programming available on campus but chose not to participate. For example, Tessa, an engineering major, indicated that she did not take part in campus programming and regards that decision. Katrina, a transfer engineering major, expressed similar regret about her lack of campus programming participation.

> I'm just not really the type to go into programs and stuff like that. Just because I don't know. That's one of the things I'm working on. Those kinds of things make me nervous

> and a little scared, so I didn't really participate too much in things that are offered to first years. I did see them. I saw my friends would participate in them, and they looked fun, but I just never really got around to doing it.

Similarly, Crystal described why she did not participate in a learning community during her first year. She explained that she only heard about the learning community when she first applied to the university; however, she did not know much about learning communities and, therefore, did not understand their value. She thought that the learning community would "isolate" her from meeting other people in different majors. However, she expressed that it probably would have been beneficial to participate in the learning community her first year because she would have had a chance to develop relationships with other computer science majors and build a more "diverse support system." She believed this could have helped her with her introductory classes, which were mainly online, by allowing her to know more people within her major. Participants were more likely to engage in programming when it was mandatory. However, when attendance was optional, there was a notable tendency for students to opt out.

Student Support Services. Seven out of eight participants discussed how they were made aware of additional campus resources, such as tutoring and counseling services, during their first year. For example, Crystal, a computer science major, discussed how she utilized tutoring, which helped her with her Calculus I course. Katrina and Tessa, engineering majors, recounted using the Writing Center on campus. Brianna, a computer science major, described her experience with utilizing counseling services on campus. She shared, "I know I went to a lot of workshops. It was mainly for counseling. And it wasn't like because anything was wrong, but it was just kind of help with my emotional intelligence. I felt like I needed that."

In contrast, Angela, Destiny, and Jennifer, all computer science majors, revealed they did not utilize tutoring or office hours. Angela indicated that she "did not use any supports," such as tutoring or attending faculty office hours. Destiny revealed that she did not feel like she needed additional support, so she "didn't look into it." Similarly, Jennifer expressed that while it was conveyed to her to attend faculty office hours, she did not utilize the resource.

> Their favorite thing to say was always go to office hours, but again I didn't know. Growing up, I just imagined going to office hours for your teachers class, you're in trouble. So I was like, I don't really think that's the best idea. But I know now that you should probably go to office hours.

Utilizing departmental and institutional support and resources can help students integrate into the academic and campus environment and contribute to a positive college experience. Students who do not utilize support may miss out on chances for academic improvement and personal growth.

Subtheme IV - Academic Discipline Impact as a Determinant of Belonging

Academic discipline impact refers to a variety of factors that either support or hinder the progress of African American women in engineering or computer science majors. Understanding these factors is essential for creating an environment that fosters academic success and inclusivity. Academic discipline impact was a noteworthy subtheme among the participants who described the gendered and racialized perspectives that were at times dominant and created a sense of exclusion.

Engineering. Four out of eight participants described the impact of the engineering discipline on their first-year experience. Jennifer, who took advanced placement courses as part of her K-12 education and transferred from a private institution, changed her major from

engineering to computer science and described the exclusivity based on gender and how it became an obstacle to navigate as part of her academic matriculation.

> In engineering, it just felt like a huge boys club. So like, even if I had an opinion, I don't feel like it would have been heard or at least like attempted to listen to [you] versus like in computer science. I feel like there's more understanding.

She decided to switch majors because she felt seen, heard, and part of the disciplinary major rather than disconnected.

Katrina indicated that her experience with engineering students was “kind of frustrating” because students in “engineering come in thinking they know everything” suggesting that they were bolstering in a way. She insinuated that the gender makeup of her engineering classes was mainly White males. She also revealed that engineering is not as “welcoming” as campus in general. Katrina expressed that “engineering professors are usually “more serious” and “it is kind of hard to feel welcomed. Furthermore, she expressed how she does not currently feel like she is a part of the engineering community, “I still don't really feel that a part of it just because, I feel a little, I don't see myself, I guess.” Katrina continued to describe the role of race broadly on campus as contrasted within STEM majors.

> I feel like that's what makes you feel most familiar because when I go on campus, you know, I see tons of other Black women. And like, in STEM in general, I know there's a bigger population of Black women in computer science, but you get in the engineering building, it's just a lot of like, there are no familiar faces, you know, everybody kind of like, is with their own groups.

Katrina outlined the necessity of being part of a community or social support.

> I feel sometimes when you don't have a group, especially in engineering, it's kind of hard because people will create study groups, and they'll create, I wouldn't say cliques, but they'll create, just groups of people that all come together.

Katrina described the nuance of race linked to group support as being "just a little different, because the main population in engineering is White men. And I felt that sometimes when talking to people, I don't see common interests. And it kind of makes [it] a little awkward. So, I feel like that doesn't create as much of a sense of belonging. She expressed that she "[doesn't] see [herself]" within the engineering community, making it difficult to feel comfortable. She indicated that the campus community has a "ton of other black women," especially in STEM in general, specifically in computer science. However, in engineering, "there are no familiar faces." Katrina's experience speaks to the disconnection and isolation she felt within the engineering community.

Similarly, Tessa denoted that she did not feel a part of the engineering community during her first two years at Rosen University. She denoted that "it's less diverse than like campus as a whole." She expressed that on the engineering side of campus you "obviously see less people of color you [and you] obviously see less women." She conveyed that the engineering side of campus is more "secluded." Comparably, Whitley discussed how the campus's engineering side differs from the main campus. She expressed, "I really don't see that much diversity over there." Also, she expressed that "it's a bunch of antisocial people" and she "does not expect to develop relationships with her classmates outside of the classroom."

Whitley also shared an experience with participating in an engineering leadership program during her sophomore year and how she found it challenging due to her being the "only black person" in the program. She expressed that she was surrounded by "White people," and it

“felt so awkward.” She expressed that she wanted to “drop out” because she only felt “welcomed” by the professors versus students. Whitley decided to complete the program because, ultimately, she wanted to “learn how to become a leader in the engineering community.” Eventually, her experience got better as she went through the program. However, it was a challenge in the beginning. Whitley’s experience in the engineering leadership program during her sophomore year highlights the continuous challenges African American women face as they matriculate through STEM majors.

Computer Science. Five out of eight participants highlighted their experience within the computer science discipline. For example, Angela expressed her appreciation for the computer science environment, noting how it has enabled her to lead group projects despite being "a pretty quiet person." She shared, "The huge highlight about computer science is that I like that feeling of being able to lead projects. I love that feeling of being responsible for getting projects done, managing projects, and managing people." Other participants highlighted the impact of diversity within the computer science discipline. Crystal mentioned that “the computer science department is really diverse,” noting that she has seen “more and more women” in her classes at Rosen University, which provides a “sense of support.” She also described the environment as “collaborative.” Similarly, Jennifer observed more African American students pursuing “computer science or software engineering.” She noted that “there are a lot more women in computer science,” which means “it doesn’t feel like a boys' club.” Jennifer indicated that this welcoming environment has “pushed” her further in her studies.

