

ABSTRACT

SMITH, CHELSEA TASHEA. *Refuge from the Storm: A Case Study of Black Womens' Experiences in STEM Peer and Research Co-Curricular Programs at a PWI in the Southeast* (Under the direction of Dr. Joy Gaston Gayles).

Black women undergraduate STEM students at Predominately White Institutions (PWI) contend with difficult experiences in their academic majors (Charleston et al., 2014; Fletcher et al., 2017; Johnson, 2007; McGee & Bentley, 2017). Black women undergraduate STEM students are battling isolation, microaggressions, chilly climate, and other systemic barriers in their respective disciplines (Charleston et al., 2014; Fletcher et al., 2017; McGee & Bentley, 2017). However, additional research is needed to understand their STEM co-curricular experiences.

The study explored the experiences of Black women STEM undergraduate students participating in STEM co-curricular and support programs on a PWI campus. Using a single embedded case design, I used the following research questions to guide the study: How are Black women undergraduate STEM students engaging in STEM co-curricular and support programs at a Predominately White Institution (PWI) in the Southeast? Additionally, using the following sub-questions: What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs? What are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs?

From this study, four major findings emerged: students are dealing with advisers and hostile STEM classroom environments, they find community in their STEM enrichment environment, they feel validated and comfortable in their STEM co-curricular environments, and they are supported academically and professionally within their co-curricular STEM environments. These phenomena were prevalent for women in STEM peer-based and research programs from a variety of academic majors.

The significance of this study is to inform institutional administrators and practitioners of the experiences and perspectives of some of their most vulnerable and underrepresented students.). Their perception of support within STEM enrichment programs are needed to facilitate enhancements for their student experiences. The study can also inform future research for studying and centering the experiences of Black women in STEM, enhancing institutional policies and practices to support Black women STEM students in the classroom and in co-curricular environments

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Refuge from the Storm: A Case Study of Black Womens' Experiences in STEM Peer and
Research Co-Curricular Programs at a PWI in the Southeast

by

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DEDICATION

To my family. I may be the first, but I will NOT be the last. And to Jay, Charlotte, Sally Jane,
Adazumanee, Lily, and Desiree.

BIOGRAPHY

Chelsea Tashea Smith was born in Atlanta, Georgia. Chelsea is the only child of Zire and Tia Hughley. Chelsea is a proud product of the Cherokee and Cobb County Public School Systems. She graduated from the University of Georgia (GO DAWGS!) with a Bachelor of Arts in History. Following her baccalaureate degree, Chelsea served two years in the Georgia College Advising Corps in Atlanta, Georgia. College Advising Corps is a college access organization that provides near-peer post-secondary advising to underserved students. This is when Chelsea found her passion for higher education as a future career to continue to support underserved students as they pursue post-secondary education. Following her service with the Corps, she completed her Master of Education in Student Affairs and Graduate Certificate in Education for Social Justice at Iowa State University. Chelsea was awarded the Southern Region Board Education Fellowship in the Fall of 2018 to attend NC State. She is actively involved with the Association of the Study of Higher Education (ASHE) Council for Ethnic Participation Mentor Protégé Program (CEP-MPP). Chelsea currently serves as the Assistant Dean of Student Professional Development at Fordham University in the Graduate School of Arts and Sciences.

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CHAPTER ONE: INTRODUCTION

In 2016, news outlets and popular culture headlines boasted that Black women were the most educated group in the United States (Essence, 2016; Jet Mag, 2016; The Griot, 2016). Large-scale enrollment and degree attainment data inform these headlines. For example, the National Center for Education Statistics (NCES) report stated that in the 2015-2016 academic year, Black women earned the most associate and baccalaureate degrees of any racial and gender group. Impressively, during that academic year, Black women earned 67 percent of all associate degrees and 64 percent of all baccalaureate degrees awarded to Black students (NCES, 2018). Moreover, the National Science Board (2018) reported that the overall enrollment of Black women in STEM disciplines has increased by 40 percent from 2000 to 2014 (National Science Board, 2018). However, these statistics mask realities such as low retention and high attrition for Black women in higher education, especially in higher wage-earning fields like Science, Technology, Engineering, and Mathematics (STEM) disciplines.

Looking at the increased rates in enrollment alone does not tell the entire story for Black women. It fails to underscore why they are less likely to earn degrees in STEM despite increases in enrollment, as well as the role the environment plays in attrition for diverse student populations. Recent national data show that Black women earned about 10 percent of all Science, Technology, Engineering, and Mathematics (STEM) bachelor's degrees (NCES, 2018). When disaggregated by specific disciplines in STEM, the numbers depict even lower percentages of degree attainment for Black women. For instance, according to the National Science Foundation (NSF) (2017), Black women earned less than one percent (0.99%) of engineering baccalaureate degrees. Moreover, Black women earn bachelor's degrees in other STEM fields at disproportionately low rates compared to other racial and gender groups. When disaggregated by

discipline, Black women earned degrees in biological sciences (4.23 %), computer sciences (2.61%), physical sciences (2.83%), statistics, and mathematics (2.35%) at low rates compared to other racial and ethnic demographic groups (NSF, 2017). Despite low retention and attainment rates, Black women are still completing STEM degrees, but structural barriers to retention, such as lack of support and representation in the pipeline, are impeding their success (Fletcher et al., 2021; McGee & Bentley, 2017; Ong et al., 2018).

The narrative of Black women succeeding in college at exponential rates provides a misleading account when data shows that Black women are severely underrepresented in STEM disciplines (NCES, 2018.; NSF, 2017). Evidence of structural oppression within their collegiate environments is symptomatic of their underrepresentation and low completion rates within STEM majors. For example, Davis et al. (2016) found that Black women in STEM environments at historically White institutions experience negative classroom environments. Furthermore, experiences in co-curricular settings may not provide the most supportive space for Black women in STEM as well because they often do not account for support of their intersectional identities (Lane, 2016).

The discourse surrounding student success is incomplete without understanding a student's holistic experience. Belonging and connection within the campus community contribute to the success and well-being of students (Murphy et al., 2022). According to Murphy and associates, students who feel they belong to the campus community are more likely to be engaged through campus organizations, undergraduate research, and interactions with peers, faculty, and staff. This feeling of belonging is vital for students from underrepresented backgrounds (i.e., Black, Latinx, Native, first-generation) (Murphy et al., 2022; Strayhorn,

2018). In particular, understanding the holistic (academic and co-curricular) experiences of Black women in STEM can better help educators support and retain them.

Landscape of Experiences for Black Women at Predominately White Institutions

A Predominantly White Institution (PWI) is an institution of higher learning where the student population accounts for 50 percent or more White students (Lomotey, 2010). PWI campuses often do not present an inclusive and hospitable environment for Black women within learning environments and social avenues (Davis et al., 2016; Porter et al., 2015; Sue et al., 2008). Black women at PWIs experience discrimination within their collegiate environment based on their racial and gender identities.

Furthermore, Black women contend with experiences of isolation, condescension, invisibility, and hypervisibility on PWI campuses (Davis et al., 2016; Sue et al., 2008). These adverse experiences are often inflicted by faculty, peers, and the larger campus community (Davis et al., 2016). Black women experience microaggressions and other forms of discrimination within their classroom environments based on race and gender identity (Porter, 2013; Robinson-Wood et al., 2015; Seaton, 2011; Sue, 2010; Wallace, 2021). For example, according to Davis et al. (2016), discriminatory treatment includes condescending remarks and alienation from professors and peers. These interactions negatively impact their holistic college experience and can detract from feeling a sense of belonging and achieving success. On PWI campuses, Black women often cite experiences of isolation due to being one of few or the “only” (Davis et al., 2016; Sue et al., 2008; Robertson & Dundes, 2017). When students feel isolated within their environment, they often have difficulty creating connections or feeling like they belong

Black Women Undergraduates in STEM at PWIs

Black women entered STEM disciplines at PWIs at a higher rate than almost all other racial/ethnic and gender groups (NSF, 2009, as cited in Dortch & Patel, 2017). In contrast, they also leave STEM majors at higher rates compared to other racial/ethnic and gender groups, except for Indigenous women (Johnson et al., 2011; McGee & Bentley, 2017; Pietri et al., 2018). According to McGee and Bentley (2017), it is common for women as an aggregate to make up about 15 to 20 percent of the student population in STEM fields at PWIs; however, representation remains low, around two percent, for Black women.

As previously mentioned, Black women are underrepresented broadly in STEM and specifically at the disciplinary level at even lower rates. For example, 4.3 percent of Black women are enrolled in biological science degree programs, while less than one percent enroll in engineering (NSF, 2017). Black women are most severely underrepresented in engineering, technology, and computer science (Charleston et al., 2014; Fletcher et al., 2017). Within these disciplines combined, Black women comprise about 4.6 percent of the enrolled population at the undergraduate level, even less at the graduate level. Black women are slightly more represented in biological and physical science but still lag behind their Black male, White, and Asian counterparts (Hill et al., 2010; Jackson & Charleston, 2012; Johnson, 2011). As such, these low representation numbers signify barriers to retention and completion for Black women in STEM. These numbers depict the importance of looking beyond the aggregate to unmask enrollment and retention disparities across race and gender.

Present Barriers for Black Women in STEM at PWIs

Several barriers impact Black women in STEM undergraduate majors at Predominately White Institutions. As previously mentioned, Black women account for only about 10 percent of

all students enrolled within undergraduate STEM disciplines at PWIs in the United States. In STEM majors, Black women experience a chilly climate characterized by unsupportive and unwelcoming environments (Fletcher et al., 2017, 2021; Simon et al., 2018). This phenomenon leads to feelings of isolation and tokenization, which can impede retention and degree completion (Fletcher et al., 2017). Tokenism is the perfunctory symbolism of marginalized people without meaningful representation (Kanter, 1977). Tokenism, a symptom of lack of representation, impacts people of color when they are the [only] representative body in space (Obiomon et al., 2007; Sherrer, 2018). Students who experience this phenomenon feel isolated, discriminated against, and have imposter syndrome as they carry unwarranted social identity pressures from their environment. The facade of representation is a mechanism to draw in Black women to, in turn, fail them with adequate representation and support. The underrepresentation is a byproduct of poor recruitment and retention effort for Black women in STEM (McGee & Bentley, 2017).

Another barrier for Black women in STEM disciplines is a lack of Black women mentors and role models (Drury et al., 2011). Having mentors with similar racial and gender identities is crucial to student success for women of color because they have tangible and realistic experiences navigating their academic journeys (Hodari et al., 2014; Ong et al., 2018). Underrepresentation and the lack of mentors and role models impact Black women's sense of belonging in STEM disciplines, resulting in decreased retention (Hodari et al., 2014; Kricorian et al., 2020). Role models reflect the presence and representation of Black women in STEM collegiate environments. Mentors, however, provide tangible and intentional support to traverse academic settings. When Black women in STEM cannot access mentors, especially those of

similar cultural backgrounds, they may have difficulty finding community and retaining (McGee & Bentley, 2017).

Lastly, Black women in STEM contend with stereotypes related to their racial and gender identities. These stereotypes translate to negative perceptions from their professors and peers of their academic aptitude in science and mathematics (Hyde et al., 2008; Smeding, 2012).

Stereotypes often lead to stereotype threat, in which Black women internalize the prophecies placed upon them due to biases, discrimination, and systemic issues within their environments. (Smeding, 2012; Steele & Aronson, 1995). To this end, these factors represent barriers to Black women persisting and attaining degrees in STEM.

Student Support Services and Co-Curricular Programs at PWIs

Student support services are a formal initiative or group of initiatives that assist students with holistic development (U.S. Department of Education, n.d.). Student support initiatives are designed to help students academically, promote campus involvement, offer counseling and wellness services, and career development (U.S. Department of Education, n.d.). Student services can also help alleviate financial, academic, personal, and physical barriers to reaching their educational goals (Wilfong, 2021).

Additionally, co-curricular programs refer to structured activities, learning experiences, and initiatives that complement a student's formal academic program (Astin, 1993; Johnson et al., 2007). Support programs and co-curricular activities are designed to enhance students' holistic campus experiences; however, not all students find the initiatives beneficial or supportive. Moreover, there are distinctions between peer-based programs and research-based programs. Operationally, peer-based programs are designed as professional development or defined qualities of reciprocal dynamics between individuals of equal status (i.e., peer mentor

program) (Eisen, 2001). Research-based programs entail a hands-on systematic study of a topic, usually under a faculty member's or formalized program's direction (Kinkead, 2003).

Black students' experiences with targeted support and co-curricular services on PWI campuses are often still met with alienation and insufficient support (Stewart, 2011). Support services that are racially and ethnically themed sometimes fall short of providing students with adequate support (Stewart, 2011). The shortcomings related to holistic student support are partially due to the lack of understanding of the specific needs and perceptions of Black students' multiple interlocking identities (i.e., gender, sexual orientation, and religion) (Stewart, 2011). As a result, Black women students are left out of campus-wide support initiatives because services provided to the general student population do not always address their unique needs.

Further, Black women are forced to find support within informal peer groups and familial relationships because campus student support initiatives focus on Black students or women as a homogenous group neglecting to recognize their multiple marginalities (Stewart, 2011). Most studies that explore targeted initiatives for Black students do so without mentioning how gender differences are attributed to student experiences (Dortch & Patel, 2017; Ong et al., 2018; Stewart, 2011). Negative and isolating experiences that decrease their sense of belonging are often exacerbated for Black women in STEM majors at PWIs because their academic disciplinary environments along with the institution are compounded by the White, male-dominated culture (Dancy et al., 2020; Dortch & Patel, 2017; Rainey et al., 2018).

De-Centering Academic Spaces and Centering Co-Curricular Spaces

The classroom experiences of Black women in STEM have been most noted in the literature. To date, most existing studies center on the experiences of Black women's academic performance and their experiences with faculty, which neglect to depict their holistic student

experience inclusive of out-of-classroom engagement such as undergraduate research opportunities, student organizations, and living-learning communities (Dortch & Patel, 2017; Ireland et al., 2018; Wallace, 2021). Most literature related to STEM support focuses on the role of faculty in Black women's STEM experiences (Wilson & King, 2016; McGee & Bentley, 2017). Winkle-Wagner and McCoy (2016) explored the nuances of undergraduate, graduate, and faculty diversity in STEM at a Historically Black University (HBCU) and a PWI. This study highlighted STEM students and faculty experiences but did not note STEM experiences and representation outside of the classroom context, highlighting gaps in the literature.

Co-curricular and enrichment programs often support undergraduate students in STEM (Hamilton & Parker, 2010; Jiang et al., 2005; Lancaster & Xu, 2017; Lee, 2015; Museus, 2008; Palmer et al., 2011; Ross & McGrade, 2016). Students of color, specifically Black students, sometimes find racially themed co-curricular spaces more affirming than their STEM classroom environments (Lane, 2016). These environments serve as a space for students to feel a sense of belonging and deepen their STEM identity. Their STEM and cultural identity are often inhibited in the classroom due to experiences with isolation, microaggressions, and lack of access to mentors (Lane, 2016; McGee & Bentley, 2017; Strayhorn, 2012).

STEM support and enrichment programs are prevalent on campuses to enhance the co-curricular experiences of students in STEM majors. Morton and Parson (2018) recognized the targeted efforts institutions and organizations are making to increase STEM degree attainment for racially underrepresented students and women. Research suggests that students participating in co-curricular environments in living-learning communities, student organizations, and other peer-based programs are more likely to persist due to engagement with these organizations (Maltby et al., 2016; Ong et al., 2018; Zephirin & Jesiek, 2018). Additionally, academic-based

programs integrating undergraduate research opportunities are more likely to increase access and completion for underrepresented groups in STEM (NSF, 2017).

These initiatives and programs leverage support for underrepresented populations in STEM disciplines. Students have shared an increased sense of belonging and access to mentors from participating in these programs and organizations (Ong et al., 2018; Zephirin & Jesiek, 2018). Museus (2008) and Palmer et al. (2011) identified positive outcomes for Black student support networks and involvement in student organizations such as community and representation. Many campuses have options for students to participate in co-curricular and student support service initiatives related to their academic majors; however, the research on co-curricular engagements does not center or illustrate the experiences specifically of Black women (Engstrom & Tinto, 1998; Fink & Hummel, 2015; Harper & Quay, 2009). This gap in the literature fails to recognize the experiences of one of the most underserved populations within the STEM landscape.

Centering Black Women in STEM Research

Scholars often describe the experiences of women or Black students as an aggregate, but almost none of them explores the unique experiences of Black women. Gayles and Smith (2018) posit that it is vital to approach research regarding women in STEM with intersectional framing, thereby recognizing their interlocking race and gender identities. McGee and Bentley (2017) and Patton and Croom (2017) identify attributes of the student experience unique to Black women compared to their other women of color counterparts more broadly noted in the literature. Furthermore, this notion illuminates the critical need to examine further one of the most marginalized populations within STEM environments, Black women. Moreover, for STEM co-curricular and enrichment programs to better serve their student populations, they must consider

pursuing more intersectional framing, which this study explored. As the literature denotes, Black women in STEM warrant unique support mechanisms due to their racial and gender identities (McGee & Bentley, 2017; Ong et al., 2011). McGee and Bentley (2017) discuss the critical need for support for the sake of Black women STEM students' holistic well-being. This study will add to the research related to Black women's co-curricular STEM experiences.