While many participants highlighted positive aspects of diversity and leadership opportunities within the computer science discipline, one participant expressed how the environment can be intimidating. Brianna revealed that her peers are “very locked in on what

they do," which made her feel insecure about her abilities. She shared, "I feel like right off the bat, maybe it's just like my insecurity. You're not feeling competent, in my abilities, but right off the bat, I'm already like, you know, I'm not on their level or where they are." Brianna felt the need to work harder to prove she was on the same intellectual level as her peers. She also noted that having "only like five girls" in each of her classes combined impacted how comfortable she felt within the computer science discipline.

Theme IV: Interpersonal Agency Toward Socialization and Engagement in STEM Majors

The notion of interpersonal agency toward socialization and engagement refers to how individuals navigate their social environment by interacting with various groups, including faculty, staff, and students. Additionally, involvement in social activities, such as participating in student organizations, allows individuals to build stronger support networks. These networks are critical for emotional and academic support, which can enhance student success.

Subtheme 1- Meaningful Interactions with Faculty and Staff (Positive and Negative)

Faculty and staff members significantly impact students' sense of belonging through meaningful interactions, which can be both positive and negative. These interactions can shape students' experiences and influence their overall success.

Positive Faculty Interactions. The majority of the participants described positive and welcoming interactions with faculty members during their first year of college. Collectively, the participants' perceptions of interactions were suggestive of faculty being approachable and willing to assist students. For example, Tessa, a senior engineering major, expressed that "overall" she had "good experience" with her professors during her first year. Similarly, Whitley, a senior engineering major, denoted she had positive interactions with multiple faculty members during her first year. Jennifer, a junior, indicated her computer science professor was

“welcoming” and helped her greatly. She expressed, “Dr. Marshall [class] was my first computer science class, and he was very welcoming. He helped me right on the spot instead of just pushing me like blowing me off and telling me to go to his office hours.”

Likewise, Angela, a junior, indicated that her computer science professors were "really sweet and cool people.” She appreciated how they addressed her so she did not feel “pitied” when asking for help. Brianna, a junior, discussed her positive experience interacting with computer science faculty members. She denoted that she was surprised that they were very “supportive,” and provided her with resources and advice. Brianna expressed that she felt “completely supported” by faculty. Destiny, a junior, also described her positive relationship with two computer science faculty members. She expressed that she considers them to be her “school teacher aunts” and she “can go to them for anything.” Katrina, a transfer junior engineering major, expressed how she “loved” all of her professors. She describes specifically how one professor checked on her during her first semester.

> She noticed that I was kind of distant in class and a little alone. My first day after class, she emailed me and was like, hope you're okay, wondering if you're just a little quiet or shy. If you need to talk like I'm here for you. And that made me open up more.

Negative Faculty Interactions. In contrast to positive interactions, there were also some negative interactions. For example, Crystal and Jennifer discussed negative interactions with faculty members. Crystal indicated an unpleasant encounter with a computer science professor when she asked for help on a class project, stating that he responded in somewhat of a sarcastic manner. She shared

> He was like, “Oh, you know, just read it”, haha. And I was like okay, that's an odd response to what I said, I'm like, that's a little rude. I knew he was laughing. So I just kind

> of laughed it off with him. Like it was kind of like a joke. But I'm like, you could have just helped me without the extra comment. That was only the main time I ever actually spoke to him. After that, I was kind of like, I don't really want to ask you for help again.

As previously stated, Jennifer was a pre-med and engineering major before switching to computer science. She did not express positive sentiments about her engineering faculty. Jennifer described a particularly negative experience with one of her engineering professors. She faced significant grading issues that ultimately led to a drastic drop in her grade, resulting in her ending up on academic probation. Jennifer approached the instructor to understand what went wrong. However, he did not provide any useful feedback and stated that she "should have gone to office hours." Jennifer was unaware she was failing the course, so she did not know she needed additional help. In an attempt to appeal her grade, Jennifer emailed the director of the engineering department. Unfortunately, he sided with the professor. Jennifer later found out that the engineering department director was also her professor's mentor. She expressed her frustration, stating, "You're basically just like, covering for him over taking the students' requests or concerns." She described the experience as being "horrible." In contrast, one participant described how she did not interact with faculty during her first year. For example, Angela described her lack of connection with faculty, expressing, "I just didn't see the use. I didn't see what the purpose was of connecting to faculty and staff. I didn't see any worth or use in it."

Positive Staff Interactions. Many of the participants described their interactions with staff members as being pleasant. For example, Crystal, a junior computer science major, described her academic advising experience as being "overall pretty positive." She explained how her advisors were "really nice and respectful," which she identified as being "super

important" for first-year students. Similarly, Katrina, who attended a STEM high school and enrolled at Rosen University as an engineering major, expressed positive sentiments regarding her advising experience. She shared

> My transfer advisor coming into engineering, I loved her. She was really sweet, and they were all really supportive, especially my first year. They helped me learn classes I needed to take, or if I needed help, I could just go to them and be like should I do this or that? But it's nice knowing that if you need help, if you need support, there's always someone you can go to talk to.

Brianna, a community college transfer student, described how she encountered positive experiences with her computer science academic advisor. She described how her advisor was "very attentive," and he had an awareness of when she was experiencing stress or difficulties. For example, Brianna's advisor was an active listener who commented, "You sound like you're struggling with something," and he made "a very big effort to connect with students." Brianna continued to explain that

> If I have an issue, or if I'm worried about a class, and I'll email him, and he'll try to get back to [me] on the same day, you know, or I'll be thinking about this and thinking about this and he's like, these are all these resources. These are people you can meet at these events you can go to. It was just very much like; I hear your concerns. I hear your worries, I'm here to help. I felt like he just provided the most support for me through this whole experience.

Negative Staff Interactions. In contrast to the positive staff interactions, two out of eight participants discussed unfavorable experiences with staff members. For example, Angela, a community college transfer, described an unpleasant encounter with her computer science

academic advisor after she did not pass her Calculus I course, which was necessary for her to graduate with a Bachelor of Science degree. Her advisor suggested she switch to a Bachelor of Arts degree, which she found “completely insulting” and “completely atrocious.” Angela expressed feeling “offended” by his comments because she perceived the Bachelor of Arts degree to be less rigorous than the Bachelor of Science degree. She did “not want to take the easy route” and indicated that this experience “turned [her] off” and led her to “dislike” advising appointments from that point forward.

Additionally, Jennifer, a transfer from a private university and computer science major, described a negative experience with her track coach due to her being late to track practice because of her professor. Jennifer was a notable exception of the participants who described the desire to remain engaged in collegiate athletics but also the potential pitfalls of being in a competitive academic program. She described the delicate balance between being a student and an athlete. She noted an example of her being late to practice due to an extended class meeting, where her “coach lost faith” in her. Jennifer was chastised by her coach who felt she “lied” and that she was “letting down the team.” Her coach went on to reprimand Jennifer by stating that she was “letting down your coaches, teachers, and the staff [no longer trusted her].” Jennifer explained the fallout of that experience became

> a big turning point because I don't really feel comfortable, you know, running for you if you're just gonna assume I did the worst. But then my friend who happens to be White, she was never at practice. Never had an excuse, but she always got to run in track meets I'm like, why is there like, you know, a difference in how you treated me versus her?

Favorable and unfavorable faculty and staff interactions can impact students' overall experience and college journey. These interactions can shape a student's perception of their ability to

succeed. Students who feel unsupported by university faculty and staff can potentially lead to negative academic outcomes and decreased motivation.

Subtheme II- Navigating Multifaceted Peer Interactions to Generate Support and Connection

Peer interactions played a crucial role in shaping the participants' first-year experiences, offering academic and emotional support. For instance, Jennifer's connections with students from her home state provided her with a sense of comfort, significantly enhancing her first-year experience. Similarly, Crystal's positive relationship with her first-year roommate was instrumental in enhancing her experience. She shared, “My roommate that I met, we clicked almost instantly. And we're both computer science majors as well. So we have the same concentration so we’re always taking the same classes. And so we've been roommates ever since.” She indicated that her roommate is Asian, and it was her first time being exposed to a different culture because her high school environment was mainly Black and Hispanic students. Crystal also recognized the value of a support system within her major and how it can make a significant impact. She denoted that “computer science is very hard, so it's always nice to just kind of find your people, find your support system, and then you'll be able to get through it.” Moreover, Destiny discussed how she met her mentor during her first semester while attending an academic conference. This connection was valuable because she offered her guidance and support as she navigated her new academic environment. She revealed

> A student I met there, April, she's a good friend now. She's like a mentor to me now because she's in the graduate program and I can ask her all of my questions because I also want to get my master's degree. So whenever I have a question about school or getting my master's I can go to her and ask all my questions.

In contrast, Angela, Whitley, and Brianna expressed how they experienced some challenges with peer interactions. For example, Angela revealed that “when it comes to friends, that is a no go.” Angela, a computer science major, was also homeschooled prior to entering community college and subsequently the university. She indicated that peer connections “has not been a reality” for her college experience.” Whitley, an engineering major, who was dually enrolled in high school prior to entering the university, indicated that she “didn’t feel connected” to students in her classes. Similarly, Brianna, a computer science major, expressed how it is “a little bit harder to make friends in the major sometimes” especially if you are a female. She described her peers as being “standoffish.” Brianna noted a gendered preference in peer interactions that was more pronounced with women students than male students. She revealed

> Like guys will be guys, and they're gonna like, I think they have their own way of making friends and getting in close groups. If you don't come in having a formidable group of friends, you're not instantly going to be accepted into a group or a clique, especially of guys. Definitely, I feel like female students could relate to what I was going through, but [I] don't think the guys did at all.

Katrina, a junior engineering major, expressed similar frustration with peer interactions. She shared that she often felt as though her peers did not take her seriously or believe she knew what she was talking about, which she found extremely frustrating. In lab settings, she noticed that her input was frequently ignored, even though she felt she was “right” the majority of the time. The lab “TA” would often confirm she was right, yet her classmates would still double-check with someone else, undermining her credibility. Katrina observed that this treatment was not as common for White students, which led her to feel she had to prove herself more. Due to

this, she developed a preference for working alone. Negative peer interactions can indeed have a significant impact on a student's connection to their academic environment.

Subtheme III - Student Involvement as an Aspect of Social Integration

Being actively involved or a part of something correlates with sense of belonging, which allows individuals to feel valued and accepted. Student involvement was identified as a prominent subtheme among seven out of eight participants. Participants discussed their involvement or lack thereof in student organizations on campus. Whitley indicated that she joined two engineering organizations in her first year, one being the Society for Women in Engineering (SWE); however, they did not have a lot of events because of COVID-19. She highlighted that she is "just now realizing" in her senior year that it would have been helpful if she had participated in student organizations earlier in her college career, such as the National Society of Black Engineers (NSBE). Similarly, Jennifer expressed limited participation in student activities during her first year at Rosen University due to juggling her coursework and a leadership program. However, she later joined student activities such as the women's basketball club and women's rugby. Tessa noted that she joined a "student-athlete" organization and another student organization that raised "awareness" about racial inequities in sports. Destiny revealed that she attended a student organization interest meeting for "BRSN;" however, she could not recall what the acronym stands for but expressed that it involved "a lot of black people in technology and computer science."

Moreover, Brianna denoted that she had attended two "Girls Who Code" events, and she was invited by another African American woman student who was a part of the organization. Brianna also discussed why she did not try out for the "Overwatch team" because there were "no girls there." She questioned if she would feel comfortable in the space because no other girls

were on the team. Alternatively, Crystal discussed why she preferred to participate in NSBE versus other computer science student organizations. The saliency of race and gender were underscored across the narratives within STEM. Crystal surmised that while there were organizations based on gender, they were not necessarily spaces that felt welcoming but more so increased feelings of isolation. She expressed

> Sometimes in the other computer science orgs. Like Girls Who Code and ACMW [Association for Computing Machinery's Council on Women in Computing]. It's like there [are] others, you know, it's like for girls in computer science, but a lot of the Black girls in comp sci that I spoke to, they kind of felt a little isolated from those other groups, or they didn't feel too comfortable. Or it's kind of like, they couldn't really go talk to them too much. Probably because they're probably one of the only few Black girls there and the rest of them are usually White, or maybe Indian, but mostly White. So even then, that can be an isolating experience too. So then I encourage them to join NSBE. We're all Black here, so it's open to people from all majors.

While groups, such as Girls Who Code and ACMW, offer support and resources, they often have a very small number of African American women members. This lack of representation can make these spaces feel uncomfortable and isolating for African American women, thus negating a sense of belonging. Crystal noted that she was able to connect and "build community" with other computer science students in NSBE. Similarly, Katrina revealed that she was active in the "Black Student Union" because she "wanted to find like-minded people."

Subtheme IV - Coping via Socialization to Leverage Peer Support

Another noteworthy subtheme was coping via socialization. The participants recognized the importance of socialization, emphasizing its impact on their connections with peers and their

overall sense of belonging within the campus community. Destiny, Jennifer, and Katrina all faced challenges with socialization, but they found ways to connect with their peers, despite their introverted nature or initial reluctance. For example, Destiny expressed her experience with socializing with others. She indicated that she is a “quiet person” and has a speech impediment, which makes her “not want to talk to a lot of people”. She revealed, “I'm not really a social person. So I don't really pay attention to my peers.” However, Destiny did express that she made herself interact with a few classmates because she needed help on a class project. Due to this experience, she learned more about her peers, and she expressed that she has a “small friend group now.” Similarly, Jennifer indicated that her social skills diminished due to COVID-19, so she had to get out of her “comfort zone” to socialize with her peers, and she indicated that it was helpful to do so. Katrina conveyed that making friends in college is “really the hardest part.” She revealed that she is a “pretty introverted person” and has to “insert” into social spaces and get herself “out there.”