Purpose of Study

This study aimed to explore and amplify the experiences of Black women STEM undergraduate students participating in STEM co-curricular and support programs on a predominantly White campus. The existence of women of color in STEM is not monolithic nor homogenous; therefore, it is imperative to investigate the unique experiences and needs of Black women STEM students participating in these programs (Espinosa, 2011; McGee & Bentley, 2017). Research posits that their classroom experiences are often traumatic, isolating, and full of discrimination. But understanding their co-curricular STEM opportunities can provide more insight into how they navigate spaces outside of the classroom to cope with the chilly climate within STEM academic spaces (Esposito, 2011; McGee & Bentley, 2017; Tate & Linn, 2005). Malcolm et al. (1976) and Moses (1989) stated that race and gender create a double obstacle for Black women at PWIs and that spaces inclusive to Black women are essential to their success. It would benefit institutions and policymakers to know how Black women in co-curricular STEM enrichment programs find and experience support to increase the retention and success of this student population (Stewart, 2011).

When studying women in STEM, White women are often centered, which often excludes the experiences of women of color in STEM (Espinosa, 2011; Ong et al., 2011). The experiences of women of color, specifically Black women, are crucial to the background of this study.

Several researchers have begun to study the experiences of women of color in STEM using a critical lens (Ong, Espinosa, & Orfield, 2011; Johnson, 2011; Rodriguez et al., 2018). Most existing literature curates a story of the experiences of women of color as a homogenous group (Alfred et al., 2019; Espinosa, 2011; Johnson, 2011a; Ong et al., 2018). Johnson (2011a) began to inquire about the importance of viewing women of color experiences from an intersectional lens by accounting for race and ethnicity in addition to their gender identity. A gap in knowledge exists from failing to capture women's experiences in STEM disaggregated by racial and ethnic groups. Bearing this in mind, it necessitates understanding how Black women undergraduate students navigate their co-curricular educational experiences and will help institutional actors better serve them as students.

Research Questions

I used the following research questions to guide my study: How are Black women undergraduate STEM students engaging in STEM co-curricular and support programs at a Predominately White Institution (PWI) in the Southeast? Additionally, the following sub-questions guided the study: 1.) What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs? 2.) What are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs?

Conceptual Framework Overview

To center the experiences of Black women students in STEM, I used a conceptual model for the theoretical framing of this research study. I used the concepts of Strayhorn's (2012, 2018) sense of belonging and Crenshaw's (1989,1991) intersectionality to contextualize how race and gender coexist as marginalized social identities for Black women and understand how multiple

marginalities manifest in a structurally oppressive academic environment (Collins, 2002; Patton, Haynes-Davis, & Croom, 2017).

Moreover, because I am examined the unique experiences of Black women, framing this study using Intersectionality provided context to their interlocking racial and gender identities within a system of oppression such as White, male-dominated STEM environments (Crenshaw, 1989; Dortch & Patel, 2017; Rainey et al., 2018). Intersectionality examines how a person's social identities intersect within the context of interdependent systems of discrimination and disadvantage (Crenshaw, 1989). Birthed from critical race studies, intersectionality originally intended to understand the oppression of Black women in society (Crenshaw, 1989; Jordan-Zachary, 2007). As the research shows, Black women are disproportionately underrepresented within STEM disciplines, and using this framework will center their stories from the context of both race and gender in a structurally oppressive space (Dortch & Patel, 2017; Fletcher et al., 2021; Johnson, 2011; McGee & Bently, 2017).

For college students, a sense of belonging is an essential element that impacts the movement toward understanding knowledge which is critical within higher education (Strayhorn, 2018). As such, many scholars have used a sense of belonging to frame the experiences of college students. A sense of belonging is characterized by the feeling of connection to the campus community, a feeling of mattering, and support during the collegiate experience (Hausmann et al., 2007; Hurtado & Carter, 1997; Johnson, 2017; Strayhorn, 2012, 2018). For Black women undergraduate students in STEM, a sense of belonging is essential to their experience. Due to isolation and the chilly climate within their classroom spaces, Black women often seek out belonging from other avenues on campus, such as student organizations, peer support programs, and academic enrichment opportunities (Morton & Parson, 2018; Stewart,

2011). This study used sense of belonging as a framework for understanding the co-curricular STEM experiences of Black Women undergraduate students within STEM majors.

For this study, these concepts framed the theoretical and methodological elements of the co-curricular involvement of Black women undergraduate STEM students at a PWI in the southeast. The interlocking social identities of Black women in a White male-dominated environment, such as STEM disciplines, inform their experiences with belonging in co-curricular experiences related to these disciplines. Moreover, the conceptual framing using these theories in tandem will highlight tenets of belonging related to identity and structural barriers. Strayhorn's intentional use of sense of belonging, including students of color, and Crenshaw's innovation of recognizing the multiple marginalities of Black women were essential to my desire to center Black women in this research.

Methodological Overview

A case study methodological approach was used for this research. Creswell (2018) conveys that case studies are a method of inquiry that allows the researcher to develop an in-depth analysis of a case, often an event, program, activity, group, or individual. The specific methodological approach for this study employed a single-embedded case study design. This design is best suited to this inquiry to capture the phenomenon of the case, STEM enrichment programs. Using a single embedded case study allowed me to focus on the experiences as different units of analysis within the single case. Embedded single-case studies are designs with multiple embedded units of analysis (Yin, 2009). For this study, the STEM support and enrichment programs (the case) were examined using two units of analysis (peer-based programs and research-based programs).

The study was conducted at a Large Public Research I institution in the Southeast. The site is a STEM-focused research university. This research site was also selected for its proximity to several STEM support/enrichment and co-curricular resources. I chose participants based on racial and gender identity and academic major. The study centered on self-identified cisgender Black women of various ethnicities across the Black diaspora. Participants were enrolled in science-based STEM majors. I used criterion and snowball sampling to recruit participants for this study and then categorized them into the two embedded units of analysis: peer and research-based programs. Using multiple participants for each unit of analysis provided a manageable but diverse perspective of participants (Yin, 2018). Participants in the study participated in four data collection activities, including a demographic survey, two individual interviews, and a journal activity. The data was analyzed using a multistep hybrid process resulting in four emergent themes.

Keywords and Terminology

This section will clarify several functions of specific language and key terms used throughout this study to better understand frequently used terminology.

Depending on how the original authors reference or use the words, Black and African American will be used interchangeably throughout this piece. This same criterion will apply to the terms woman/women/female(s). To this end, I will intentionally capitalize the “B” in Black as it represents a cultural group and denotes a proper noun (Crenshaw, 1991). The following terms will be used and thereby defined for clarity of the operationalization of this text.

- **Co-curricular:** complementary but not a part of the formal curriculum (Lee, 2015)
- **Enrichment Program:** A program that takes action to improve or enhance the quality or value of a student’s experience.

- **Program:** A formal initiative or group of initiatives that constitute prolonged student involvement
- **Support:** Perceived positive impact or assistance
- **Support Program:** A program that contributes to a student's holistic development (e.g., financial, academic, social, mental).

Significance of Research

The significance of this study was to inform institutional administrators and practitioners of the experiences and perspectives of some of their most vulnerable and underrepresented students in STEM disciplines. Black women undergraduate STEM students are battling isolation, microaggressions, chilly climate, and other systemic barriers in their respective disciplines. The perception of support within STEM enrichment programs was needed to facilitate enhancements for the student experiences (Charleston et al., 2014; Fletcher et al., 2017; McGee & Bentley, 2017).

The research significance of the current study was to center the experience of Black Women in STEM outside of the historical women of color or Black students in the STEM narrative. This study addresses some of the unique experiences of Black women as it relates to nuances associated with their racialized and gendered experiences. Moreover, when examining Black women outside of traditional scopes related to homogenous groups of marginalized students in STEM, center privileges that Black women are often not afforded in racialized and gendered spaces. This privilege-centering is frequently done in the literature related to STEM degree completion; however, not as widely addressed in co-curricular contexts. This study provides another perspective on the holistic experience of Black women in STEM. In practice, this study informs higher education administrators in STEM co-curricular programs of the

importance of catering to the needs and experiences of all students they are serving. The finding of this study addresses the needs of Black women in undergraduate STEM majors in STEM co-curricular environments, specifically as it relates to representation and access to other Black women.

Dissertation Layout

The first three chapters of this study provide an essential background to the purpose of this study. Chapter one delivered a solid introduction and background to the purpose of this study, exploring the nuanced experiences of Black women undergraduate STEM students and their participation in STEM enrichment and support programs. The second chapter of this study provides a relevant review of literature related to barriers for women in STEM and the unique challenges Black women in STEM face due to the double bind (Ong et al., 2011; McGee & Bentley, 2017). The chapter also discusses the current literature concerning STEM support and enrichment programs, highlighting the gaps in Black women's experiences with these programs. Chapter three of this study details the use of embedded case study methodology to investigate the research questions. Chapter four focuses on participant profiles and the significant findings of the research study. Finally, chapter five discusses the significant findings and their connection to the literature. Lastly, recommendations for policy, practice, and research to further address ways to engage Black women STEM students involved in support programs. This embedded case study examines the experiences and perceptions of some of the most marginalized stakeholders in the STEM landscape.

CHAPTER TWO: REVIEW OF LITERATURE

This study sought to understand the unique experiences of Black women undergraduate STEM students and their participation in STEM enrichment programs. This literature review provides a synthesis of scholarship related to their experiences, barriers, and academic and co-curricular environments to contextualize Black women and their STEM experiences. In this review of literature, I illustrate the theoretical underpinnings that guided this study using the concepts of intersectionality and sense of belonging. Further, I outline the following in this review of literature: (1) The underrepresentation of women in STEM (2) Barriers that exist for women in STEM, (3) An overview and synthesis of support mechanisms and environments within STEM disciplines to combat these barriers. Furthermore, in these sections, I synthesize and illuminate the nuanced experiences of women of color and Black women with STEM academic and co-curricular environments at PWIs. Thus, when examining and overviewing STEM enrichment programs, I focus on the nuances between research-based and peer-based programming. Surveying what existing literature posits provides a foundation of understanding of how the current study surrounding experiences of Black women STEM students in support and co-curricular programs can enhance current research.

Conceptual Framework

For this study, I framed the experiences of Black women undergraduate STEM students participating in STEM enrichment programs using the Sense of Belonging and Intersectionality (Crenshaw, 1990; Strayhorn, 2012). The use of these frameworks together provides theoretical support for understanding the student engagement experiences from a lens that centers on Black women's two-ness or double consciousness (Malcolm et al., 1976). Research raises the issue that many traditional higher education theories fail to recognize the racial and gender identities of

students outside the majority (i.e., White students or White men). This phenomenon illustrates a less critical mass of Black women in higher education literature and illuminates gaps in telling the stories of their experiences in higher education. (Cabrera, 2014; Dancy et al., 2020; Miller, 2017, Moore et al., 2017).

Intersectionality

Intersectionality is a theoretical framework developed by Kimberle Crenshaw (1991). Both a practical and theoretical model, intersectionality discusses the multiplicative nature of marginality. The term intersectionality describes the exclusion of Black women from White feminism and discourse surrounding racism typically equated to the experience of Black men (Crenshaw, 1991). Race and gender are often treated as mutually exclusive categories of both experience and analysis (Crenshaw, 1989). However, these identities are social constructs used to categorize people. Crenshaw (1991) situated her work on concepts of Critical Race Theory and Black Feminist scholarship.

Multiple Intersectional Identities

One of the most central tenets of intersectionality is social categories (e.g., gender, race, socioeconomic status, sexual orientation) (Bowleg, 2012). Principles of intersectionality illustrate that marginalized identities are not independent and unidimensional; instead, they are multiplicative, interdependent, and mutually reinforcing. For example, a person is not just Black plus a woman; these social identities are interdependent. Intersectionality, as defined by Crenshaw (1991), advises that race intersects with other social constructs of identity (i.e., gender, religion, ability, sexual orientation) and ultimately impacts the lived experiences of those from racially or ethnically marginalized groups. Crenshaw's (1991) intentions when investigating this phenomenon was to center Black women, and she stated:

My objective there was to illustrate that many of the experiences Black women face are not subsumed within the traditional boundaries of race or gender discrimination as these boundaries are currently understood and that the intersection of racism and sexism factors into Black women's lives in ways that cannot be captured wholly by looking at the race or gender dimensions of those experiences separately (p.1244).

It is essential to understand how social identities not individual characteristics of a person are but rather interdependent upon one another. Namely, studies illustrate how Black women in education have distinctive experiences related to their interlocking social identities, psychological processes, and education outcomes. For Black women in STEM, their racial, gender, and cultural identity may be considered more salient than their STEM identity; however, these identities are still interlocking and impact how they navigate educational spaces (Ireland et al., 2018; Ong, 2005).

Systems of Power

As a foundational tenant of intersectionality, we must understand how gender, race, and other identity markers are situated as part of systems of power and inequality (Crenshaw, 1989; Rodriguez et al., 2018). When considering how Black women must operate in and navigate these various systems, a key consideration is distinguishing the additive (Black + Woman) from the Black Woman experience, especially in environments plagued with privilege and power, such as higher education institutions and STEM fields.

Another critical element of intersectionality is how interlocking identities of Black women exist within oppressive structural environments such as STEM spaces. Ireland et al. (2018) discuss how racial and gender identities of Black women girls provide social context to their STEM interests, perceptions of abilities and attributes, and support systems with STEM

environments. Intersectionality within STEM calls for examining the systemic oppression Black women face inside and outside the classroom.

STEM environments at PWIs are characterized as insulating spaces for White males to succeed. Black women in STEM are not able to crutch the privilege of racialized or gendered identities because the systems esteem whiteness and patriarchy (Charleston et al., 2014; Ireland et al., 2018). When examining STEM environments, Black women face nuanced discrimination due to stereotypes related to gender and race. Ideals such as a lack of aptitude in science and mathematics or being loud, aggressive, and lazy often impact their sense of belonging, psychological processes, and education success outcomes (Ireland et al., 2018). Even in instances of addressing Black students in STEM, the interlocking racialized and gendered experiences of Black women are often not fully addressed in the educational and co-curricular context (Charleston et al., 2014a, 2014b).

Connection to Current Research

Research posits the importance of intersectional identities on the success of Black women in STEM because their development hinges upon an environment that is compatible with their racial and gender identities and their academic interests (Johnson, 2011; Ong et al., 2011). The complex nature of race and gender is conceptualized as a specific phenomenon for women of color in STEM fields (Hodari et al., 2014; Ong et al., 2011). The current study centers these experiences based on the intersectional identities of Black Women.

Sense of Belonging

“Belongingness is a basic human need” (Maslow, 1962). It is an inherent need for people to feel as if they belong. The term has many operational meanings, but they all identify the importance of this basic human need. A sense of belonging is essential for college student’s

success. Administrators, practitioners, and educators must facilitate environments where students feel they belong (Strayhorn, 2018). Belongingness, or a sense of belonging, is defined as a feeling of connectedness or mattering to others (Rosenberg & McCullough, as cited in Strayhorn, 2018). The absence of belonging often results in feelings of isolation, alienation, or marginalization. College students who experience a lack of belonging often do not complete college, or if they do, they are left with long-term outcomes of dissatisfaction and low-performance indicators (Murphy et al., 2022). In terms of college student belonging, Strayhorn's (2018) working definition of the theoretical concept is as follows:

In terms of college, a sense of belonging refers to a student's perceived social support on campus, a feeling or sensation of connectedness, and the experience of mattering or feeling cared about, accepted, valued, and important to the campus community or others on campuses such as faculty, staff, and peers (p.4)."

This phenomenon has been identified as an anticipated indicator of a student's success, engagement, and overall well-being during college (Gopalan & Brady, 2020). The phenomenon is imperative for marginalized students on campuses or subcultures of the campus environment, as their social identities may impact their feelings of belonging.

Sense of Belonging and STEM Students of Color

Historically, women and students of color encounter more negative experiences in STEM. They describe these experiences as more unwelcoming, hostile, and unsupportive than their White male peers (McGee & Bentley, 2018). Strayhorn (2018) draws upon the importance that a sense of belonging has on STEM students of color and its impacts on their academic and social success in the STEM context. In STEM environments, especially for students of color, a sense of belonging takes on a heightened consciousness of importance because these individuals

are often confronted with a lack of support, marginalization, and unwelcoming environments (Freeman & Anderman, 2007). Furthermore, fewer women and students of color matriculate and remain in the field. When they do, they feel isolated, unsupported, and have an absence of belonging (Strayhorn, 2018). Another factor that impedes the sense of belonging of women and students of color is the stereotypes they may encounter from faculty and peers alike about their abilities to be successful in STEM due to their racial or gender identities (Strayhorn, 2009). These stereotypes not only exert influence on their sense of belonging in the field but further diminish their confidence, second guess their abilities, and welcome thoughts of failure (Strayhorn, 2018). These factors often negate the feeling of mattering for students.

For years, scholars have studied the impacts of sense of belonging on college students, but few account for the intersectional identities such as gender, race, or ethnic background of students' color in STEM. Previously, studies related to student experiences have been summarized by individual parts (i.e., race+gender+major=student experience) (Strayhorn, 2018). Individual social identities are only one factor in understanding the complexities of the intersectional experience of STEM students. It is widely accepted that students do not all experience a sense of belonging in STEM equally; their social identities intersect and impact their experiences with belonging.

Johnson (2007) discusses the nuances of belonging for women of color in STEM disciplines. Johnson posits that women are not monolithic, and women of color experience different experiences with a sense of belonging in STEM based on their racial and gender identity. Women of color in STEM disciplines are some of the field's most vulnerable and underrepresented aggregates (Fletcher et al., 2017; Johnson, 2007). Cultivating ways to enhance their experiences are pivotal in maintaining their engagement and recognizing the importance of

how their sense of belonging manifests within STEM disciplines on campus. Stakeholders need to invest in eliminating these inequities that exist to create barriers for Black women in engineering (Fletcher et al., 2017). This engagement can present in many ways, including relationships, organizations, and other opportunities.