Conversely, Angela and Whitley struggled with socialization, highlighting the negative impact of a lack of connection. For example, Angela noted that connections with her peers have not been a part of her college experience. She indicated that socializing with her peers is “pretty much absent.” Angela, a community college transfer, described the complexity of how she “never felt connected to people” and has “this chronic sense of disconnect.” Similarly, Whitley, who was a dual-enrolled high school college student prior to enrollment at Rosen University, expressed how she felt “lonely” during her first year because she had difficulty connecting to her peers. In addressing loneliness she described the need to assert more efforts toward socialization. She tried to immerse herself into campus life and “get [her] name out there”. She indicated that she had to do more compared to others to find connections.

> So I would join multiple clubs and just do different things around campus, hoping that it would help me connect with people who maybe don't even look like me. You know, I'm just trying to connect with anyone at this point and that didn't work.

Even though Whitley faced challenges with making connections on campus during her first-year, she shared that she has been able to build more relationships since then. The participants' experiences highlight the importance of socializing as a coping mechanism for personal and academic growth, which can positively impact a student's college journey.

Summary

Chapter 4 provided an overview of the participant summaries and findings of the salient themes and subthemes derived from the thematic analysis. The findings were organized based on the two research questions, with two themes relating to research question one and two themes relating to research question two. The four major themes included: (1) intentionality in decision-making processes: identification of early experiences for STEM access, (2) messaging: parental "college-going expectations" vs. family "STEM major selection" influence, (3) psychosocial influencers of belonging in STEM, and (4) interpersonal agency toward socialization and engagement in STEM majors. Chapter 5 will discuss the relationship between the themes and the sense of belonging theoretical framework. Also, it will provide implications for higher education administrators and recommendations for future research.

CHAPTER 5: DISCUSSION

Despite national efforts to increase STEM participation among underrepresented minorities, African American women still face substantial challenges with degree attainment in engineering and computer science. The purpose of this basic interpretive qualitative research study is designed to understand the first-year experiences of African American women in engineering and computer science majors at a PWI. Unlike a significant amount of research that focuses on the experiences of all women of color or URM in STEM, this study has a unique focus on the critical and underexplored aspects of the first-year experiences of undergraduate African American women who are engineering or computer science majors. This chapter will discuss the connection between the study's key findings and previous literature. Also, the chapter will address the study's limitations and implications for future practice and research.

Summary of Findings

The findings from this study responded to the guiding research questions: (1) What influences African American women's first-year academic major choices in engineering and computer science? and (2) How are African American women's first-year experiences in engineering and computer science at a PWI understood within the sense of belonging framework? There were four key findings that emerged from the data, which include: (1) intentionality in decision-making processes: identification of early experiences for STEM access, (2) messaging: parental "college-going expectations" vs. family "STEM major selection" influence, (3) psychosocial influencers of belonging in STEM, and (4) interpersonal agency toward socialization and engagement in STEM majors. Early exposure to STEM can significantly impact a student's interest and confidence in pursuing engineering and computer science. Family support and expectations are crucial because they can motivate and guide

students toward STEM careers. Psychosocial influencers can help students integrate into the STEM community, impacting their persistence and success in these disciplines. Additionally, interpersonal agency toward socialization and engagement allows students to build support systems and participate in activities or organizations that enhance their sense of belonging. The findings suggest that multiple factors influence the first-year experiences of African American women in engineering and computer science. These experiences are not one-dimensional but are multilayered, including various challenges and supports.

Discussion of Findings

Strayhorn's (2019) sense of belonging model was used to help frame and understand the first-year experiences of African American women in engineering and computer science majors. Previous literature has emphasized the critical role that a sense of belonging plays in the experiences of URM women in STEM majors, as highlighted by Johnson (2012) and Ong et al. (2018). The findings suggest that African American women pursuing engineering and computer science degrees encounter distinct experiences related to sense of belonging, which influences their first-year experience. Importantly, these findings reveal that the experiences of African American women in these fields are not monolithic; rather, they are heterogeneous and shaped by various factors that contribute to the complexity of their college experience. This highlights the need for nuanced and individualized support mechanisms that address the diverse needs of this student population to enhance their sense of belonging and academic success.

Intentionality in Decision-Making Processes: Identification of Early Experiences for STEM Access

Early Accessibility to STEM Disciplines in K-12 Education

The influence of K-12 education was prominent within the data. Participants in this study had access to early STEM education opportunities, such as attending STEM-focused high schools and enrolling in AP courses. Similar to previous literature, early success in mathematics and science is associated with a greater likelihood of students choosing to major in STEM disciplines (Thompson, 2021). This suggests that the foundation built during K-12 education plays an important role in shaping students' academic and career trajectories in STEM fields. Prior literature has emphasized that pre-college experiences are closely associated with the success of African American women in post-secondary education (Porter et al., 2018). In contrast, other studies have highlighted that historically, students from culturally diverse backgrounds have often lacked adequate STEM preparation (Bottia et al., 2021; Young et al., 2019). However, participants in this study were afforded the opportunity to be exposed to STEM at an early age. This early exposure likely contributed to their readiness to pursue STEM fields, contradicting some of the common trends observed in the literature.

Impact of the Transfer Process into STEM Majors

The findings revealed that the transfer process in STEM was another prominent experience among the participants. This suggests the importance of understanding the transfer experiences of African American women in engineering and computer science and how it can impact their overall adjustment to a new campus environment. Previous literature has highlighted the significance of institutional programs focusing on transfer student success by focusing on academic and non-academic supports (Ghazzawi et al., 2021). By focusing on academic and non-

academic supports, institutions can help African American women in engineering and computer science disciplines transition smoothly and thrive in their new academic environments. This support allows students to develop a connection to the institution, which enhances their sense of belonging.

Additionally, the findings highlighted that switching majors in STEM fields was common among first-year students. Prior research has identified that low academic performance in mathematics and science courses plays a role in women switching their major in STEM (Ellis et al., 2016; Russell & Russell, 2015). However, this study revealed that disinterest in the initial STEM major is a significant factor. For example, Angela shared that she felt “miserable” in her biology courses, which ultimately prompted her to switch her major to computer science. These findings highlight the importance of major switching as a crucial aspect of the first-year experience. Broadly, there is an opportunity for STEM departments to include as part of the FYE opportunities for students to further explore not only their selected major, but others within the field. It is vital for institutions to offer more support and guidance to students as they navigate the transition between different STEM disciplines.