Sense of belonging and Student Organizations and Clubs

Sense of belonging is a critical element of collegiate experience and life in general. A college student's sense of belonging can be enhanced or diminished through their involvement experiences. Strayhorn (2018) contends that a student's initiative to get involved on campus satiates the psychological necessity to belong. The satisfaction of this need impacts perceptions, behaviors, and likely optimal functioning (Hausmann et al., 2007; Strayhorn, 2018;). Thereby a student's involvement can facilitate a sense of belonging.

Involvement. Astin (1984, 1999) defines involvement as how much physical and psychological effort students exert in their academic experience. Involvement pertains to what a student *does*, not just what they think or feel. Synonyms for Astin's concept of involvement are effort, vigilance, or to "engage" (p.519). As a development process, college student involvement postulates five central tenets. First, involvement considers physical and psychological elements of the student experience. Another consideration is that involvement happens on a continuum, meaning students' levels of involvement can be different depending on the object or activity.

Furthermore, student involvement can be measured qualitatively and quantitatively based on how much time a student spends doing an activity or how engaged they are. The final two tenets of student involvement speak directly to how policy and practice play into student experiences. According to Astin, student learning, personal development, and policy effectiveness directly impact the capacity in which students are involved (Astin, 1984, 1999).

Generally, the more a student is involved in academically enriching and social activities of college, the more successful they will be (Strayhorn, 2018). Pascarella and Terenzini (2005) developed a body of literature that supports this notion of involvement for college students of all races and the binary sexes (male and female). This concept is imperative as this study centers on students from marginalized racial and gender groups.

Engagement. Moreover, engagement is “the time and energy that students devote to educationally purposeful activities...that lead to student success” (Kezar & Kinzie, 2006, p. 150). Many scholars have studied the impacts of engagement on a college student’s learning and development, acknowledging the differences between sexes [gender identity], race/ethnicity variations, and roles of campus racial composition (Bingham & Okagaki, 2011; Harper & Quay, 2009; Hu & Wolniak, 2013). However, with substantial empirical support, engagement enhances college student learning (Carini et al., 2006). Examples of these engagement activities include clubs, organizations, and other groups on campus. To understand how these phenomena impact student experiences, we must also delineate the difference between involvement and engagement.

Operationally the link between engagement and involvement can be distinct, but many scholars use the words interchangeably. Understanding the distinctions is imperative to know how they impact college students. Involvement refers to both academic and extracurricular activities. It refers to the investment of physical and psychological energy into different objects or activities and the amount of time and quality of students’ investment in experiences designed to produce the desired outcome (Astin, 1999; Strayhorn, 2018). Engagement is the amount of time and effort students devote to their academic and social activities that “lead to the experiences and outcomes that constitute student success” (Wolf-Wendel et al., 2009, p. 412).

While these concept definitions are very similar, engagement assumes student success, but a student can be involved in an extracurricular or academic activity and not be “successful” in said activity (Strayhorn, 2018). For this study, I will focus on the operational definition of involvement of an element of my theoretical underpinnings.

Strayhorn (2018) found a positive relationship between student involvement in academic and extracurricular activities and a student’s sense of belonging. This notion posits that the more frequently a student is involved in meaningful activities, the stronger their sense of belonging. Furthermore, students are more advantageous in terms of a sense of belonging when engaging with their peers in meaningful ways and when they socialize with faculty outside of the classroom (Strayhorn, 2018). Valuable involvement outside (and inside) of the classroom directly impacts a sense of belonging in college. My study explored the involvement and engagement experiences of Black women in STEM-enrichment environments.

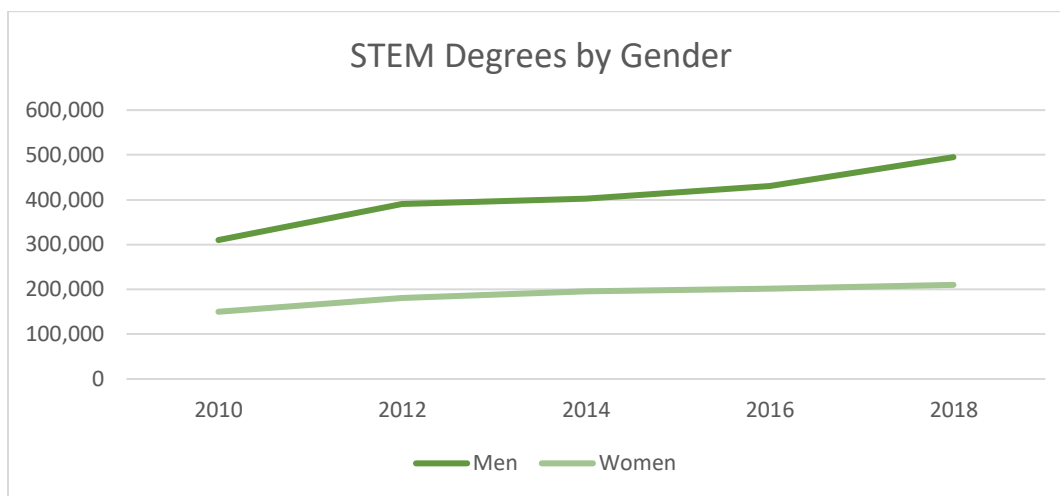
Summary of Framework

For this study, I framed the experiences of Black women undergraduate STEM students using the theories of intersectionality and sense of belonging. These two concepts provide theoretical support by recognizing the marginality related to race and sex [gender] of Black women undergraduate STEM students and exploring a sense of belonging based on their positionalities as college students. As outlined in this framework, the nuances of identity being Black and a woman in a STEM discipline and STEM enrichment involvement program related to a sense of belonging further provide theoretical context to this study.

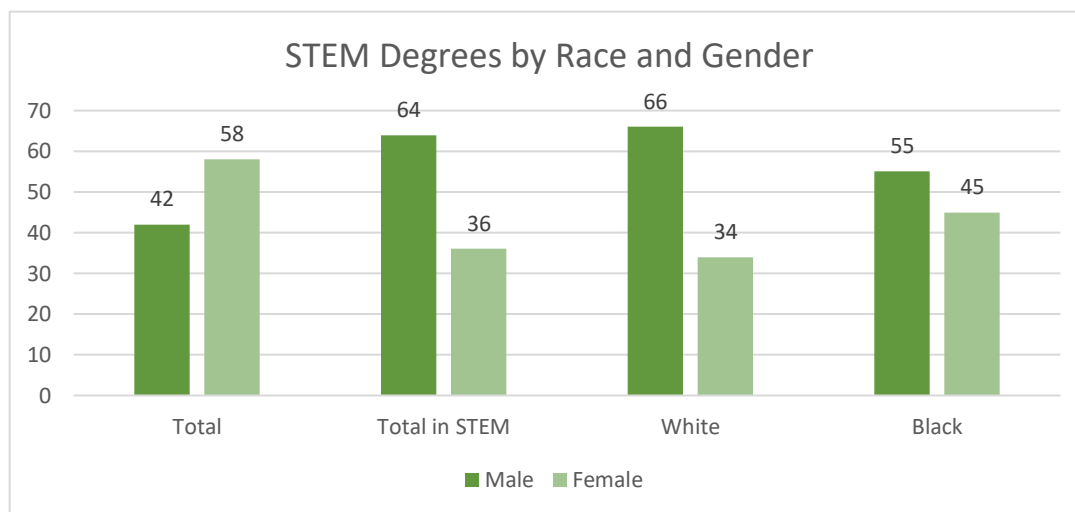
Underrepresentation of Women as an Aggregate in STEM

At the many institutions of higher learning in the United States, men make up a large fraction of faculty and students in STEM disciplines (National Science Foundation (NSF) 2017;

National Center for Science and Engineering Statistics (NCSES), 2013). Women in STEM earn STEM degrees at much lower rates, limiting the talent pool of women in STEM faculty, postdoc, and industry positions (NSF, 2013). In 2012, women earned 41 percent of doctoral degrees in STEM, 32 percent of postdoc fellowships, and comprised 37 percent of the faculty in STEM fields (NSF 2017; NCSES, 2013). The limited representation of women across degree attainment perpetuates fewer women-identified role models and mentors in STEM fields (Cheryan et al., 2011; Drury et al., 2011; Hermann et al., 2016). The underrepresentation of women in STEM can signal to prospective women-identified students that they do not belong in STEM, which is linked to low enrollment and retention rates (Walton & Cohen, 2007). If disaggregated by race and gender, the numbers are even sparser for representation in STEM disciplines. Figure 1.1 depicts STEM degrees awarded to men and women in the U.S. from 2009 to 2018 (NCES, 2020). Figure 1.2 illustrates the STEM degree conferrals by race and gender from the 2015-2016 academic year. Although Black women received STEM degrees at a higher rate than women across racial and ethnic groups, they only accounted for less than 9 percent of all STEM enrollment (NCES, 2020).

Figure 1.1*2010-2018 STEM Degrees by Gender*

Note. Adapted from the National Center of Education Statistics (NCES) (2020) reports the number of STEM degrees for males and females in STEM from 2010-2018

Figure 1.2*STEM Degrees by Race and Gender*

Note. Adapted from the NCES (2020) shows the number of STEM degrees of males and females by race from the 2015-2016 academic year.

Black women in STEM face unique challenges because they are in an environment historically dominated by White and Asian males (Jackson & Charleston, 2012; Johnson et al., 2011b). These images illustrate the STEM landscape of women of color and Black women.

Overview of Barriers for Women in STEM as an Aggregate

Barriers are challenges or obstacles that prevent access or movement (Oxford, 2020). Historically women in Science, Technology, Engineering, and Mathematics (STEM) fields have remained underrepresented over time (Johnson, 2011b, 2012; Espinosa, 2011; Perna et al., 2009). Institutions and organizations lay out two main priorities to increase the participation and completion of women in STEM fields. First, increasing the recruitment of women entering the STEM pipeline is vital in dismantling underrepresentation. Secondly, increasing retention rates of women in STEM is also essential in improving the talent pool of women in STEM (Drury et al., 2011).

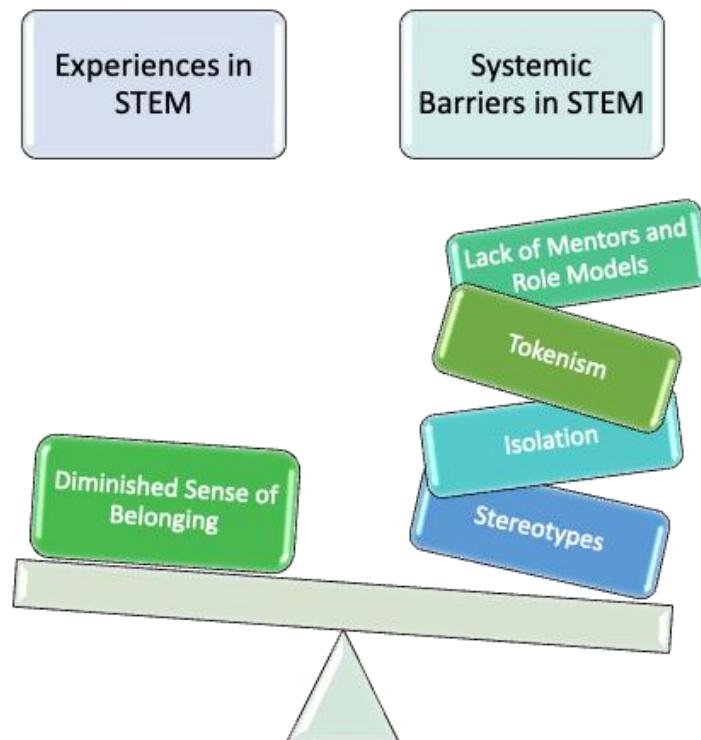
Furthermore, some factors inhibit the recruitment and retention of women in STEM, such as lack of role models, negative stereotypes and stereotype threats, negative self-concepts, and incompatibility with feminine gender roles (Dasgupta & Stout, 2014; Drury et al., 2011; Perna et al., 2009). The factors mentioned earlier can be classified as barriers that can inhibit the success of women in STEM fields. These barriers are often compounded by racism and sexism against women of color (Johnson, 2011a; Ong et al., 2018).

Research has developed over time on the experiences of women of color in STEM-related to persistence, retention, sense of belonging, and completion (Espinosa et al., 2011; Johnson, 2011a, 2017; Ong et al., 2010; Rodriguez et al., 2018). Yet, women of color are underrepresented in the literature on undergraduates in STEM majors (Johnson, 2011). If women of color are included in empirical research regarding STEM, the sample sizes are generally too

small to conduct a meaningful analysis (Johnson, 2011). Johnson (2011) began to inquire about the importance of viewing these women's experiences from a more intersectional lens. Further, Johnson iterated on the importance of considering the race and gender identities of women of color in STEM and the impacts on their sense of belonging in STEM disciplines. Conceivably, most existing literature curates a story of the experiences of women of color as a homogenous group (Espinosa, 2011). More nuanced examinations of women's experiences in STEM by specific racial and gender highlight unique experiences faced by women from different racial/ethnic backgrounds.

Figure 1.3

Illustration of systemic barriers impacting women's sense of belonging in STEM.



Note. Literature denotes that women of color experience a number of systemic barriers in STEM fields, including but not limited to stereotypes, microaggressions, tokenism, and a lack of mentors and role models (Fletcher et al., 2017; Ong et al., 2018).

Barriers for Black Women in STEM at PWIs

Black women in STEM at PWIs face different experiences than their White and Asian counterparts due to their race and gender (Hill et al., 2010). Because of their racial and gender identities, Black women are consistently at the intersection of the double bind of discrimination (Malcolm et al., 1976; Moses, 1989; Ong et al., 2011). In 2016, only about 10 percent of Black women undergraduate students were enrolled in a STEM major, including engineering, biological science, mathematics, and physical science (Gayles & Smith, 2018). These statistics are products of low retention rates and the persistence of Black girls and women in STEM disciplines. Furthermore, structural barriers create chilly climates, or unwelcoming and hostile environments, which can be related to Black women's departure from STEM disciplines. (Fletcher et al., 2017; Simon et al., 2017).

Many Black women in STEM face discrimination due to chilly climates and isolation based on their interlocking racial and gender identities (McGee & Bentley, 2017; Ong et al., 2011; Tate & Linn, 2005). In a study of women of color college students in STEM, Esposito (2011) found that Black women chemistry students experienced sexism and racism in their classrooms and lab environments, challenging their feelings of belonging. In these cases, the students experienced these negative behaviors. Esposito (2011) ultimately found that they had to understand and navigate the "hidden curriculum" of identity and respectability to withstand the gendered racism in their discipline.

The negative racialized and gendered experiences of Black women in STEM manifested in White male-dominated environments through oppression, negative stereotypes, and isolation (Lee, 2008; Dancy et al., 2020). In a qualitative report of Black women engineers at Purdue University, Fletcher et al. (2016) found semblances of negative stereotypes, discrimination, and isolation for Black women in engineering majors that Esposito (2011) uncovered for Black women in chemistry. The participants' experiences reflected isolation, tokenism, lack of representation, and a diminished sense of belonging. Fletcher et al. (2017) interrogated the experiences of Black women because statistics showed that Black women received engineering degrees at three times a lower rate than Black men (Fletcher et al., 2017; NCES, 2018). These findings further illuminate gender disparities among Black students in STEM.

In a similar study, Charleston et al. (2014a) used qualitative inquiry with theoretical underpinnings of Black Feminist Thought (BFT) and Critical Race Feminism (CRF) to examine the experiences of Black women computer science students at a PWI campus. Incidents related to racism, sexism, isolation, and subordination are all found by Charleston et al. (2014a). The commonality across these students' experiences is the isolation, discrimination, and difficulty within their disciplines based on their racial and gender identity while navigating male and White dominated spaces. These studies necessitate more inquiry into Black women's experience in co-curricular STEM spaces since they are experiencing hostile classroom environments.

Diminished Sense of Belonging for Women in STEM Environments

The lack of belonging is another barrier for women in STEM fields. Even though negative stereotypes can adversely affect women's abilities in STEM, a sense of belonging (or lack thereof) is a more robust indicator of women's success in STEM than negative stereotypes (Drury et al., 2011; Strayhorn, 2012). Unequivocal evidence links how a sense of belonging in

academic settings influences students' academic success (Lewis et al., 2016; Strayhorn, 2018). Because of perceived incompatibility with feminine identity, lack of role models, negative stereotypes related to abilities, and underrepresentation, women often feel they do not have a place in STEM fields (Drury et al., 2011; Lewis et al., 2016).

A lack of sense of belonging in STEM causes women to question their desire to persist in STEM majors. Lewis et al. (2016) discusses the nuances of what it means to belong or "fit in" in STEM or whether it is just best to "opt-out." The elements mentioned above, such as the quantity and quality of peers and role models, negative stereotypes, and influences outside of academics (i.e., the media), are empirical evidence collected by Lewis et al. (2016) in the systematic literature review. The literature also found that women in mathematics felt a diminished sense of belonging when they perceived their peers and instructors believed that women were less academically talented in the subject (Good et al., 2012). However, this study did not explore the relationship between a sense of belonging or ability within other disciplines related to STEM outside of mathematics. Future research is warranted to understand how this phenomenon may impact women in engineering, physics, and technology and recognize the nuances that may affect women of color and Black women.

The disproportionate underrepresentation of women in STEM impacts their ability to feel they belong (Rainey et al., 2018). Colleges and universities have difficulty recruiting and retaining women in STEM (Drury et al., 2011; Landgraf et al., 2008; Seymour & Hewitt, 1997). The field cannot maintain steady recruitment and enrollment of women in STEM. Hill et al. (2010) point out the irony that scientists and engineers are solving some of the most complex modern issues but cannot figure out how to appropriately value the input of women in their fields. The environment around them often shapes women's and girls' desire to stay within

STEM. Eliminating negative stereotypes and biases can improve environments that positively impact a sense of belonging. Hill et al. (2010) found that small cultural changes within computer science and physics departments, such as amended admissions requirements, student physical spaces, and broader overviews of introductory courses, were promising in making gains for female student recruitment and retention. Hill discusses the importance of relinquishing unconscious biases about women's limitations in STEM disciplines which is also important for increasing feelings of sense of belonging for women in STEM.