Messaging: Parental "College-Going Expectations" vs. Family "STEM Major Selection" Influence

Parental Expectations Foster Postsecondary Educational Pursuits

The findings of this study revealed that parental expectations significantly influenced the participants’ decisions to pursue higher education. Many participants received strong messages from parents about the importance and value of attending college. For example, Katrina shared that attending college was an expectation because both of her parents had also attended college. 62% of the participants identified as being non-first-generation college students, which means

they had at least one parent who attended college. Previous studies, such as those by Martin, Stefl, et al. (2020) and Thompson (2021), have highlighted the unique challenges first-generation college students face, particularly in STEM fields. While first-generation students often encounter significant obstacles, the participants in this study, who were mostly non-first-generation students, faced different challenges. Their experiences highlight how parental educational background can shape their college experience.

Family Guidance Influences STEM Major Aspirations

Family influence emerged as a significant factor in the decision-making process for participants majoring in engineering or computer science. As discussed in previous literature, particularly by Winkle-Wagner (2015), family relationships are essential in impeding college success for African American women. Many participants recounted how their family members played a pivotal role in shaping their major choices. This finding aligns with the existing literature, emphasizing the importance of familial support and guidance in educational pursuits. Several participants shared personal stories highlighting the impact of family members on their decision to pursue engineering or computer science. For example, Destiny recounted how her aunt, who worked in the tech industry, inspired her to major in computer science. Her aunt's success in the field inspired her to pursue computer science. Other participants mentioned how their siblings are in engineering or computer science fields. These findings suggest that family members play a crucial role in guiding students toward STEM career fields, especially for African American women.

Psychosocial Influencers of Belonging in STEM

Acculturation to STEM as a Persistence Mechanism

The findings highlighted the connection of applied opportunities in STEM as it relates to acculturation. This emphasizes the practical implications of prior research, reinforcing the importance of early access to STEM and extracurricular educational programs, as noted in previous research (Charleston, 2012; Holmlund et al., 2018; Mulvey et al., 2023). For example, Angela shared how practicing coding before entering college sparked her interest in computer science, while Crystal spoke about how her passion for playing video games in high school steered her toward the same field. These experiences underscore the crucial role that early exposure and access to STEM education play, particularly for URM in STEM disciplines, as emphasized by Cheryan et al. (2017).

Environmental Impact as Being Conducive to Inclusivity and Well-Being

COVID-19. The impact of COVID-19 emerged as a significant theme among the participants, highlighting the profound effects of the global health crisis on students' socialization and academic experiences. The pandemic hindered students' ability to engage in face-to-face interactions and participate in campus events, which many participants noted as a barrier to forming connections with peers and developing a sense of belonging. These elements are crucial for first-year students. Moreover, this disruption was particularly concerning given the importance of first-year development for African American students, as emphasized in previous research, which suggests that a strong sense of belonging during this period is essential for fostering positive academic outcomes (Walton & Cohen, 2011).

Furthermore, COVID-19 had a significant impact on the participants' academic learning. For example, Destiny expressed how she retained less information with online learning, and

some participants even expressed that online learning was less rigorous and that they had some challenges with transitioning back to in-person learning. As highlighted in prior literature, students faced several challenges during the pandemic, including diminished motivation and concentration (Toti & Alipour, 2021). These students faced the dual challenge of adapting to the demands of being first-year students in higher education while also navigating the complexities of a global pandemic.

Adjustment to New Academic Life. The transition from high school to college represents a significant adjustment for students, particularly in fields like engineering and computer science. The participants in this study reported a noticeable increase in academic expectations, making the transition more challenging. This is especially pronounced in the rigorous coursework associated with STEM majors. This aligns with previous literature that emphasizes the critical role of introductory courses in STEM disciplines (Harris et al., 2020; Meaders et al., 2020; Sax et al., 2018). These introductory courses are often gatekeepers that can determine students' continued persistence in STEM disciplines. One participant, Angela, provides an example of this challenge. She struggled significantly with a pre-calculus course, which can be considered a “weed-out” course for STEM students. Despite this challenge, Angela persisted in her major, showing resilience and determination. This is in contrast with findings from Hatfield et al. (2020), which linked low academic performance in introductory courses to a higher likelihood of URM students not completing their STEM degrees. Moreover, participants also indicated that the academic rigor at their four-year institution was significantly higher than what they had experienced at their community colleges. This suggests that the academic transition and adjustment is not only from high school to college but also from community colleges to four-year institutions as well.

Engaging Campus Environment - Feeling Welcomed. Campus climate significantly shapes a student's first-year experience, particularly for African American women at PWIs. Research has shown that students who have more favorable perceptions of campus climate tend to have more positive outcomes, such as academic success and overall well-being (Brown et al., 2005). Other studies have emphasized the importance of African American women developing connections to the campus community in order to succeed (Sims, 2008). The findings of this study suggested that despite attending a PWI, many participants reported feeling welcomed and a sense of belonging on campus. This finding is in contrast with other studies, such as those by Leath and Chavous (2018), which indicate that African American women often encounter more hostile racial climates at PWIs. It is important for institutions to understand the nuanced view of the campus climate experiences of African American women at PWIs, especially those in engineering and computer science, since they may not experience a sense of belonging within their academic disciplines. As emphasized by Strayhorn (2019), sense of belonging leads to positive outcomes and success. When students feel connected to their campus environment, this connection can significantly influence their persistence and degree completion.

Department and/or Institution Support Systems Contribute to Integration and Positive Outcomes

The findings from this study indicate an emphasis on institutional support over departmental support among participants. This trend aligns with previous research that highlights the significant impact institutional structures can have on student outcomes. While institutional structures can positively affect student outcomes, they can also negatively impact students' sense of belonging (Means & Pyne, 2017). This dual impact suggests a need for a balanced approach in designing institutional support systems. Institutional support, particularly through various

programming, has been shown to enhance students' first-year experiences significantly. Three participants specifically mentioned the positive impact of university programming, such as mentoring, new student orientation, and transfer success programs. This aligns with prior studies that have documented how institutions develop programming to aid students' transitions from high school to college (Everett, 2017). For example, Jennifer highlighted the benefits of participating in a “mentoring chat” during her first year. As Budney et al. (2010) and Sharp (2021) discussed, peer mentoring has been associated with positive experiences for first-year students. Beyond mentoring, other support resources such as tutoring and counseling were also reported to have positively impacted participants. These resources play a crucial role in providing the necessary academic and emotional support to help students succeed.

Additionally, the findings indicate that some participants opted not to participate in campus programming, learning communities, tutoring, or office hours. Previous research has emphasized the importance of learning communities in retaining first-year students (Cabo & Satyanarayana, 2018). Despite this, the findings indicated that one participant, Crystal, chose not to participate in a learning community due to her lack of understanding of its purpose. This highlights the need to raise students' awareness of the benefits of such programs. Similarly, other participants opted out of various student support, such as tutoring and office hours. Despite recognizing the potential benefits of these resources, they did not initially engage with them. However, they later reflected on how they should have participated more, understanding that it could have helped their integration and adjustment to campus life. This insight made them aware of the missed opportunities for connection and support during a crucial transition period.

Institutional support structures are crucial in fostering a sense of belonging among students, which enhances their well-being, academic success, and personal growth. Universities

can significantly improve students' overall experiences and outcomes by offering support resources. These resources help students navigate their academic experience and strengthen their connection to the institution, which is vital for student retention and degree completion. When institutions understand that sense of belonging is a basic human need, they can implement programs and practices that make students feel welcomed and valued. Students who feel like they belong typically perform better academically and complete their degrees. Therefore, prioritizing belonging through support structures is essential for student success, especially for African American women in engineering and computer science disciplines.

Academic Discipline Impact as a Determinant of Belonging

The findings indicated that some participants struggled with sense of belonging within their academic discipline. However, this struggle was more prominent among the engineering participants. Previous literature has suggested that African American women in engineering and computer science often struggle more with a sense of belonging in their disciplines (Fletcher et al., 2021; Solomon et al., 2018). The engineering participants discussed feelings of isolation within the major and noted seeing fewer people of color, specifically women of color. Even though the engineering participants expressed a lack of belonging, they also conveyed greater confidence in their academic abilities. For example, Tessa shared that she experienced more academic successes than challenges during her first year in college. As suggested in prior literature, URM women's persistence in engineering is associated with their academic confidence (Verdín, 2021).

In comparison to the engineering participants, the findings suggested that the computer science participants had more positive experiences within the major. The participants expressed appreciation for the welcoming computer science environment, noting that it is more diverse and

that they see more women within the major. This aligns with earlier research that highlights the importance of a sense of belonging for the persistence of African American women in computing fields (Solomon et al., 2018; Walton & Cohen (2007). The computer science participants indicated that the environment was supportive and collaborative, which likely contributed to their positive experiences.

In engineering and computer science fields, a sense of belonging plays a crucial role in determining students' academic success and personal adjustment. African American women are vastly underrepresented in engineering and computer science, which makes sense of belonging within these disciplines more imperative. As discussed by Strayhorn (2019), individuals strive "to be accepted by others, valued, and respected as competent, qualified individuals worthy of membership in a defined group or particular social context" (p. 34). African American women face significant challenges in engineering and computer science due to their underrepresentation. This lack of representation can lead to feelings of isolation and marginalization, which can negatively affect their sense of belonging. In these environments, it may be more difficult for them to form positive connections with their peers or receive adequate support from their academic departments. Sense of belonging within the discipline greatly impacts students' adjustment to their academic environment and overall success.

Interpersonal Agency Toward Socialization and Engagement in STEM Majors

Meaningful Interactions with Faculty and Staff (Positive and Negative)

The findings of this study support the significance of students' interactions with faculty and staff. Participants primarily reported positive and supportive interactions with engineering and computer science faculty members. Previous literature has highlighted the critical role of student-faculty interactions in influencing academic outcomes and overall college success (Cox

& Orehovec, 2007; Komarraju et al., 2010). Specifically, studies have emphasized the importance of these interactions in relation to the graduation gap for underrepresented students in higher education (Guzzardo et al., 2020). Additionally, the findings suggest that faculty members who are engaging and foster supportive relationships improve retention and persistence among college students. These positive interactions can help mitigate challenges and provide the encouragement needed to succeed in demanding STEM fields. By cultivating an inclusive and supportive academic environment, faculty can significantly contribute to the success and retention of African American women in engineering and computer science.

As denoted in previous studies, academic advising is the cornerstone of student retention, persistence, and overall satisfaction with the institution (Drake, 2011; Pascarella & Terenzini, 2005; Tsui, 2007). Academic advisors had a significant impact on the participants' experiences in this study. Previous literature has emphasized the importance of academic advising for students of color at PWIs (Museus & Ravello, 2021). The findings from this study identified that academic advisors were attentive and supportive, contributing positively to the participants' first-year experience. However, other studies have noted that African American students in STEM fields often find academic advising to be a barrier to degree completion (Lancaster & Xu, 2017). This suggests a need for more effective advising practices to better support the unique needs of African American women in engineering and computer science.

Interactions with faculty and staff are related to Strayhorn's core element of mattering. It is important for students to feel like they are valued and accepted within their academic community. Faculty and staff play a critical role in fostering a sense of belonging through their interactions with students. Faculty and staff can significantly enhance students' academic experiences and outcomes by creating welcoming environments and establishing positive

relationships with students. For example, when students feel connected to faculty and staff, they are more likely to seek out help or advice, which is particularly important for African American women in engineering and computer science majors. Prioritizing sense of belonging and support within the academic community is essential for student success.

Navigating Multifaceted Peer Interactions to Generate Support and Connection

Peer interactions, as they relate to social capital, were prevalent among the findings. Previous literature has highlighted that varying levels of social capital can significantly affect persistence and retention rates among undergraduate URM students in STEM fields (Samuelson et al., 2016; Skvoretz et al., 2020). The findings from this study emphasized the importance of building peer relationships and developing social support systems within engineering and computer science programs. Moreover, the study's findings shed light on the implications of stereotype threats that African American women face in engineering and computer science. For example, Katrina indicated that her peers did not take her seriously and often challenged her intellect. As identified in previous studies, stereotype threats can adversely impact attrition rates for women and minorities in STEM fields (Beasley & Fischer, 2012). These threats can negatively impact self-confidence and academic performance, leading to higher dropout rates. Therefore, fostering a supportive peer network and addressing stereotype threats are crucial for improving the retention and success of African American women in engineering and computer science.

Strayhorn (2019) highlighted how a sense of belonging takes on heightened importance in certain contexts and among certain populations. The participants acknowledged the importance of forming social networks and establishing peer relationships. The importance of peer interactions and sense of belonging is magnified among African American women in

engineering and computer science fields due to their significant underrepresentation. This underrepresentation makes social integration and peer support even more critical. When students can foster social integration and build strong peer support networks, it enhances their chances for college success.

Student Involvement as an Aspect of Social Integration

The findings suggested that the participants were involved in student organizations. Consistent with previous literature, extracurricular involvement helps URM students in developing a sense of belonging (Litzler & Samuelson, 2013; Ong et al., 2018). Participants particularly gravitated towards culturally affirming student organizations such as the National Society of Black Engineers (NSBE). This aligns with earlier research indicating that safe spaces are crucial for students to fully engage on college campuses (Booker, 2016). Specifically, the engineering and computer science participants highlighted the significance of NSBE in enhancing their college experience. For example, Crystal shared that NSBE provided her with a sense of community. NSBE played a pivotal role in fostering a sense of community, support, and belonging among the participants.

Student involvement is a critical factor in fostering sense of belonging, which significantly influences human behavior. When students feel like they belong, they are more likely to participate in activities that nurture positive relationships and drive their motivation, ultimately enhancing their academic performance. Student involvement includes participating in student organizations, clubs, or events, which allows students to build connections with their peers who share similar interests. These environments provide a sense of community and make students feel supported and welcomed. Fostering student involvement is crucial for cultivating a sense of belonging and enhancing positive student outcomes.