Sense of Belonging for Women of Color and Black Women in STEM

Sense of belonging and isolation are essentially the most disparaging factors related to the underrepresentation of women of color in STEM (Dortch & Patel, 2017; Johnson, 2012). Hausmann et al. (2007) define a sense of belonging as a psychological feeling valued within their college or university community; this could also include subsets of that community. Black women in STEM often contend with their peers and faculty avoiding them, being dissuaded from persistence in STEM by faculty, and excluded from the insider information on how to excel within their disciplines (Johnson, 2012; Ong, 2005; Seymour & Hewitt, 1997). These experiences contribute to a diminished sense of belonging, especially within STEM majors on a PWI campus (Dortch & Patel, 2017; Hausmann et al., 2007).

The notions of masculinity and femininity also play a substantial role in gender disparities in STEM-related occupational values, which begins with choosing a major (Simon et al., 2017). Women of color often opt out of STEM majors and careers because the masculine culture often produces a “chilly climate” for them based on their racial and gender identities (Callister, 2006; Herzig, 2004; Xu, 2008). A chilly climate in STEM can be partially explained by women feeling incompatible with STEM culture, discriminated against within the science’s

masculine dominance, and experiencing feelings of overt or covert hostility (Callister, 2006; Herzig, 2004; Xu, 2008). With this in mind, because of the communitarian and altruistic values often associated with femininity, women of color often choose STEM careers at lower rates (Diekman et al., 2010).

Mentors for Women in STEM

Mentors are essential to achieving goals and accessing resources within STEM (Collins, 1996; Lockwood & Kunda, 1997). Literature defines mentorship as helping relationships that support positive outcomes (Collins, 1996; Lockwood & Kunda, 1997; Stelter et al., 2020). Mentors provide advice, leadership, and guidance relevant to accomplishing a goal (Stelter et al., 2020). Women in STEM often experience a lack of women-identified role models and mentors at the peer, teaching assistant, and instructor levels in higher education (Hermann et al., 2016). The presence of mentors can help mitigate barriers such as isolation, tokenism, and stereotype threat for women on STEM pathways by promoting a positive self-concept toward STEM and assisting women in envisioning the benefits of a STEM degree (Cheryan et al., 2011; Hermann et al., 2016). While men and women can serve as mentors for women in STEM, data underscores that the most influential mentors identify with similar gender or ethnic groups as their students (Cheryan et al., 2011; Lockwood, 2006; Ong et al., 2018).

Presence of Women-Identified Mentors in STEM

STEM mentoring relationships promote more positive attitudes and outcomes for women in STEM (Drury et al., 2011; Stelter et al., 2020). Stout et al. (2011) posits that exposure to and support from women experts in STEM increases positive attitudes and self-concept toward STEM because mentoring relationships provide direct contact, affirmation, and social belonging for students (Hermann et al., 2016). Recruitment and retention of more women in STEM rely

heavily on the presence of women (i.e., faculty, staff, postdocs) because research contends that women have more influence on girls and women's abilities and desires (Drury et al., 2011; Hermann et al., 2016, Kricorian et al., 2020). Female and male role models can be equally effective in enhancing recruitment efforts for women in STEM; however, women-identified mentors aid in performance and a sense of belonging for women in STEM more effectively than males (Drury et al., 2011; Lockwood, 2006). Because mentors with similar gender identities are important to the recruitment, retention, and success of women in STEM, evidence of interlocking identities of race and gender are also essential mentor attributes.

Racial and Ethnic Identities of Mentors in STEM

As previously mentioned, a lack of mentorship is a barrier for women in STEM fields (Hermann et al., 2016; Drury et al., 2011, Lockwood & Kunda, 1997; Collins, 1996). It is crucial to understand mentorship experiences and preferences regarding mentors in STEM for minoritized women (Kricorian et al., 2020). Regarding mentors for women of color in STEM, gender and ethnic identity were essential in mentorship preferences (Kricorian et al., 2020). This study sought to understand the experiences of underrepresented groups in STEM as they related to beliefs and mentor preferences. Kricorian et al. (2020) assessed the key attributes of gender and racial identity of mentors for women of color pursuing STEM careers. Furthermore, the presence and support of mentors impacted their participation and success in STEM. The study highlighted the importance of STEM mentors for women of color interested in pursuing STEM careers and the importance of structured mentorship from someone in STEM with the same gender and ethnicity (Kricorian et al., 2020).

For women of color in STEM, seeing role models that share their identities creates a connection through gender and cultural connection Hodari et al. (2014) found that mentors

served as critical sources of what success looked like in the field of STEM. Hodari et al. (2014) shared that role models can serve as community representatives for women of color within the STEM field, empowering success; however, the representation alone is not always sufficient for women of color. These role models represent the experience of intersectionality within STEM disciplines. On the other hand, mentors that demonstrate caring attitudes are just as critical as the presence of role models alone for women of color in STEM. The study did not, however, discuss the nuances of Black women mentors and experiences in STEM environments. Co-curricular STEM environments often are where mentorship occurs, and investigating these experiences is imperative, especially for women of color and Black women.

Significance of Black Women Mentors

For Black women contending with marginalized racial and gender identity, mentorship is even more critical. Without the presence of similarly identified mentors, exit is often inevitable, or racial battle fatigue supersedes the motivation to persist in the area (Fletcher et al., 2017; Smith, 2017). The National Science Foundation (2017) reported that Black women made up only two percent of practicing scientists and engineers and are similarly underrepresented in academia. They found that this severe underrepresentation of Black women occurs in the STEM pipeline as early as primary school (NSF, 2017).

The underrepresentation in industry and academia directly impacts the potential mentorship opportunities for Black girls and women in STEM (Charleston & Jackson, 2011; McGee & Bentley, 2017). Charleston et al. (2014b) found Black women were less likely to aspire to computing fields without having same-race or gender role models. Ong et al. (2018) alluded that gender and racial/ethnic diversity in STEM could be catalyzed by unique cultural backgrounds, traditions, and perspectives, leading to innovation and new scientific discoveries.

Nonetheless, STEM fields continue to disregard the rich contributions of Black women by failing to recruit and retain them but instead upholding values of inequity.

Stereotypes

Another barrier for women-identified individuals in STEM is contending with negative stereotypes. The term stereotype originally appeared in social psychology literature due to the social categorization leading to in and out-groups (Katz & Braly, 1933). Stereotypes are the process of attributing traits, characteristics, behaviors, or values to an entire group or category of people (Tatum, 2017). Due in part to the historical, normative male dominance and overrepresentation of men in STEM, many [negative] gender-based and performance stereotypes impact women-identified individuals in STEM disciplines (Drury et al., 2011). For women of color and Black women, stereotypes are compounded by race and ethnicity. Gender-based stereotypes for women in STEM are associated with more feminine attributes that seem incompatible with STEM disciplines (Dasgupta & Stout, 2014). These gender-based stereotypes catalyze biases about women's perceived abilities and performance in science and mathematics as early as primary school, often deterring girls and women from pursuing STEM careers (Dasgupta & Stout, 2014; Shapiro & Sax, 2011). The intersectional identities of women of color result in instances of gender bias and racial and ethnic stereotypes within STEM.

Gender-Based Stereotypes

The socialization of gender mismatch in STEM begins as early as childhood. Children learn about gender and encounter gender roles early in childhood (Eccles et al., 1990). During childhood and adolescence, masculine stereotypes about science and math manifest. Furthermore, parent and guardian expectations of their [daughters] and perceived lack of fit with personal goals move girls and young women away from STEM (Dasgupta & Stout, 2014). As

women merge into adulthood, the gender mismatch in STEM is continually characterized by incompatibility with feminine characteristics (Van Velveen et al., 2019). Buck et al. (2002) posit that assigned masculine gender roles are popular representations of math and science. This notion makes women perceive STEM as more masculine and incompatible with female gender roles (Cheryan et al., 2009).

In STEM, feminine attributes (e.g., nurturing, team-oriented, cooperative) are perceived as negative stereotypes. Still, masculine-identified attributes (e.g., status-orientated, technical skills, individualism) represent positive professional culture in STEM (Van Veleen et al., 2019). Feminine-associated gender role stereotypes are associated with being communal, and masculine gender roles are more agentic (Konrad et al., 2000). Van Veleen et al. (2019) classified these social identity threats to women in STEM as ‘double trouble’ because they are outnumbered by men and negatively stereotyped in STEM. Empirical evidence suggests that challenging the perpetuation of negative STEM stereotypes may be more effective in recruiting and retaining more women in STEM (Drury et al., 2011).

Representation of STEM in the media also often casts an image of being more stereotypically masculine. Cheryan et al. (2011) found that media portrayals of STEM communicated an environment not fitting for women. Women in an introductory computer science classroom environment exposed to Star Trek posters and video games found that this imagery impeded their sense of belonging in computer science (Cheryan et al., 2011). Furthermore, encountering potential role models and peers without meaningful representation in a similar environment decreased women’s sense of belonging and desire to major in the field (Cheryan et al., 2011). On another note, stereotypical features of STEM are being withdrawn and preoccupied with technology. These characteristics are associated with masculine identities,

which act as a deterrent for women in STEM (Barbecheck, 2001). This perceived incompatibility can make women question their place in STEM environments.

Performance Stereotypes

Women and men take STEM courses at the same rate, and women often receive higher grades than men (Cimpian, 2020). Men with lower math and science high school grade point averages and math SAT scores are still four times more likely to choose a math-intensive college major than a woman (Cimpian, 2020). Women are less likely to choose STEM careers and remain in STEM majors at a lower rate than men (Ceci & Williams, 2010; Ceci et al., 2010). Standardized test scores and performance in math across the gender binary impact women's pursuits and abilities in STEM more negatively than men (Hyde et al., 2008). For example, Smeding (2012) measured math stereotypes of female engineering students compared to female humanities students, male engineering students, and male humanities students using the Implicit Association Test (IAT).

Additionally, they tested whether female engineering reasoning stereotypes were more strongly and negatively associated with students' math grades in the other three comparison groups. Results showed that female engineering students have weaker math and reasoning stereotypes than students in the other three comparison groups; however, these stereotypes were not necessarily negatively associated with poor math performance for all women. This study illustrates the deterrent of counter-stereotype success of women in STEM, and this negative stereotype reinforced the concept of women's implicit gender stereotypes and performance relationship (Smeding, 2012). When contending with these negative stereotypes, women in STEM fields often experience doubt in their abilities to perform well in their field (Spencer et al., 1999). However, as mentioned above, the study limited its scope to engineering and no other

STEM majors, where women are more broadly represented. This study consequently failed to underscore racial and ethnic differences as a descriptor for participants, necessitating more nuanced examinations of how Black women are contending with STEM performance stereotypes inside and outside the classroom.

Racial-Based Stereotypes and Discrimination

Women of non-White races and ethnicities must leverage potential racialized and gendered maltreatment in STEM fields. The nuanced nature of being a woman of color in STEM presents gendered and racialized barriers in STEM (Alfred et al., 2019). STEM fields are essential to the future, yet women of color and Black women are still overwhelmingly underrepresented within these fields (NSF, 2015). Pervasive and daunting racial and gender stereotypes often discourage Black women and girls from pursuing STEM careers (Perry et al., 2012). These stereotypes began as early as K-12 education. Hill et al. (2010) found that instructor biases and deterring Black girls from pursuing advanced STEM [Advanced Placement] courses undermine their pursuit of STEM pathways at the collegiate level.

Black women are subject to racial bias in STEM at the collegiate level following their primary and secondary school experiences. McGee and Bentley (2017) examined how Black women in STEM undergraduate and graduate students contended with and responded to racialized and gendered bias and stereotypes. McGee and Bentley (2017) interrogated how racialized and gendered experiences were salient for Black women STEM students. Dickey (1996) articulated the experience of a Black woman who was the only minority woman in her laboratory. In the findings of the study, the woman said, “I have become more suspicious...I’ve become more aware of a lot of stereotypes, mostly negative, about women and Blacks that are internalized [by other students]” (p.126). She also stated... “As far as being a Black woman, they

don't expect you to be there at all." This statement indicates a diminished sense of self and further perpetuates these stereotypes and unfavorable climate (p. 310). Ultimately, these ideals can lean lead to negative self-concept and stereotype threat.

Stereotype Threat

Stereotype threat is a psychological barrier that impacts underrepresented groups. Stereotype threat is an additional factor that impedes the attainment of women in STEM. According to Steele and Aronson (1995), stereotype threat is a self-evaluated threat that negatively influences the performance of an individual because negative performance will confirm a negative stereotype about the group to which an individual belongs. Historically, literature illuminates that stereotype threat contributes to gaps in academic performance between Black and White students and between women and men (Steele & Aronson, 1995; Brown & Josephs, 1999). In the case of men and women, this threat is omnipresent in STEM disciplines because of disparities of representation and negative stereotypes about women's STEM abilities. Stereotype threat represents a contributing factor to gender and racial gaps in STEM. According to Cadaret et al. (2017), stereotype threat directly and indirectly, influences women's academic self-efficacy in STEM. They also theorized that stereotypes for women in engineering induced career development—the majority (73 percent) of the 211 respondents in the study identified as White women. The study also underscored the importance of the environment in decreasing the vulnerability of stereotype threat and retention and completion for women in STEM. Practical implications supported this conclusion by calling on administrators and educators to create programmatic interventions to increase access and equality within engineering for women (Cadaret et al., 2017). However, for Black women in STEM, the phenomenon is compounded by double marginality.

The Double Bind

As previously mentioned, human beings occupy many privileged and oppressed social identities. In STEM fields, intersectionality related to underrepresented minority (URM) women are often characterized by the *double bind*. Ong et al. (2011) described the complex simultaneous presence of racism and sexism in STEM as the *double bind*. The [double bind] phenomenon presents a set of “unique challenges minority women [face] as they simultaneously experience sexism and racism in their STEM careers” (Ong et al., 2011, p. 175). Disaggregating the experiences of women of color by race/ethnicity begins to explore the unique experiences of these women within academia (Espinosa, 2011). Because women of color are not a monolith, this experience looks different for Black women (Johnson et al., 2012; Johnson, 2011 a). The *double bind* suggests that the underrepresentation of women of color in STEM fields results from the underutilization of human capital and an effect of inequities in education and employment (Ong et al., 2011). The authors suggest in their comprehensive synthesis of the literature that double bind does not impact all women of color equally. Black women experience discrimination and bias in STEM differently than their Asian or Latina counterparts. Recognizing that women of color are not a homogenous group is essential to a more nuanced understanding of their experiences.

Women and Minorities ≠ Minority Women

The marginalized identity of all women is an essential concept to addressing inequities; understanding the ethnic, racial, and gendered discrimination of women of color and Black women in the STEM field is imperative (Hill et al., 2010). The potential boundaries of the equitable success of women of color in STEM related to gendered racism highlight the privilege of White women in the field (Espinosa, 2011; Rodriguez et al., 2018). More dishearteningly, the

scarce research recognizing the ethnicity and race of women in STEM focuses on undergraduate women and often excludes graduate, faculty, and professional women. This concept needs further exploration because role models connect students with others who share their identities within the field. Furthermore, without the presence of those representative relationships, departure is often inevitable, or racial battle fatigue supersedes the motivation for undergraduate Black women to persist in the STEM field (Fletcher et al., 2017). Compared to Black men and their other women of color counterparts, Black women enrolled in STEM undergraduate programs are significantly lower than all other racial and ethnic groups besides Native and Indigenous women (Hill et al., 2010; Johnson, 2011).

Language such as “women and minorities” featured in an abundance of STEM literature fails to recognize the intersectional identities of women of color and Black women. As a result of racial and gender identity, McGee and Bentley (2017) contend some discriminatory experiences are distinctive to Black women in STEM. Moreover, much literature on Black or African American women in STEM fails to recognize their intersectional identities of being Black *and* a woman.

In 2015, the National Science Foundation and the National Center for Science and Engineering Statistics reported the consistent lack of diversity regarding women and underrepresented minorities within STEM disciplines (NSF, 2017; NCES, 2018). However, Black girls and women persist and excel in STEM courses, majors, graduate programs, and careers (Espinosa, 2011; Johnson, 2011a, McGee & Bentley, 2017). This persistence is partly due to how resilient Black girls and women are in the face of adversity and systemic barriers (Gayles, 2005). Even with triumph for Black women in the STEM field, more research is needed

to understand if they excel because of or despite systems designed as support mechanisms. This study examines those experiences.

Contending with Hypervisibility and Invisibility for Black Women in STEM

Numerous studies and reports discuss the contention of hypervisibility and invisibility of Black women in STEM (McGee & Bentley, 2017; Newton, 2022; Settles et al., 2019; Wilkin-Ye et al., 2019). The notion of underrepresentation evokes a double consciousness of the isolation that comes with being one of a few or the only and the stark reality of being the sole representative in a space. For Black women, this double consciousness represents hypervisibility (overly visible and fixated upon) as well as invisibility (isolated and overlooked) because of their race and gender identities in the STEM context. An intersectional perspective into the visibility of Black women concluded with expressed feeling hypervisible in the classroom environment and generally invisible in other campus settings (Newton, 2022). Both phenomena were affixed to their racial and gender identities.

For Black women in the STEM space, hypervisibility often results in tokenization. Tokenism is often characterized as the hypervisibility of Black women as diverse fixtures in a space without meaningful recognition of their presence (Settles et al., 2019). Further, this hypervisibility comes with a recognition that is surveilled, scrutinized, and micro-aggressed by White peers and faculty (Simpson & Lewis, 2005). This visibility can also be disempowering when used as a means to magnify failures or center stereotypes (Brighenti, 2007; Simpson & Lewis, 2005). It is incredibly challenging when you are vying for visibility to empower, dismantle stereotypes, and avoid isolation.

It is twofold when interrogating the invisibility of Black women in STEM spaces. The exclusion of Black women is epistemic and pervasive for many reasons (Settles et al., 2019).

Alternatively, Black women often use this invisibility as a strategic advantage to separate themselves from their challenging environments (Settles, 2019). Being confronted with invisibility in one's discipline also contributes to isolation, scrutiny, and marginalization. This invisibility may look different in different disciplinary environments. Black women deal with varying levels of underrepresentation across STEM disciplines. Yet their experiences with racialized and gendered systems do not significantly differ.

As noted, Black women are widely underrepresented across STEM disciplines overarchingly. In some specific fields of study, underrepresentation is disproportionate yet pervasive. Namely, when disaggregated by discipline, Black women earned degrees in biological sciences (4.23 %), computer sciences (2.61%), physical sciences (2.83%), statistics and mathematics (2.35%), and (1.6%) in engineering at low rates compared to other racial and ethnic demographic groups (NSF, 2017). Regardless of their major, Black women still struggle with the invisibility and hypervisibility that comes from the racism and sexism that contribute to their further marginalization in predominantly White majors on a historically White campus (McGee & Bentley, 2017; Wilkin-Yel et al., 2019). Simultaneously rendered hyper- and invisibility necessitates internalizing messages of success and support communities that may be cultivated in a co-curricular context.

Out-of-Classroom Experiences in STEM

When examining the STEM learning ecosystem (SLE), all contexts must be accounted for (classroom, co-curricular, and institutional) when exploring student experiences (Bae et al., 2022). This study aimed to understand how students "felt" in science environments, the cultural relevance of the programs, and experiences with bias or microaggression at the institution. The study was framed using Strayhorn's (2012) conceptualization of sense of belonging, specifically

recognizing the need for a comprehensive effort within the STEM learning ecosystem in a student's sense of belonging. The model developed by Bae et al. (2022) advanced Strayhorn's work on belonging with three latent traits that illustrated essential aspects of students' sense of belonging within the STEM learning ecosystem.

The first trait associated with belonging in the SLC was *impediments to belonging*. This trait included how they encountered bias and felt infringements toward belongings. Bae et al. (2022) posit that results revealed issues of gender, race, and ethnicity being contributing factors to these findings. The second trait, *Support for Belonging*, included how students felt support in belonging within science (Bae et al., 2022). The third and final trait revealed, *assurance in belonging*, demonstrated how undergraduate STEM students recognize a sense of comfort and confidence in having a place in STEM learning environments. Furthermore, the research aligns with the work of Chang et al. (2014) that universities' undergraduate student support programs play in creating an inclusive environment at the institution; however, this study focused holistically on student experiences but not specifically on those with marginalized identities. While the research recognized that racialized and gendered experiences play a role in the culture of marginalized students in STEM, they sought experiences as a collective. The study had 517 respondents; 66.33 percent reported as [female], but only 9.5 percent (or 47) of them identified as Black [females]. They further illustrated the marginalization and underrepresentation of Black women in STEM learning environments. Moreover, the survey responses lacked the detailed stories behind these participants' experiences with SLC, especially within the out-of-classroom context.

Other studies have examined the out-of-classroom experiences of women in STEM. Gayles and Ampaw (2011) explored the extent of college experiences on STEM degree

completion in four-year colleges and universities differed for women and men. Gayles and Ampaw recognized that the substantial gap in traditional college impact literature did not account for the experiences of subpopulations (e.g., women, students of color, LGBTQIA+). Furthermore, they examined how very few students have situated participants in student organizations, and other groups varied based on race and gender. The study examined what college experiences mattered concerning STEM-degree attainment within six years. Gayles and Ampaw's (2011) model based on interactions with gender shed light on how influential out-of-classroom experiences were based on STEM degree attainment for women. This inquiry revealed several factors that impeded and enhanced degree completion for women in STEM. This study focused broadly on college experiences, not specifically those affiliated with STEM programs or student organizations. As reported, student-faculty interactions outside of the classroom significantly influence degree attainment and interactions with advisors (Gayles & Ampaw, 2011).

Furthermore, variables and implications for future research in the study accounted for background characteristics such as race. However, findings were presented as an aggregate accounting for women in STEM as a homogenous group, not explicitly highlighting the experiences of women of color or Black women. The literature surrounding the out-of-classroom experiences for STEM majors has accounted for a variety of background factors, contexts, and relationships; however, much of the research does not account for the co-curricular STEM experiences of Black women.

STEM Support and Co-Curricular Programs

Despite systemic barriers, isolation, and chilly climates, Black women have opportunities to succeed in STEM by way of structured support and enrichment programs for STEM students

(Museus, 2008). Many programs, initiatives, and services on college campuses are meant to support STEM students in developing academically and socially. Students of color, specifically Black students, find these co-curricular spaces more affirming than their STEM classroom environments (Lane, 2016). The settings are a space for students to develop a sense of belonging and STEM identity (Lane, 2016). STEM identity and sense of belonging are often inhibited in the classroom because marginalized students experience feelings of isolation, encounter microaggressions from faculty and peers, and incongruence with the STEM professional identity (Lane, 2016; McGee & Bentley, 2017; Strayhorn, 2012). STEM support and enrichment programs are present on campuses to enhance the co-curricular experiences of students in STEM majors. Research indicates that communities such as Women in Science and Engineering (WISE) programs and the National Society of Black Engineers (NSBE) have had positive outcomes from engagement with these organizations (Maltby et al., 2016; Zephirin & Jesiek, 2018). Additionally, research programs such as the Louis Stokes Alliance for Minority Participation (LSAMP) integrate research opportunities to increase access and completion for underrepresented groups in STEM (NSF, 2017). Programs and initiatives such as these leverage support for underrepresented populations in STEM disciplines, and students have shared favorable outcomes from their participation with these programs and organizations (Ong et al., 2018; Zephirin & Jesiek, 2018).

Peer-Based Programs

Peer-based programs focus on the social development of students. These programs are often associated with student engagement, leadership development, and peer mentoring (Budge, 2006). Shook and Keup (2012) explored the powerful influence of peers on human development widely within education. Astin (1993) states that “[the] student’s peer group is the single most

potent source of influence on growth and development during undergraduate years” (p. 398). In addition to influencing a student's personal development, peer-based interactions can significantly impact student success and influence their transition to college, likeness to college, persistence, and academic success (Budge, 2006; Shook & Keup, 2012). This notion is true for both negative and positive peer influences. With this in mind, peer-based programming, such as living environments and student organizations, influence a student's college experience (Baker, 2007; Shook & Keup, 2012; Spaniermann et al., 2013).

Living Learning Communities (LLCs)

Living Learning Communities (LLCs) are high-impact practices that are pivotal in cultivating the student experience (Maltby et al., 2016; Spaniermann et al., 2013). Inkelas et al. (2007) illustrated the importance of LLCs on women in STEM experiences at a university. As these women persist throughout their undergraduate experience, LLCs provide them with environments to thrive socially, academically, and professionally (Inkelas et al., 2007, 2011; Maltby et al., 2016; Spaniermann et al., 2013). Universities continually utilize the high-impact practice of LLCs to increase the support and representation of women and other marginalized students in STEM (Maltby et al., 2016). Yet, often exclude how these programs impact different student populations based on their identities and diverse experiences.

Women in Science and Engineering (WISE) living-learning communities are specific learning communities for women within STEM disciplines (Maltby et al., 2016). Living learning communities emerged in the 1980s, intending to support and retain students. WISE programs emerged in the early 1990s to support and retain women that share STEM interests (University of Wisconsin, n.d.). Research depicts that these environments have positively impacted their transition, performance, and engagement within STEM (Hathaway et al., 2001; Inkelas et al.,

2007; Maltby et al., 2016). WISE often serves first-year students and uses a peer mentor model; students become acquainted with academic resources and community engagement activities (Maltby et al., 2016). Participation in WISE communities has also aided in the sense of belonging to women within STEM fields (Spaniermann et al., 2013). Scholars have identified that these communities include women primarily pursuing biological and other physical sciences; those majoring in engineering or computer science are disproportionately underrepresented (Hill et al., 2010). These may be institutionally specific in some instances. Still, the study presented by Hill et al. (2010) confirmed the disproportionate enrollment in STEM majors represented in WISE communities, with physical and biological science majors outnumbering engineering and technology majors (Maltby et al., 2016; NCES, 2018). In literature and practice, WISE communities are representative of all women participants and often not disaggregated by the racial or ethnic background of the women participants. This highlights gaps in the literature related to the experience of women of color and Black women (Maltby et al., 2016).

Consequently, like many similar studies, Maltby et al.'s (2016) study concerning WISE LLCs, women of color and specifically Black women, are disproportionately underrepresented compared to White and Asian women. The study espouses that these STEM-focused learning communities have long-term benefits for women within STEM fields; however, when disaggregated, the study was composed of 57 percent White women, 13 percent Black women, and four percent Latina/x women. With this in mind, identifying the benefits for Black women is more difficult due to disproportionate underrepresentation within the sample (Maltby et al., 2016). Findings stated that underrepresented minorities' (URM) benefits proved statistically significant. Still, the student was first compared to the matched control group, and the numbers

of URM represented in the study were significantly lower than that of Whites students within the sample (Maltby et al., 2016). These critiques do not invalidate the findings and existing data but raise awareness of contributing to the lack of representation of underrepresented populations within research. In previous research, administrators, practitioners, and educators must be committed to understanding the students they are serving. Inkelas et al. (2007, 2011) investigated student outcomes from participation in LLCs, but these studies also did not disaggregate by race or ethnicity. Johnson (2011a) previously established the message that a small sample size of women of color within these studies often produces statistically insignificant results.

As universities illustrate the narrative that LLCs are high-impact practices that create “seamless learning environments,” Fink and Hummel (2015) questioned the notion of institutions doing an adequate job of engaging underserved and underrepresented students within living-learning communities (p.29). Harper and Quay (2009) say that not adequately engaging underrepresented groups constitutes institutional negligence. Fink and Hummel (2015) primarily center on LLCs designed for serving traditionally underserved student populations, including students of color, first-generation and low-income students, and women in science and engineering, but with consideration for intersectional identities. Espinosa (2011) recognized the potential of intersectionality among these student populations and how the disregard can impact their experiences. Hill et al. (2010) created a guide for 25 essential practices of planning, implementing, and sustaining effective learning communities; however, this guide offered scant resources for LLCs that focus on serving some of the most vulnerable populations, including Black women in STEM. These practices further perpetuate the notion that learning communities may not serve all students equally. Fink and Hummel (2015) recommend that the most powerful learning communities consistently use data and assessment to enhance practices, which means

that amplifying students' voices from marginalized racial and ethnic groups will more precisely identify the needs of student participants. Living Learning Communities have become a practice intended to foster academic, social, and professional development. Still, little data is known about serving all students with the same intended benefits because race disaggregation is generally a limitation of many students' outcomes. (Lord et al., 2009; Szelényi & Inkelas, 2010).

Student Organizations

Student organizations are significant to students' college experience (Astin, 1994; Kuh, 1995). These student-centered organizations are often categorized as interest groups related to governing bodies, academic clubs, club sports, religious organizations, interest/cultural groups, and honor societies (Astin, 1993; Montelongo, 2002). On-campus collegiate student organizations are often labeled as "the other education" to allow students to apply academic knowledge to a real-world setting and develop social and academic skills (Montelongo, 2002, p. 50). Involvement within student-centered professional organizations includes leadership development, social development, and increased feelings of belonging (Montelongo, 2002). Baker (2008) found that students involved in student organizations are more likely to be academically successful. Co-curricular involvement in student organizations has been cited as a means to supplement academic learning with learning outside the formal classroom setting (American Council on Education (ACE), 1949; Montelongo, 2002). Which many stem students take advantage of to complement their education experiences.

STEM-based student organizations exist to support students enrolled or interested in STEM majors. Professional and student organizations such as the National Society of Black Engineers (NSBE) and Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) are peer-based professional organizations with undergraduate student participation

designed to facilitate professional and co-curricular support to underrepresented groups in STEM (MANRRS, 2020; NSBE, n.d.). Specifically, these programs are associated with international and national professional organizations and have local chapters on university campuses.

National Society of Black Engineers

The National Society of Black Engineers (NSBE) is one of the largest consortiums of student and professional engineers (NSBE, n.d.). Initially, the Society of Black Engineers (SBE) was founded in 1974 by a group of Black engineering students and a professor at Purdue University (NSBE, n.d.). The organization was unanimously recognized as the National Society of Black Engineers by 48 students from 32 institutions within a year. Shortly following, NSBE was incorporated as a national nonprofit organization. Presently, NSBE has more than 30,000 members and more than 790 chapters (NSBE, n.d.).

STEM-focused student organizations such as NSBE give students access to social and career development opportunities. Ross and McGrade (2016) explored student perceptions of the impact that participation in NSBE had on their experiences. They found that students experience a greater sense of belonging through participation in an ethnic professional/student organization. Students reported that being in community with “people who look like [them]” provided them with opportunities for support and contributed to their academic success (Ross & McGrade, 2016, p.2). The study specifically focused on the completion rates of the students who participated in NSBE at a small Midwestern University. Participants’ social integration through active involvement with NSBE significantly contributed to students’ academic success. Of the five participants, three were [Black] women-identified students and expressed that NSBE positively influenced their engineering experiences. However, these women only spoke of incidents related to their racial identity. The study did not suggest any inference of support

impact related to their intersectional identity of being Black and a woman, which would provide context to their unique experiences.

Furthermore, co-curricular experiences such as student organizations have also been linked to developing nontechnical and academic skills of African American engineering students (Young et al., 2014). Through an analysis of the influences of co-curricular experiences of professional student organizations (NSBE), Young et al. (2014) found that students who participated in engineering clubs such as NSBE reported greater teamwork and reflective behaviors. Additionally, the study found that collaborative learning through these co-curricular experiences supports the development of African American engineering students.

Both studies support the notion that ethnic-based professional student organizations such as NSBE positively influence the experience of Black students. However, neither student specifically focused on the intersectional experience of Black women, undergraduate STEM students. Further research is warranted to understand how NSBE impacts the specific experiences of Black women within this organization and how participation can contribute to their sense of belonging, specifically in a male-dominated environment.

Minorities in Agriculture, Natural Resources, and Related Sciences

The Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS) is a society that “fosters and promotes agricultural science and related fields positively among ethnic minorities” (MANRRS, n.d. p.x.). Presently, there are six regions and 56 active chapters across the U.S. For URM students, organizations such as MANRRS are vital to the STEM experience (McKim et al., 2017). MANRRS is an organization tasked with increasing participation and success opportunities for minority students in agriculture and related sciences.

Talbert et al. (1999) interrogated how students involved in MANRRS experienced mentorship and whether these experiences were significant. The study found that the mentoring model used by MANRRS was effective for minority students; nonetheless, student experiences were not disaggregated by race or gender, therefore missing the voices of some of the most vulnerable populations, even among minority students (Talbert et al., 1999).

Organizations such as MANRRS are designed to assist students with barriers associated with their academic disciplines. McKim et al. (2017) explored the challenge and support mechanisms and success of URM students studying agricultural STEM in a College of Agriculture. Using a phenomenological research design, McKim and associates used student biographical statements, MANRRS newsletters, and individual interviews to examine their experiences. The study's findings revealed that students experience various challenges but support in family resources, professional experience, and affiliation with MANRRS. Students reported they were heavily involved in their institutional MANRRS chapter, frequently interacted with their advisor, and took advantage of opportunities at the national MANRRS conference. The study, however, did not aggregate by race and gender.

Another study focused on the relationship between inclusion, intrinsic motivation, and psychological needs of former MANRRS participants. Barber (2020) explored factors contributing to improving feelings of inclusion when pursuing agriculture. The study used mixed explanatory methods to explore the psychological need and motivations of former MANRRS and non-MANRRS participants in agricultural careers. For the qualitative portion of the study, findings indicated five significant themes related to positive preparation experiences amongst former MANRRS (Barber, 2020). The analysis was disaggregated by gender and race, but the experiences of African American women were not centered within the study. While the

organization provided a supportive and growth-minded environment for students of color in STEM, there is room for improvement related to understanding the experiences and support needs of Black women involved in these organizations by listening to their unique voices.

Research-Based Programs

More than half of undergraduate student majors in science disciplines have participated in an undergraduate research opportunity (Russell et al., 2007). Carter et al., 2016, found that research programs are a bedrock of the success and positive outcomes for students in STEM disciplines, especially engineering. This study failed to underscore how the opportunities impacted students from diverse backgrounds. Research-based STEM structured enrichment programs and opportunities have been cited in research to assist underrepresented students in having more positive outcomes (Gasiewski et al., 2008). Scholars also contend that underrepresented students who engage in these structured research programs benefit from increased persistence in STEM disciplines, increased interest in graduate school, access to more academic resources, as well as higher GPAs and graduation rates (Barlow & Villarejo, 2004; Chang et al., 2008; Gasiewski et al., 2008; Hurtado et al., 2010).

Louis Stokes Alliance for Minority Participation (LSAMP)

A historically well-known example of a research-based program is the Louis Stokes Alliance for Minority Participation (LSAMP) Program. This National Science Foundation-funded research program was launched to increase the number of underrepresented minorities receiving baccalaureate degrees in STEM (Hamilton & Parker, 2010). There are over 40 LSAMP alliances across the continental U.S. (Hamilton & Parker, 2010).