Coping via Socialization to Leverage Peer Support

The findings of this study indicate that socialization plays a crucial role in shaping students' overall experience during their first year, particularly for African American women in engineering and computer science majors. Previous research has highlighted the significant impact of social support, and the challenges related to social integration on the experiences of African American students in these fields (Huang et al., 2021; Porter et al., 2018). The participants in this study reported difficulties with socialization and forming connections with their peers, a challenge that was further complicated for those who identified as being introverted. These introverted students often had to act against their natural instincts to establish social connections, highlighting the extra effort required to navigate their social environments. The importance of social capital for the success of URM in STEM disciplines has been well-documented in the literature (Martin, Lee, et al., 2020; Samuelson et al., 2016; Skvoretz et al., 2020). The current findings align with these studies, reinforcing socialization's critical role in the academic success and retention of African American students in STEM fields. This study adds to the growing body of evidence that underscores the need for institutions to provide targeted support that fosters social integration and capital among these students to enhance their overall academic experience and success.

Limitations

The primary limitations of this study were associated with recruitment, the demographic questionnaire, and the interview protocol. Initially, the goal was to recruit 10-12 engineering majors whose admit type was classified as a first-year college student (e.g., no prior college enrollment). However, my initial recruitment efforts did not yield enough participants meeting these criteria. The final sample consisted of only eight participants. Another notable limitation

was the smaller number of African American women who majored in engineering and computer science. Individuals may have opted not to participate in the study due to concerns about being identified. Additionally, due to the limited number of participants, it was not possible to distinguish between specific engineering disciplines, such as engineering science or engineering technology, to protect the participant's identities.

Another limitation of the study was the demographic questionnaire. The questionnaire did not ask the transfer students if they completed their associate's degree or how many credits they earned before transferring. Additionally, the interview protocol did not include questions about pre-college experiences relating to diversity in AP courses or high school. It was unclear whether the participants were aware that there would be limited diversity in engineering and computer science majors.

Implications/Recommendations for Practice/Policy

Three recommendations are offered for practice and policy initiatives. First, a comprehensive approach is necessary to help retain African American women in engineering and computer science fields. Focusing on early exposure to STEM, mentorship programs, dedicated support systems on college campuses, and strong policy advocacy can create an environment for African American women to thrive in STEM disciplines. As noted in the present study's findings, early exposure to STEM can increase students' interest and provide them with the foundational skills to succeed in the field. Higher education administrators should collaborate with community partners to develop targeted outreach programs that can encourage African American girls from elementary to high school to pursue STEM fields. This can be done by partnering with local science centers and community organizations to provide students with hands-on learning experiences. Multiple and consistent experiences can cultivate interest in

STEM. Additionally, K-12 administrators can host career days and invite guest speakers to expose students to diverse opportunities and demonstrate representation and success within various STEM fields.

A second recommendation addresses the undergraduate experience, which could be enhanced by administrators providing funding and support for peer mentoring programs. As noted in the findings of this present study, the participants experienced multifaceted peer actions; however, when the interactions were positive, they provided the participants with academic and emotional support. Connecting students with upperclassmen as peer mentors can provide them with academic and social support, which promotes persistence and degree completion. Also, institutions should prioritize offering designated support services specifically tailored to the needs of African American women. These services can include student organizations and targeted academic and social resources. As highlighted in the findings of this study, participants were more inclined to engage with organizations where they found commonalities among their peers, such as the NSBE. These organizations provide a sense of community, shared experiences, and networking opportunities that are essential for fostering a sense of belonging and support. By aligning student services with the specific interests of African American women, institutions can better address their needs and improve both retention and success rates.

Finally, a third recommendation focused on policy advocacy supporting diversity in STEM education is imperative for fostering supportive environments for African American women in engineering and computer science. This includes advocating for funding for programs that promote African American women's increased participation in STEM, advocating for inclusive policies within institutions, and collaboration between educational institutions and policymakers. Funding more programs will give African American women more early access to

STEM educational opportunities. Moreover, inclusive policies within institutions will allow administrators to implement recruitment strategies to increase the enrollment of African American women in engineering and computer science and establish support systems that provide safe spaces for them to complete their degrees. As noted in the findings of this present study, the participants highlighted the lack of diversity within their academic discipline, especially in engineering. It is imperative that educational institutions and policymakers collaborate to develop and promote diversity in STEM. This multifaceted approach will broaden participation and create more inclusive environments for African American women in engineering and computer science fields.

Implications/Recommendations for Future Research

This study identified five recommendations for future research. First, recruiting participants from multiple institutions will increase the sample size and enhance the reliability of the research findings. This can be implemented by collaborating with various universities and colleges across different regions to recruit a larger sample of African American women in engineering and computer science programs. Broadening the data collection will allow researchers to have a more comprehensive understanding of the experiences of African American women in these particular fields.

A second recommendation is conducting a longitudinal qualitative study to track the long-term outcomes of African American women in engineering and computer science. This will allow researchers to gain a better understanding of their progression and challenges over time. Additionally, conducting more qualitative studies will enable researchers to gain a deeper understanding of African American women's personal experiences, challenges, and successes in

engineering and computer science. Qualitative data provides rich and detailed insights that quantitative data does not provide.

A third recommendation for future research is to explore the impact of peer networks and affinity groups on African American women's first-year experience in STEM. Investigating this dynamic could provide researchers with insights into how these social structures influence retention rates and sense of belonging within academic disciplines. By examining the role these support systems play, administrators can better understand the ways in which community and representation foster success. Additionally, this can lead to more targeted interventions to improve outcomes for African American women pursuing STEM degrees.

A fourth recommendation for future research is implementing a mixed-method study to evaluate existing support programs for women in STEM to determine their impact on African American women's sense of belonging. This will help institutions identify best practices to improve and enhance support systems for African American women in engineering and computer science majors. Also, conducting a study that focuses on the intersectionality of race and gender will allow researchers to examine the unique challenges faced by African American women in contrast to their male counterparts and women of other races. By addressing these areas, institutions can create more inclusive and supportive environments for students, ultimately leading to greater diversity within these fields.

Finally, a fifth important area for future research is evaluating how parental and family support impacts African American women's academic and career choices in engineering and computer science. This can be done by conducting a quantitative study. Family support is a critical factor in the decision-making process related to career paths and belonging in STEM. Investigating this influence can shed light on additional opportunities for early STEM

engagement and access for African American women. To enhance their representation and success in these fields, it is important to acknowledge the role of parental influence and family support while also addressing the broader barriers that impact their participation in engineering and computer science.

Conclusion

Efforts have been made to increase STEM participation among racially minorized groups. However, African American women remain underrepresented in STEM fields, particularly in engineering and computer science. Earlier studies have often focused on a general sense of belonging throughout the undergraduate experience or on FYE programming specifically. This study, however, takes a holistic approach, examining the entire first-year experiences of African American women and the connection to sense of belonging. Unlike previous research that may have emphasized FYE programs or isolated aspects of belonging, this study highlights African American women's broader, nuanced experiences, showing that focusing solely on first-year programming may overlook critical influences that shape these students' journeys.