The North Carolina Louis Stokes Alliance for Minority Participation (NC-LSAMP), based at North Carolina Agricultural and Technical State University (NC A&T), houses

programmatic initiatives to facilitate positive outcomes in STEM. Jiang et al. (2005) conducted a longitudinal study about the sustainability of increasing the number of underrepresented minorities in STEM at NC A&T. In the program year of 2003-2004, NC-LSAMP at NC A&T enrolled 80 undergraduate students and 12 graduate students; 89 of these students identified as African American, with around 40 percent of enrolled students identifying as Black women (Jiang et al., 2005). Jiang et al. (2005) found that students at this Historically Black University graduated exponentially. Students at this Historically Black University graduated at exponential rates through funding, summer bridge programs, supplemental instruction, research opportunities, and more experiential learning opportunities. Specifically, in 2003 the number of conferred bachelor's degrees in STEM went from 841 the previous year to 916, citing growth in the retention of program participants (Jiang et al., 2005).

The University of Maryland-College Park LSAMP (UMCP-LSAMP) was established in 1995 and has since received funding for continued programming. Hamilton and Parker (2010) studied the progression of the UMCP-LSAMP since its program inception in 1995 in three phases. Phase one, 1995-2000, initiated the program's mission to increase the number of underrepresented students pursuing STEM degrees. Funding for this program allowed students to attend a six-week credit-bearing summer bridge program. Phase two, 2000-2005, established the integration of pathways to STEM graduate study or industry opportunities for bachelor's degree recipients. To accomplish this goal, UMCP-LSAMP established pathways to advanced math bridge programs for first-year students, increased student scholarships, awards for program participants, and an end-of-the-year celebration dinner for LSAMP participants. Phase three, 2005-2010, marked the institutionalization of LSAMP retention strategies. This also marked the creation of the Undergraduate Research Program for LSAMP students and increased

opportunities for students to attend professional development conferences (Hamilton & Parker, 2010). With the inception of each phase, the university administrators, practitioners, and educators assessed to facilitate stakeholders' need to invest in LSAMP principal and co-investigators. From 1995 to 2005, there were significant increases in baccalaureate degrees awarded to Black/African American students; however, there was no formal assessment or research about individual students' support and impact experiences. Further, there was no disaggregated data about the degree-awarding amongst Black/African American men and women, thereby neglecting to examine these programs' impact on gender groups.

When understood together, these programs serve students of color; however, they are not addressing the nuances of the intersectionality of Black women in a White male-dominated space. In programs such as this, Black women are contending with the double marginality of interacting with their Black male peers benefiting from male privilege in STEM spaces. Future studies need to address these nuances to address this gap in literature and practice in many instances.

TRIO and McNair Scholars Program

TRIO, the U.S. Department of Education's federally sponsored program, also focuses on supporting STEM students. TRIO “helps [college-bound] students overcome class, social, and cultural barriers to higher education” (TRIO, 2007, p.4). TRIO Student Support Service STEM (SSS-STEM) is a program that helps students recognize and develop academic skills and career pathways to successful STEM careers. The program is explicitly designed to provide students with opportunities for individual and peer-based support, college coaching, academic support, and cultural enrichment activities (Fayetteville State University, n.d.). TRIO SSS-STEM strongly emphasizes college retention and completion, which is imperative for marginalized STEM

students. Research has shown that this program can enhance the student experience in STEM. Scholars and practitioners alike are continuously looking for ways to broaden the participation of underrepresented groups within STEM.

The Ronald E. McNair Scholars Post-baccalaureate achievement program, referred to as McNair, is a federally funded TRIO program across 151 U.S. and Puerto Rican institutions (McNair Scholars, n.d.). The program is designed to prepare traditionally underrepresented minority (URM) first-generation students for graduate study through involvement with research, mentorship, and other scholarly activities. Eligible students must identify with one or more groups to participate in McNair. Participating institutions provide research opportunities and support for students who wish to pursue graduate education. The programming and projects sponsored by McNair are intentional. McNair projects must provide opportunities for research, other scholarly activities, seminars, summer internships, and opportunities that prepare students for doctoral studies, such as academic counseling (McNair Scholars, n.d.). Institutions then track participants' progress through the completion of their advanced degrees. The goal of McNair is to increase the attainment of advanced degrees for underrepresented populations (McNair Scholars, n.d.).

As previously stated, the McNair Scholars program focuses on increasing graduate degree attainment for underrepresented groups. Fifolt et al. (2014) examined the McNair Scholars program at the University of Alabama at Birmingham (UAB) as if it helped URM. Their study focused on pre- and post-Graduate Record Examination (GRE) scores and a longitudinal approach to track the student's academic accomplishments (Fifolt et al., 2014). Findings illustrated that students who participated in the UAB McNair Scholars between 2007 and 2012 found significant success in the program. The results were substantial as students from

diverse populations have more difficulty being recruited and retained in STEM disciplines as they often lack proper support channels. Additionally, the study found that most students who participated in UAB McNair improved their GRE scores and enrolled in some form of advanced education or professional schooling.

Similarly, in a pilot study, Bancroft et al. (2016) explored the perceptions of McNair Scholars' program experiences. The researchers used a self-designed questionnaire to survey the experiences of the McNair scholars. Because McNair is a program targeted to traditionally underrepresented students, the questions align with race, gender-based barriers, academic preparation, and social support (Bancroft et al., 2016). The study found that most participants perceived their support from the McNair Scholars Program at their respective institutions as beneficial. Moreover, participants reported varying levels of judgment or discrimination in their academic environments based on race and gender. Black male and female participants cited a more mindful awareness of race awareness; however, the Black female participants reported both instances of heightened race and gender awareness.

In both studies, McNair participants reported positive outcomes and academic success. However, because the URM was used as a categorical factor in these studies, there is room to explore the specific experience of Black women. Bancroft et al. (2016) disaggregated survey respondent data by race and gender but reported most study results only by aggregated racial and gender groups. These factors warrant a closer examination of the experience of Black women STEM students participating in STEM enrichment activities.

Summary of Enrichment and Co-curricular Programs

Systemic barriers for Black women in STEM are often combatted by STEM enrichment and support programs. These programs were established to serve some of the most vulnerable

and underrepresented in STEM; however, understanding that women, Black students, and other marginalized groups have unique needs requires diverse means of support. This study seeks to understand how these programs can center the voices and needs of Black women within STEM co-curricular programs.

Summary of Review of Literature

This chapter provides an overview of the literature related to the experiences of women and women of color in STEM, highlighting the nuances associated with the unique experiences of Black women in STEM. The review of literature illustrated their experiences with barriers in STEM, such as lack of access to mentors and role models, stereotypes, and discrimination. Further, the synthesis of literature discussed the gender and racial identity nuances that impact their experiences in STEM. Lastly, as most literature centers on the academic and classroom experiences of Black women in STEM, this review of literature provides context on their co-curricular experiences in the STEM context. The theoretical foundations for this study, intersectionality and sense of belonging, were also addressed in this section.

CHAPTER THREE: METHODOLOGY

For this study, I employed qualitative inquiry to explore the STEM co-curricular experiences of Black Women undergraduate STEM students. Qualitative methodology is best suited when the study aims to understand how individuals or groups perceive their own experiences (Mertens, 2014). These methods most frequently derive from a constructivist paradigm. A constructivist paradigm asserts that our realities are socially constructed and that multiple realities can exist (Mertens, 2014). For this study, I worked with the participants co-constructing their experiences representative of their truths to be representative of a case. Because much of the previous literature on the experiences of women of color and Black women in STEM has been grounded in quantitative inquiry, this study aids in lessening a gap in methodological approaches by examining the participants' experiences through qualitative inquiry.

Epistemological Foundations

Conducting empirical research is historically framed by philosophical foundations. In practice, a researcher must reflect on the paradigms guiding the research design, questions, and analysis. These perspectives inform how the research views reality and ontology and how they view the construction of knowledge, known as epistemology (Creswell, 2018). In qualitative research, philosophical perspectives construct the ways we interpret the data through assumptions and frameworks. The philosophical perspectives represent social constructivism and critical theory for the current study.

Social Constructivism

Social constructivism is defined as the ways in which humans understand reality through interactions within a social context. The creation of meaning-making occurs when individuals

interact with each other and engage in their environments (Denzin, 2000). Social constructivism suggests that knowledge [reality] is socially constructed through collaboration between the researcher and participants (Denzin, 2000). Social constructivism also supports the notion that multiple realities exist partly due to the multiplicity of identity, especially for marginalized individuals (Duran, 2019).

Critical Theory

Critical theory recognizes that liberation is fundamental for marginalized individuals to gain access to liberation from systemic barriers (Fay, 1987). Critical theory suggests that exploring and naming social institutions empowers individuals with marginalized identities to participate in social justice dialogues utilizing their personal power. When using critical theory in qualitative research, the researcher and participants can reconstruct reality dependent upon the social identities within their environments. Critical theory is often intentional in critiquing how power structures impose on the liberation of marginalized individuals (Fay, 1987).

Informing The Current Study

For this study, social constructivism and critical theory inform how Black women undergraduate STEM students at a Predominantly White Institution in the Southeast engage in experiences with STEM co-curricular programming. If employed separately, these two paradigms do not account for the holistic experience of how identities inform the reality of social interactions within complex environments. However, when framed in tandem, these perspectives explore how multiple-marginalized individuals, specifically Black women, in a predominately White male environment (STEM majors) at a historically White and male-dominated institution, namely in spaces that are intended to provide support and community (Miller, 2007).

Qualitative Case Study Methodology

A case study is a rigorous form of qualitative inquiry that many social science disciplines have adopted. Qualitative case study research contributes to the knowledge of individual and group phenomena. Yin (2018) states that case study research is a linear yet iterative process. Case study research tends to be the most appropriate method when the researcher desires to understand a social phenomenon (Yin, 2018). In brief, a "case" focuses on individuals, groups, events, or processes. Merriam and Tisdell (2016) declared that case study research is characterized by the unit of analysis, not only the methodology. There are unique elements of case study research that set it apart from other forms of qualitative inquiry.

Case study research is practical for everyday problems and applied fields such as education (Merriam, 2009). Some distinct characteristics of case study research are bounded systems, the flexibility of philosophical assumptions, and data collection and analysis methods (Yin, 2018). Qualitative methods such as narrative inquiry or phenomenological research often view phenomena through the individual's perspective; however, case study explores the phenomenon through a bounded system (Yin, 2018). Additionally, qualitative case study research uses multiple perspectives and data sources.

Research Design

This study used a single-embedded case study design to explore the participants' experiences using multiple units of analysis. An embedded, single-case design is appropriate when a case requires more than one unit of analysis (Yin, 2018). This study's context was Black women undergraduate STEM students' co-curricular experiences. STEM support and enrichment programs on a PWI campus bound the case. Finally, the two embedded units of analysis depicted student participation in two types of programs, peer-based and research-based STEM enrichment

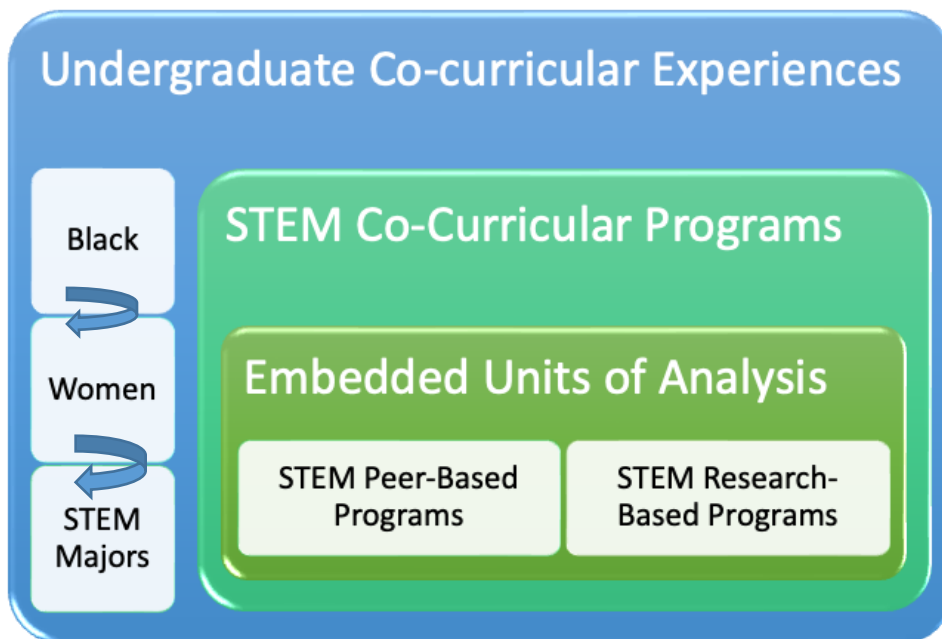
programs, as illustrated in Figure 2.1. This design aided in understanding the experiences of participants in a variety of co-curricular environments related to their STEM major.

The following research questions guided this single embedded qualitative case study:

1. How are Black women undergraduate STEM students engaging in STEM enrichment and support programs at a Predominately White Institution (PWI) in the Southeast?
 - a. What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs?
 - b. What are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs?

Figure 2.1

Black Women in STEM Co-Curricular Embedded Case Study Visual



Note. This model represents the case study for the current study, depicting the context, case, and the two embedded units of analysis.

Research Site

The study was conducted at a large public Research I institution in the Southeast, Upper State University (Carnegie Classification, n.d.). The Carnegie Classification of Institutions of Higher Education (n.d.) classifies Research I institutions as research intensive with a minimum requirement of \$45.3 million in research funding per academic year. Upper State University is a land and sea-grant institution grounded in agriculture and engineering (University website, n.d.). Upper State University has a student population of approximately 30,000 students. The institution offers more than 300 undergraduate and graduate majors within 65 departments available to attendees (University Website, n.d.). According to the institution's web page (n.d.), "[Upper State University] is a powerhouse in science, technology, engineering, and math," which aligns with the land and sea-grant mission. Further, the university is situated in a geographic locale known for its robust opportunities related to tech and pharmaceuticals.

The selected research site served as an environment for exploring the participants' experiences with involvement in STEM support service initiatives. The research site was also chosen for its accessibility to several STEM enrichment programs and support resources available on campus. The STEM enrichment programs and support services are described in detail but de-identified to protect the program participants' identity and the programs' integrity.

Justification of a Land and Sea-Grant Institution

The Morrill Act of 1862, legislated by congress, was endowed for institutions of higher learning to function through teaching, research, and extension. This legislation focused on teaching science, agriculture, military science, and engineering (APLU, n.d.). Presently, land-grant institutions still serve as public universities offering a full spectrum of educational and

practical opportunities. To this end, because of the focus on science, agriculture, and engineering, Upper State University was an ideal site for the context of this study.

Participant Selection

In most studies, Espinosa (2011) critiqued literature related to women of color in STEM, finding that women's experiences are not historically disaggregated by racial and ethnic identity. To this end, I intentionally selected to highlight the experiences of Black women for this research study. Yin (2018) asserts that case studies are bound only if clearly identifiable and limited in scope. Therefore, centering Black women specifically recognized how their identities and experiences may differ from those of White women and non-Black women of color. Also due to the historical labor and contributions of Black women within the higher education landscape each participant was compensated with a \$20 Amazon e-gift card for their contributions.

For this study, I specifically centered on the experiences of self-identified Black women within co-curricular STEM programs, as previous literature has established this population is studied infrequently. However, Black women's experience is not monolithic; therefore, the inclusion criteria for participants' ethnic identity was not limited to the Black American experience. Participants from various Pan-African backgrounds, including but not limited to Caribbean women, African, and other adjacent identities to African ancestry, shared their experiences (George-Mwangi et al., 2016).

Additionally, Trans* women were welcomed and encouraged to participate in this study to highlight the multidimensional Black woman experience further and challenge cisnormativity assertions. Trans* individuals and other sexual and gender minorities often feel invisible in their labs, classrooms, and institutions (Powell et al., 2020). Representation within a study increases the critical mass of diverse individuals within the STEM landscape. However, no self-identified

Trans* women participated in the study, and each participant self-identified as a cis-gendered woman.

Historically, Black women are underrepresented across most STEM disciplines; however, they are slightly more represented in biology (4.23%) as compared to computer science (2.61%), for example. For this study, all STEM-based majors, as outlined by the U.S. Department of Homeland Security (2022) designated list, were eligible for this study as the focus was on their co-curricular STEM experiences and not their individual disciplinary experiences (see Appendix G). All participants were enrolled in a declared science-based major at Upper State University. Despite extensive recruitment and outreach efforts, no engineering or technology-based majors were present in the participant profile of this study for either program type.

All participants in the study had completed at least two full academic years of attendance at Upper State University to articulate students' experiences with more long-term engagement within their respective support programs. I considered the circumstances and perspectives of students who experienced their first year of college and participation in their respective programs during the ongoing COVID-19 pandemic. University and state guidelines restricted programmatic initiatives due to the pandemic, which may have impacted student engagement and their perceptions of the program they participated in at their institution. To this end, I asked each participant how the COVID-19 Pandemic impacted their academic and co-curricular experiences.

Sampling Procedures

I used multiple sampling procedures to increase the opportunity to recruit participants. As research and practice show, Black women are disproportionately underrepresented in STEM

disciplines, especially at historically White institutions (NCES, 2018). In this regard, I used criterion and snowball sampling to recruit eligible participants. Creswell & Creswell (2018) cite these sampling methods as effective for qualitative inquiry. Criterion sampling is commonly used when selecting participants based on pre-established criteria (Patton, 2002). Snowball sampling increases the number of participants for the study using the network of initially recruited participants (Creswell, 2018; Patton, 2002).

Criterion Sampling

Participants needed to adhere to predetermined inclusion criteria to participate in the research study. I deemed participants eligible for inclusion who meet the criteria as listed (1) self-identified Black/African American/Caribbean/African/Multiracial woman, (2) enrolled in a declared STEM major (i.e., pre-engineering or pre-vet/med did not meet criteria for study unless the student were in a declared STEM major), (3) at least two full academic years of participation in a STEM support or enrichment program at Upper State University. I wanted to ensure participants could accurately and candidly speak on their experiences based on their time in STEM courses and STEM enrichment programs at Upper State University. The predetermined criteria for inclusion were also tethered to the theoretical frameworks to provide further support to add to the body of literature. The identity-based criteria, being a self-identified Black woman and at least one academic year of engagement, addressed the multiple, intersectional identities possessed and salience to their experiences (Crenshaw, 1991; George-Mwangi et al., 2016). Moreover, the inclusion criteria of participation in a STEM support or enrichment program on campus addressed Strayhorn's (2018) Sense of Belonging construct concerning student engagement and involvement as well as student sense of belonging in STEM majors.

Initially, ten participants that completed the demographic survey met the inclusion criteria for the study. From the initial sample, nine participants were in a science-based major, and one was enrolled in an engineering-based major. Due to the low number of respondents from engineering disciplines, I reached back out to the two gatekeepers with connections to participants in engineering majors at Upper State; however, I did not receive a response from the gatekeepers. I then reached out to another gatekeeper to serve as a reference for me to the gatekeeper I could not get in contact with, but neither of us received a response (see Appendix F). I then proceeded to schedule interviews with the participants.

I reached out to all ten participants to schedule their initial interviews. The first three participants scheduled their interviews but did not attend. I followed up with them via email, and one participant responded by voluntarily withdrawing from the study. The other two participants did not respond to my correspondence. Shortly after, I began conducting the interviews with the remaining participants in the sample. I completed two individual interviews with six of the participants in the sample; however, the seventh participant voluntarily withdrew from the study as she did not attend her interview or respond to my email correspondence. The final sample included six participants across research and peer STEM co-curricular programs.

Snowball Sampling

As I recruited initial participants, I used them as key informants to elicit more participants for participation in the study (Patton, 2002). I also worked collaboratively with the staff members who run STEM-based co-curricular programs to assist in recruiting initial and additional participants. I shared the recruitment materials with staff members to distribute to their network of potential participants. Devers and Frankel (2000) posit that qualitative researchers often encounter gatekeepers to negotiate and gain access to participants, especially those that

may be more difficult to access. The collaboration with gatekeepers for this particular study helped maintain the integrity of co-constructing the research of Black women and involving Black women in the process.

I encouraged participants to share with their peers to elicit interest in participating in the study. The participants in the study were connected to networks of other students that fit the study's inclusion criteria. After participants received their confirmation email for their first interview, I asked them to share the flyer (see Appendix B) with their networks of other Black women STEM students. At the conclusion of the second interview, participants were asked to share the flyer with peers as well. This method was helpful as most targeted recruitment took place during the summer. Still, a brief recruitment period occurred at the beginning of the 2022-2023 academic year at Upper State University, but no further participants were obliged.

Recruitment Methods

For this study, I recruited multiple eligible participants for each program type: STEM peer-focused and research-focused programs at Upper State University. Recruitment was ongoing until I reached crystallization based on the information shared by the eligible participants. Crystallization in qualitative research is defined as the reflection of the analysis process as a means to identify and articulate patterns during the immersion process (Ellingson, 2009). According to Ellingson (2009), crystallization is messy, paradigm-spanning, and resists the dichotomy of traditional research processes. This sentiment echoes the experiences often associated with Black women in STEM. I bear in mind that the Black women in the [STEM] population are overwhelmingly underrepresented at Upper State University, impacting final participant numbers. In Fall 2021, two semesters before data collection, Black students in general at Upper State University only made up about six percent of the total student population meaning

Black women only made up a small percentage of that, and even more scarce in STEM disciplines (University Website, 2023).

The primary method of recruitment for this study was through email. I distributed an initial recruitment email to participants via listservs and gatekeepers such as faculty and program administrators (see Appendix A). Additionally, gatekeepers were asked to share the electronic flyer shown in Appendix B on official social media channels for their programs and to accompany the recruitment email to recruit participants in their internal program listserv and network. Recruitment also involved participants that engaged in snowball recruitment to distribute the flyer to other potential participants (see Appendix B). Each participant was also made aware they would be compensated with a \$20 Amazon e-gift card at the conclusion of their participation in the study. As previously mentioned, initial and follow-up emails were sent to recruit participants to increase the sample size. I sent a final round of recruitment emails at the beginning of the 2023-2022 academic year at Upper State University. However, the sample size did not increase, and I ceased recruitment. This will be further discussed in the limitations section and future recommendations.

Data Collection

One of the unique strengths of case study research is the variety of data collection methods to conduct one's research (Yin, 2018). To capture the participants' experiences, I employed four data collection activities: a brief demographic survey, two individual semi-structured interviews, a reflection journal entry with three prompts, and document analysis of program documents. Participants were asked to complete each data collection activity to provide an in-depth view of their experiences. Table 1.1 provides a research map of how each research

question will be explored and analyzed. Before individual interviews, participants were asked to complete a brief demographic survey to ensure they met the study's inclusion criteria.

Table 1.1

Research Map

Research Question	Data Source	Analysis Technique
N/A	Demographic Survey	N/A
How are Black women undergraduate STEM students engaging in STEM support/co-curricular programs at a PWI?	Interview #1 Reflective Journaling Document Analysis	In Vivo and Thematic Analysis (Braun & Clarke, 2017; Saladaña, 2015)
What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs?	Interview #2 Reflective Journaling	In Vivo and Thematic Analysis (Braun & Clarke, 2017; Saladaña, 2015)
What are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs?	Interview #2 Reflective Journaling	In Vivo and Thematic Analysis (Braun & Clarke, 2017; Saladaña, 2015)

Electronic (Qualtrics) Demographics Survey

Participants were asked to complete a brief demographic questionnaire via the secure online platform, Qualtrics (see Appendix C). This data collection measure ensured that participants met the inclusion criteria. Students answered a series of questions related to demographics, including self-identified race/ethnicity, gender identity, matriculation year, current classification, and declared major. Further, they were asked to answer what type of co-curricular STEM program they were engaged in peer-based, research-based, or both. Lastly, they listed the names of STEM co-curricular programs they were involved in or had been involved in at Upper State University. I also asked for program names in order for me to acquire the correct

documentation for document analysis. An electronic consent statement accompanied the survey to obtain voluntary consent from participation in the research study (see Appendix C).

Semi-Structured Individual Interviews

Semi-structured interviews were conducted with all participants in the study. Josselson (2013) identified interviewing as a method of qualitative inquiry that highlights the dynamics of creating a relational experience between the interviewer and participants. Yin (2018) also stated that interviews are an essential source of evidence for case study research because the studies invite human actions and experiences. Interviews were semi-structured to allow organic conversation and probes to emerge (Josselson, 2013). Prior to the individual interviews with participants, I piloted the interview protocols with a trusted research partner for coherence and relevance. Piloting is used to refine data collection plans and ensure a developed line of protocol questions (Yin, 2014). All interviews were conducted and recorded via Zoom, a password-protected video conferencing service.

Interview One

Interview one was used to build a rapport with participants and learn about their backgrounds and experiences within the STEM classroom and support or enrichment program they are affiliated with on campus. Each first round of individual interviews lasted from 55-75 minutes. At the beginning of the interview, I asked participants to confirm their pseudonyms. I reviewed the electronic consent forms they completed before the first interview before proceeding with the protocol (see Appendix D). Each interview question addressed a component of the research questions (1) How are Black women undergraduate STEM students engaging in STEM support/enrichment programs at a PWI? (a) What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs? (b) What

are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs? Additionally, the questions were guided by the theoretical underpinnings of the frameworks used for this research.

Using the semi-structured research protocol, I began each interview by asking participants to share their backgrounds. I asked probing questions based on their responses to provide context for future questions in the research protocol. For example, when asked about her background, one participant shared how she ended up at Upper State University, outlined in another subsequent protocol. I also forfeited some questions because the participants shared a response to them when asked preliminary questions (i.e., Q6. Tell me about your experience thus far in your STEM support/enrichment program was...) (see Appendix D). However, I did ask them to elaborate on specific experiences if I could not ask a question outlined in the protocol. The questions outlined in the protocol were presented to learn about their backgrounds, transition to their STEM academic experiences, and learn more about their co-curricular experiences.

Prior to each interview, I prepared the interview protocol to reflect the answers given by the participants in their demographic survey. Therefore, for question three, I would ask each participant: "What has your experience been like being a Black woman [insert major] student at PWI" I would insert the major outlined in their demographic survey responses. I would use this same practice when initially asking questions four and five (see Appendix D). Because of the open-ended questions and the interview participants' semi-structured format, the conversation organically flowed as participants shared their experiences. I concluded each interview by asking each participant, "What did I not ask that you would like to share?" None of the participants declined this question and provided a thoughtful response to this question. Following the

interview, they were instructed to complete the reflective journal prompts and schedule the second interview.

Reflective Journals

The second data collection activity involved the participants responding to three reflective journal prompts to document their thoughts and experiences regarding engagement with their STEM support or enrichment program. A journal is defined as "the process of participants sharing thoughts, ideas, feelings, and experiences through writing or other media" (Hayman et al., 2012, p.28). In qualitative research, reflective journaling has been cited as a means to obtain reliable person-level information, documenting change over time, individual differences, and personal insights. Reflective journaling can be simultaneous with a person's actions or experiences (Alaszewski, 2006). Journaling has been a data collection method accepted to collect rich qualitative data (Hayman et al., 2012). In this study, this activity provided context to the case by expounding upon the participants' individual interviews.

All participants completed reflective journals within 72 hours of their first individual interviews and before their second interview. Participants were asked to complete the reflection journal prompts using a personalized Qualtrics link on their mobile device or personal computer sent to them by email within 24 hours of their first individual interview. One participant had difficulty accessing the link and opted to share her journal responses via email. All six included participants completed the following guiding prompts for the reflective journal exercise: 1.) What do you enjoy about the initiatives/events/experience put on by your STEM enrichment program? 2.) What do you think could improve your experience in your STEM enrichment program? 3.) Share how you think your STEM-enrichment program could support you as a Black woman in STEM? As a note for confidentiality and security, if students needed to use a

public or university-issued computer, I provided verbal instructions on how to securely log out of Qualtrics after completing the survey to help protect their identity. The instructions and details for documenting their reflective journals can be found in Appendix E.

The journaling activity provided a more in-depth illustration of the participants' experiences because they were encouraged to speak freely about their experiences and perspectives. This activity was meant to capture data complementary to the embedded units of analysis within the case and serve as a participant reflection activity. Furthermore, this activity aided in establishing the validity of the research through the triangulation of the data (Yin, 2018).

Interview Two

The second interview took place following the submission of the reflective journals. The protocol for the second individual interview focused on providing context and understanding of the participant's journal responses. This interview addressed research questions (a) What are the experiences of Black women undergraduate STEM students in peer-based STEM support/enrichment programs? (b) What are the experiences of Black women undergraduate STEM students in academic or research-based STEM support/enrichment programs? The interview was semi-structured with three guiding prompts (see Appendix D). This interview allowed me to ask more detailed questions about their reflection journal and outlined experiences to aid in co-constructing the case formation.

The second interview with participants lasted from 20-30 minutes. In each interview, I briefly checked in with each participant to follow up on how they were doing since the last time we met to maintain a rapport. I then reminded them of our previous conversations (e.g., the date, a quick overview of their programs and major) and began discussing their reflective journal responses. I used the screen-sharing feature on Zoom and displayed their response in case they

needed a reminder of their responses. Participants responded to probes regarding their responses. For example, I would ask them to tell me more about their response or provide more context as to why they answered a particular question in the manner they did. I then asked if there was anything else they wanted to share before we closed the interview. Finally, at the conclusion of the second interview, each participant confirmed the email address they desired for me to send their \$20 Amazon e-gift card.

I completed two individual interviews with six participants. As mentioned, I recruited participants in the Summer of 2022 and attempted to increase the sample size in the Fall of 2022. However, although the sample size did not grow, the data had reached a point of crystallization and saturation across the participants' responses in the interviews and journal responses. As described earlier, crystallization is defined as a reflective point in the analysis portion of the immersion process (Ellingson, 2009). Saturation is characterized as no new information being shared in the data collection process. I ceased data collection after I received no follow-up response from the seventh participant.

Program Written and Media Content

As previously addressed, the participants shared the names of their respective programs in the demographic surveys. I thoroughly searched program documentation and contacted program administrators (e.g., gatekeepers) to inquire about obtaining official university-sanctioned program documentation. Documents included but were not limited to regulation guides, official web pages, social media sites, student organization constitutions, mission and value statements, curriculum maps, and learning outcomes. I utilized these documents to provide detailed information about the mission, learning goals, values, and aims of the STEM support and enrichment programs. I also used these documents to evaluate the demographic makeup of

the program's community. The demographic information included but was not limited to the number of participants in the program, aggregates of gender, race, and ethnicities of participants, and majors of students involved in the program. These documents were also beneficial for the triangulation of the data.

Data Analysis

Data analysis for this study involved a multi-iterative process to provide a rich and thick interpretation of the participants' experiences to present a case of the STEM co-curricular experiences of Black undergraduates at PWI in the Southeast. This section documents the steps of analysis of the collected data. The initial stage of my data analysis entailed creating participant profiles based on demographic questionnaire data. These profiles were then used to identify the participants in each embedded unit of analysis: peer-based programs and research-based programs.

Following constructing profiles, I gathered and analyzed documents for each program participant listed in their demographic survey responses. I analyzed these documents using a priori codes aligned with the theoretical frameworks used to guide the study. I also analyzed these documents to provide context for the interviews and journals from the participants. The codes from the documents were then later used in the thematic analysis process of the data analysis.

The next stage of the data analysis process was the audio transcription of the individual interviews. I used the built-in transcription tool of the Zoom cloud to transcribe the participants' individual interviews. I manually cleaned and audio-checked the transcripts after each interview by listening to the recordings. Cleaning the transcripts is a procedural way to support the trustworthiness and validity of the interview data (Creswell & Poth, 2018). Following the

transcription and cleaning of each transcript, I also expanded the memos I composed during the interview data collection.

I used the analytical memos as a reflective process to make sense of the data. In turn, the memos serve as data sources and support during the thematic analysis process. The memos were used to provide supplemental support and context to the other data sources and additionally served as data "to the data (Braun & Clarke, 2016, p.60). The following sections will overview how each data source was analyzed.

Demographic Survey

The demographic survey was administered by Qualtrics and served as the first data source that was analyzed. I used descriptive analysis of the survey results to create the participant profiles and give a demographic overview of the participants within the study and embedded units of analysis. Categories of analysis of demographic data included the following information:

- Chosen Pseudonym (False Name)
- Declared STEM Major
- Self-identified racial/ethnic identity (e.g., Black, African American, Afro-Latinx, etc.)
- Self-identified gender identity (e.g., cisgender, Trans*, etc.)
 - Cis woman
 - Trans*
 - Gender Nonconforming/Non-Binary
 - Other_____
- Matriculation Year
- Current Classification (i.e., junior, senior, etc.)
 - First Year
 - Sophomore
 - Junior
 - Senior
 - Fifth Year

- Type of Program: peer-based or research-based (you may select more than one and must be related to STEM)
 - Peer-Based (programs with a social component, e.g., student organizations, learning village, etc.)
 - Research-Based (programs with a structured research component, i.e., URE)
- Name of STEM support/co-curricular program(s) in which you are currently participating in at Upper State University

I also compiled this data to give individual participant profiles and classify the profiles for each embedded unit of analysis. The demographic data highlighted the diversity among the participants and deterred the notion of viewing *Black Women in STEM* as monolithic (Espinosa, 2011). The data illustrated the intersectionality of their identities and experiences, an important theoretical application of the study.

Document Analysis

Document analysis is a systematic technique for reviewing and evaluating written and electronic documents to answer a specific research question (Frey, 2018). Documents of all types can be helpful when uncovering perceptions, theory development, and gaining a greater understanding of a specific topic or phenomenon (Frey, 2018). Document analysis is a way to ensure research is critical and comprehensive by following because they are described as stable and "non-reactive" sources of data, which means they can be read and analyzed multiple times. Yet, they will remain unchanged by the researcher's process of influence (Bowen, 2009, pg. 31).

Using a priori coding, I appraised the documents for key phrases, terms, and themes. In the documents and media, I identified particular words, phrases, and concepts within each aligned with the a priori codes. A priori codes included words such as "identity," "belonging," "community," "diversity," "Black," "people of color," "woman," and "minorities." These words

or synonyms for them were also reflected in program and university documents, social media posts, and webpages. Utilizing this type of data analysis will stimulate theoretical positioning and critical analytical strategies to identify links within the data to understand themes (Saldaña, 2015). An advantage of document analysis is its systematic technique, thorough review, and examination of data within qualitative research (Bowen, 2009; Frey, 2018, Saldaña, 2015).

There are several uses of document analysis in qualitative research. Document analysis can be used to provide evidence to answer specific research questions. It can also be used for triangulation, refuting, corroborating, elucidating, or expanding findings across other data sources (Frey, 2018). For this study, I used document analysis to identify the intentions and focus of trends of both individuals and their groups [STEM-enrichment programs]. Furthermore, I employed this technique to contextualize the findings from the individual interview and reflective journal submission. Additionally, document analysis was used to triangulate other data collection sources.