The eight participants in this study reflected on experiences that had occurred two to three years prior to the study's timeline. For transfer students, this typically aligns with their second year at Rosen University. Comparatively, non-transfer students recalled experiences from even earlier in their academic journey, potentially during their first year or the transition from high school to college. These differences in reflection can influence the depth and clarity of recollections, as well as the way participants perceive and frame their past experiences. Participants' cumulative average GPAs at the institution suggest they were high-performing students. This characteristic likely influenced their academic experiences and perceptions. Subsequently, their experiences and reflections may only partially represent the broader student

population, particularly those with lower GPAs or those facing significant academic difficulties. Furthermore, the COVID-19 pandemic introduced an additional layer of complexity to the first-year experience, affecting the traditional ways students engage with their academic and social environments. While COVID-19 may have altered aspects of the FYE, the underrepresentation and lower graduation rates for African American women in STEM existed long before the pandemic.

This study specifically explored the connection between first-year experiences and sense of belonging for African American women in undergraduate engineering and computer science majors at a PWI. By viewing their experiences holistically, it provided an understanding of the complexity of their journeys in STEM disciplines. The findings offered a comprehensive understanding of the first-year experiences of African American women in two selected STEM majors while also bringing to light the unique challenges and factors that influence their persistence and success. The study exemplified the challenges that may occur in programming efforts that focus exclusively on the first year while potentially minimizing early experiences that provided the context and grounding for being in a STEM discipline.

The results of this study provide critical insights into the experiences of African American women in engineering and computer science majors, offering a holistic perspective that can help academic departments better understand the first-year experiences of this student population. One significant finding pertains to transfer students, who often navigate two sets of first-year experiences, one at their initial institution and another at their transfer institution. The study highlights the challenges these students face during the transition between schools, demonstrating the complexity of their academic journeys. The findings emphasize the diverse

pathways students take today, which may differ from the traditional model of transitioning directly from high school to a four-year institution.

Another key insight from this study is that it identifies the challenges related to departmental culture within certain STEM disciplines. Engineering departments, for instance, were found to be less welcoming and even less diverse than computer science departments. Although computer science still lacks adequate diversity, the study suggests that it offers a somewhat more inclusive environment than engineering. This disparity in departmental culture can significantly impact the sense of belonging for African American women and may influence their persistence in these fields. The study brings attention to the need for targeted efforts by administrators and academic departments to improve the experiences of African American women in engineering and computer science to increase degree completion rates. Another critical finding is the lack of support for these students within their academic departments. While many participants found support in organizations like the National Society of Black Engineers (NSBE) and Girls Who Code, these groups are not exclusive to African American women.

Furthermore, this study begins to underscore the importance that early exposure to STEM plays in the success of African American women pursuing degrees in engineering and computer science. Early access to STEM education and experiences allows these women to explore the multiple possibilities within these fields, even though they are often male-dominated. This exposure can increase interest in these fields and provide a foundation for long-term engagement and success in STEM disciplines. Another component of this study is the importance of preparing African American women to navigate the lack of representation they may encounter in engineering and computer science majors. They may not see many people who look like them in these fields. However, it is important for them to proactively identify supportive peers and

mentors to help guide them through their STEM journey. These mentors and peers may not always be African American women or even come from within STEM, but having a reliable support network is critical to their academic success and sense of belonging. Additionally, this study highlights the importance of giving back. African American women who have successfully completed their degrees are in a unique position to mentor and support the next generation of students. All stakeholders, such as students, mentors, faculty, staff, and higher-level administrators, play an essential role in fostering success and improving retention rates for African American women in these STEM fields.

The end of the interview protocol focused on the participants' recommendations for other African American women considering majors in engineering and computer science. A key theme that emerged was the need for confidence in one's ability to successfully navigate and complete these academically rigorous disciplines. The participants emphasized the importance of adapting to the social environment early by getting involved both academically and socially. One recommendation was the importance of being proactive in seeking help when facing academic difficulties. The participants encouraged future students to ask for assistance when needed and emphasized that setbacks are sometimes a part of the academic journey. They emphasized that encountering challenges does not mean failure and that students can still succeed in their major despite obstacles.

Another significant recommendation centered around building and utilizing social support networks. Participants highlighted the benefits of joining both academic and non-academic student organizations, emphasizing that socialization plays a critical role in positive academic progression in engineering and computer science. The participants also highlighted the importance of not being discouraged by the lack of visible representation in STEM fields. They

encouraged African American women to remain resilient and focus on their goals. Lastly, participants expressed a strong commitment to giving back and mentoring the next generation of African American women in STEM. They stressed the importance of being role models and examples of success to show others that it is possible to thrive in engineering and computer science. By sharing their experiences and supporting others, they believe they can help foster a sense of community and inspiration for future students.

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APPENDIX: INTERVIEW PROTOCOL

The First-Year Experiences of African American Women in Engineering and Computer Science Majors

Building Rapport/Warm Up

1. Tell me a little about yourself.
2. Why did you decide to attend college?
3. What made you interested in pursuing an engineering or computer science degree?
4. What made you interested in attending Rosen University?

First-Year Experience [RQ1]

1. Describe your first year as a college student.
    a. What was it like to be a first-year student in your engineering or computer science program?
    b. What first-year experiences stand out to you? Why?
2. Describe the first-year academic experiences of being a college student.
    a. What courses did you take during your first year?
    b. What kind of academic experiences stand out for you as part of your first year?
        i. Challenges
        ii. Supportive
        iii. e.g., academic rigor and competition
3. What would you list as the major factors that shaped your first-year experiences?
4. How would you describe the role of who you are as,
    a. being African American in this program
    b. being a female in this program

Sense of belonging (experience of mattering of feeling cared about, accepted, respected, valued) [RQ2]

1. Describe your experiences with faculty and staff during your first year.
    a. Discuss your perception of interactions with faculty and staff members.
2. Discuss your experience with participating in first-year experience programs.
    a. Seminar Courses
    b. Mentoring
    c. Learning communities
3. Discuss support that you were aware of during your first year .
    a. Academic supports (e.g., faculty, staff, peers).
    b. Social supports (e.g., student organizations).
    c. Departmental, institutional, or other supports.
4. Discuss any academic and social supports that were helpful to you during your first year.

Campus Climate (institutional)

1. For someone who is unfamiliar with Rosen University, how would you describe the campus environment? (e.g., culture, attitudes, and behaviors)
    a. How would you describe the engineering or computer science environment?
    b. What does that mean for you?

2. Describe how you feel as part of (or not) the campus environment? (e.g., living on campus)
3. Describe how you feel as part of, or not, the engineering or computer science environment?

Wrap Up

Is there anything that we did not discuss that you would want to share related to the first-year experience?

a. Recommendations for faculty and staff
b. Recommendations for students.