Individual Interviews

As previously stated, I used the built-in transcription tool of the Zoom cloud to transcribe each participant's two individual interviews. I then manually cleaned and audio-checked the transcripts after each interview by reading and listening to the audio of the individual interviews. Creswell & Poth (2018) cleaning transcripts is a procedural way to support the trustworthiness and validity of the interview data. The individual interviews were opportunities to learn more about the participants' identities, motivations, and experiences. As stated, the individual interview data was verbatim transcribed and cleaned for accuracy (Creswell & Poth, 2018). I used a multistep and in-depth process to become familiar with the interview data by reading the transcripts in totality before the initial coding process. Braun and Clarke (2016) cite this practice

as a way to familiarize oneself with the data iteratively. Next, I began the coding process for the interview data.

The initial coding process for individual interview transcripts entailed manual in-vivo coding using the comment feature in Google Docs and analytical memos (Saldaña, 2015). In vivo coding is considered a first-cycle coding procedure that uses the "direct language of the participants as codes rather than researcher-generated words and phrases" (Saladaña, 2015, p.61). I used in-vivo coding to maintain the integrity of the participants' voices and reflections. I used in-vivo coding for a step in the data analysis procedure for the first and second interviews. These initial codes can be found in Appendix G, which depicts an excerpt from my code book.

Following the first coding cycle, I began to use the initial codes, grouped into code families and memos, to start theming the data (Braun & Clarke, 2016; Saldaña, 2015). For this process, I used a color-coding system to identify the thematic categories (i.e., community color coded as blue). I grouped words and phrases that revealed repeated patterns and topics together. For example, participants would use similar words or phrases to address a lack of representation or being isolated, and I would color code and group these phrases as "underrepresentation." Following this procedure, I reviewed that data again to identify emergent thematic patterns.

The second step of the coding analysis process was employing thematic analysis as a qualitative research technique to identify repeated patterns, topics, and ideas that may be presented as themes (Braun & Clarke, 2016). The patterns that emerged were consistent patterns that were present in the documents and interview data. Namely, experiences in their classroom, community, intellectual validation, support, and development all emerged as themes in the data that will be discussed in the subsequent chapter. This analysis method will help better understand how the themes of the case. The emergence of themes in the data allows for the application of

theory, relating back to the original research questions and theoretical frameworks (Grause, 2015). Additionally, I used thematic analysis to address the preliminarily coded interview and the codes from the documents. It was necessary to begin noting recurring codes and themed patterns that appeared in the interviews and the analyzed documents, which signified congruence between the program objectives and the student experiences.

Reflective Journals

The reflective journals submitted by participants were analyzed in the first cycle using descriptive coding. Descriptive coding uses labels [codes] to describe or summarize the data in words or phrases (Saldaña, 2015). In the second cycle of coding, using relevant codes I began to make note of thematic categories that aligned with the patterns from the previously analyzed data sources. With the conclusion of the analysis of the two interviews and the journal entries, I began to identify significant themes present in the data sources based on salient and recurring thematic categories that emerged from the data.

Analytical Memos

Memoing is a process in qualitative research in which the researcher uses reflective notes about the thoughts, questions, and ideas that surface during the data collection, coding, and analysis processes (Birks et al., 2008). Most often used in grounded theory research, Birks and associates (2008) note that memoing generally serves as a paper trail of decisions made through the data collection and analysis process in qualitative research. Memoing assists in the conceptual formation of raw data into the studied phenomena (Birks et al., 2008; Charmaz, 2002; Clark, 2005). Memoing provides the opportunity for the researcher to engage with the data in a more in-depth approach. For this study's context, memoing helped contextualize the cases under consideration of the small sample size and the nuance of two embedded units of analysis.

For this study, I used qualitative memoing during the interview process. Following each individual interview, I organized and expanded the reflective memos to address my thoughts and questions regarding the candidates' responses. During the coding and thematic analysis of the interviews, I used reflective, analytical memos to provide depth, context, and support to the patterns being identified in the data. When drawing upon the codes and themed data, I employed memos to extract meaning from the data. The memos provided support to the transcripts, documentation, and reflective journal.

Identifying Final Themes

To this end, following this multi-iterative data analysis process using, multiple data source themes and subthemes emerged. Using a combination of the themed data and the participants' words, I named the themes and subthemes that emerged from the data. I identified patterns in the themed data from individual interviews and reflective journals. I then contextualized and found support for these patterns using the document analysis data and analytical memos. Four themes and ten sub-themes emerged, which will be discussed in the subsequent chapter. The themes will aid in presenting the case in subsequent chapters as well.

Ethical Considerations

Minimizing ethical implications is an essential part of the research process. In order to decrease ethical issues associated with this study, I sought approval from the Institutional Review Board (IRB) to ensure intentional care for my participants and the data. With approval from IRB, I followed detailed procedures to facilitate steps to protect the participants' confidentiality, identity, and integrity. Because I worked with Black women, a vulnerable population within STEM, I vowed to honor and center their experiences with dignity and care. Moreover, because of their underrepresented identities in many STEM disciplines, I took

extensive measures to protect their identity to prevent unethical disclosure and further marginalization. Each participant selected a pseudonym. I also used a pseudonym for the research site (Upper State University).

I used secure password-protected Google folders to store each participant's interview recordings, transcripts, journal submissions, and demographic information. Access to the folders required a password and Two Factor Authentication (2FA). These folders were secured on a password-protected computer. I assured none of the data was accessed on public computers.

As a doctoral candidate and higher education administrator, my role presented a power dynamic during recruitment and data collection; therefore, I built a rapport with participants and candidly shared my identities. Each interview protocol outlined rapport-building questions to gain participant trust and increase comfortability. Electronic consent forms were distributed with the demographic survey. Participants were reminded about consent and voluntary participation in the recruitment email and at the beginning of each individual interview. Finally, participants had the right to withdraw from the study at any time without consequence.

Validity and Trustworthiness

To ensure the quality and significance of this research, multiple validation methods were used to ensure the trustworthiness and validity of the data. I employed multiple data sources as evidence for the study, including interviews, reflection journals, and document analysis. This triangulation method maintains reliability and trustworthiness (Creswell & Poth, 2018). I utilized a detailed protocol and maintained a protected chain of data (Creswell & Poth, 2018).

Following the data collection activities and analysis, member checking of the interview transcripts and analysis of the key findings were sent to participants to ensure trustworthiness and an authentic interpretation of the participants' stories (Creswell & Creswell, 2018; Creswell

& Poth, 2018; Mero-Jaffe, 2011). Additionally, I used rich, thick descriptions by using direct quotations from the participants to illustrate participant data (Creswell & Poth, 2018). The portrayal of the thick, rich detail of the participants' experiences establishes validity in qualitative data in this case (Creswell & Miller, 2000). This method of established validity is that of a constructivist paradigm, as the findings are co-constructed by the researcher and participants (Creswell & Miller, 2000).

Limitations and Delimitations

This study is not without limitations. I outlined a few limitations and delimitations to this research study. The first limitation of the study is the systematic underrepresentation of Black women in STEM disciplines, especially at PWIs (Johnson et al., 2007). This underrepresentation may have had a result in the low engagement rates of participants. Additionally, this study will rely on gatekeepers to help identify participants, which presented a barrier to participant recruitment. The reliance on gatekeepers may have caused them to identify or exclude participants based on personal biases (Atkinson & Flint, 2001).

Delimitations provoked by me as the researcher are also present in this study. First, I chose to study participants at one research site, which may limit perspectives. However, the research site has a robust presence of peer-focused and research-focused STEM co-curricular programs, which ultimately gives access to participants from diverse co-curricular environments. An additional delimitation would be the decision only to include Black women in the study. Indigenous and Latinx women are also disproportionately underrepresented in STEM and often do not have their voices amplified in STEM studies related to women of color-identified students. Nonetheless, the intentional decision to center on Black women is related to amplifying Black women's voices based on an extensive review of the literature. Furthermore, the decision

is rooted in my own social identity. I will revisit how limitations and delimitation impacted the study in chapter five.

I would also be remiss not to mention the potential limitations that the ongoing COVID-19 pandemic presented to the execution of this research study. Due to the pandemic, some participants may not have had immersive experiences in their co-curricular activities due to COVID during a part of their undergraduate tenure resulting in entirely virtual experiences.

Reflexivity Statement

A culmination of environmental influence, personal experience, and professional pursuits shape my positionality surrounding the research on women of color in Science, Technology, Engineering, and Math (STEM). The work that has been done serves as hope to create meaningful change to enhance the experiences of women of color, but how can optimal change be reached if these women are treated as a homogenous group? Disaggregating the experiences of women of color by race, I plan to examine Black women's experiences.

My identity as a Black woman is the first aspect attributed to positionality. My research focuses specifically on Black women and STEM affiliation; with the shared identity, there is potential for inherent biases and assumed experience; however, as an intentional and ethical researcher, diverging bias is my priority to ensure the validity of the research (Creswell, 2018). Furthermore, institutional affiliation plays a role in the positionality of the researcher. Though I am not directly connected to the participants, indirect connection through student status at the same institution plays into possible assumptions. While these factors inform potential biases, they also connect the researcher to the research to produce a rich case. My positionality has no bearing on the validity and potential significance of the study.

As a qualitative researcher, I am interested in the stories and experiences of the participants. In addition to those stories, I desire to provide recommendations for tangible and accessible ways to impact organizations. The accessibility of this research also plays into the elements of power and privilege associated with being a researcher. Furthermore, considering the potential risk related to maintaining the anonymity of participants of underrepresented backgrounds in studies with small sample sizes is important. However, my identity as a marginalized person influenced the careful attention paid to preserving the integrity of this research as I know the potential implications related to further marginalization.

My experience as a Black woman college student on a predominantly White campus is an aspect that can be attributed to my interest in studying Black women collegians. While I identify as a Black woman, my educational background in the social sciences gives me an outsider perspective on disciplinary knowledge. Nonetheless, my role as an educator and former co-coordinator of a women-of-color learning community brought my attention to the need to understand and enhance these women's STEM experiences. I related firsthand to the difficulties associated with navigating a predominantly White campus and empathized with the idea of further marginalization within a specific academic discipline.

As I proceed with this scholarship, I bring assumptions based on biases as a Black collegiate woman, previous literature, and past and current professional experience. However, I plan to approach this research with an anti-deficit mindset. As a qualitative researcher, I aim to preserve truthful experiences. Since these are the experiences of those with identities I share, it is imperative to maintain integrity and an ethic of care (Garza, 2009). Kress (2011) illustrated how research can transform into "mesearch." As a researcher investigating a topic, you can become attached to identity, purpose, and context issues, and these elements translate to a re-

conceptualization of self (Kress, 2011). This critical approach serves as a factor in my motivation to pursue research on the experiences of Black women college students. Through further investigation of my chosen research topic, I plan to maintain an ethical, inclusive, and equitable methodology and future dissemination of my research.

CHAPTER FOUR: FINDINGS

This qualitative case study investigated the experiences of Black women undergraduate STEM majors engaged in peer-focused and research-focused STEM support/co-curricular programs at a Predominately White Institution (PWI) in the southeast. This study sought to explore their experiences in co-curricular STEM spaces using the following research question: How are Black women undergraduate STEM students engaging in STEM co-curricular and support programs at a Predominately White Institution (PWI) in the Southeast? Additionally, the following sub-questions: What are the experiences of Black women undergraduate STEM students in peer-based STEM support/co-curricular programs? What are the experiences of Black women undergraduate STEM students in research-based STEM support/co-curricular programs?

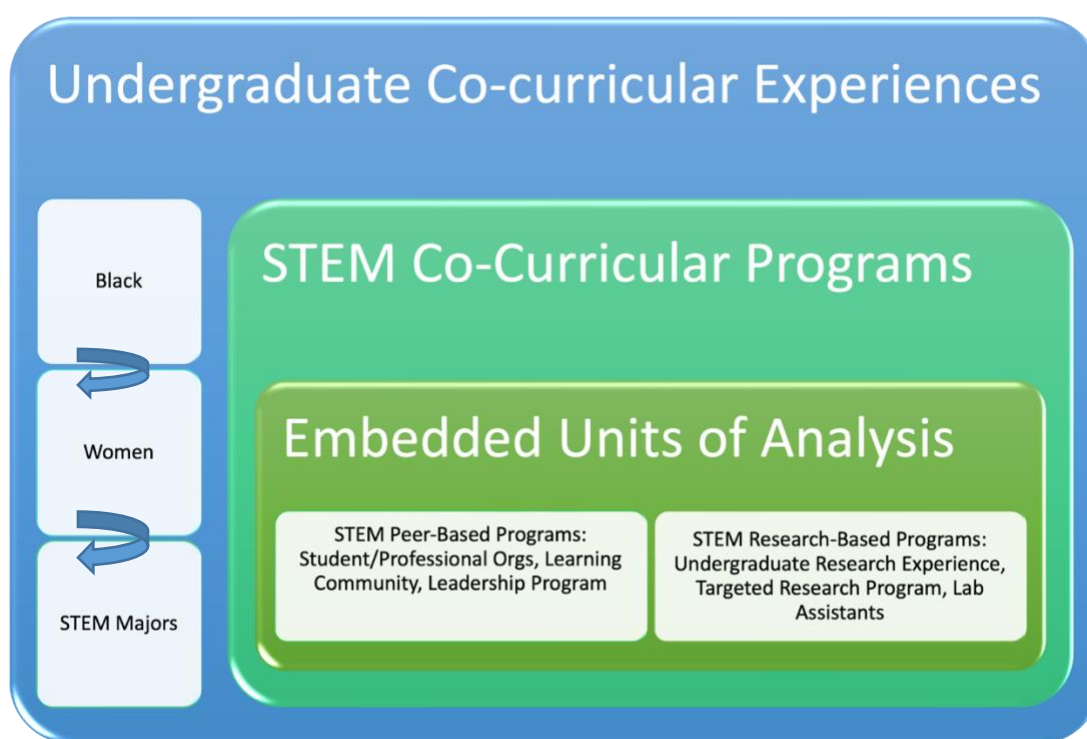
This study was guided by two theoretical frameworks, Intersectionality and Sense of Belonging. In tandem, these theoretical underpinnings framed the study by examining the multiple marginalities of Black women STEM students and how their identities situate them within systems of power and oppression within STEM environments. The research questions, interview protocols, and reflective journal prompts were framed using these theoretical frameworks.

The context for the case study was the co-curricular experience of Black women in undergraduate STEM majors. The case is bounded by their racial and gender identity, academic major, and co-curricular experiences with STEM-based support and enrichment programs at a Predominantly White Institution (PWI) in the Southeast. Moreover, the embedded units of analysis focused on two programmatic types, peer-based and research-based STEM co-curricular programs. For this study, peer-based programs were defined as initiatives that focused on student social development with the dynamic of similar status (Eisen, 2001). Research-based programs

depict the hands-on systematic study of a specific topic or subject under a faculty member's or formalized program's direction (Kinkead, 2003). The embedded units of analysis in the study were classified based on the aims and initiatives of the program based on several factors such as funding source, university, and national classification, and documented learning outcomes of the program. Figure 2.2 depicts the case study with bound context and embedded units of analysis.

Figure 2.2

Case Analysis Visual



Note. This figure is a visual of the case, context, and units of the two embedded units of analysis: peer-based and research-based programs.

Findings for this study emerged through a series of data collection activities and multiple iterations of data analysis. First, I examined program documentation, including but not limited to social media, mission and vision statements, learning objectives, and university and national websites. Analyses of these documents provided context to the individual interviews related to

the types of programs in which participants were involved and contributed to thematic analysis. Each participant engaged in two-individual interviews. I also employed analytical memoing during each interview session. Each participant completed reflective journal prompts between the first and second interviews.

Following the data collection activities, I used a hybrid data analysis approach that included document analysis guided by the theoretical underpinnings of the study, inductive and deductive coding, and thematic analysis. Through thematic analysis, I arrived at the following themes and subthemes.

Table 1.2

Thematic Findings

Themes	Subthemes
The storm before the calm: In-class experiences	<ul style="list-style-type: none"> • Underrepresentation • Unreasonable Doubt • Culture of Competition
"If I'm going to eat, we all gone eat": Community	<ul style="list-style-type: none"> • Counterspaces • Collaboration
Free to just be: Comfort and Validation	<ul style="list-style-type: none"> • Emotional Comfort • Intellectual Validation
"Never once doubted me": Support and Development	<ul style="list-style-type: none"> • Mentorship <ul style="list-style-type: none"> ○ Peer Mentors ○ Paying it forward • Academic and Professional Development <ul style="list-style-type: none"> ○ Internships

This chapter provides an overview of the four themes and ten sub-themes that emerged from this qualitative case study: *The storm before the calm: In class experiences*, *"If I'm going eat, we all gone eat": Community*, *Free to just be: Community and Comfort*, and *Never Once Doubted Me: Support and Development*. The themes and sub-themes will be presented through

the participants' culminating experiences inside and outside the classroom. The first theme, *The storm before the calm: In-class experiences*, represents the participants' generally unfavorable STEM courses and course-related lab experiences. Each participant was enrolled in various STEM majors across different academic disciplines at Upper State University but universally experienced unpleasant experiences within the STEM classroom environment.

The second theme, *"If I'm going to eat, we all gone eat": Community* was prevalent within both units of analysis. Participants characterized access to community as opportunities for social connections with peers and mentors that elicit feelings of belonging. The sub-themes that emerged from *community* were counterspaces and collaboration. Counterspaces showed up as access to peers, mentors, and supportive faculty and staff with shared experiences and identities that further enforce belonging. Collaboration, as a subtheme, represented opportunities to cultivate and build professional, social, and academic relationships for participants.

The third theme, *Free to just be: Comfort and validation*, emerged as participants engaged in co-curricular environments that minimized feelings of risk and provided experience a sense of security and affirmation. In the classroom space, it was risky for them to speak without feeling the need to code-switch, be contested by peers, or be blatantly ignored. Emotional comfort and intellectual validation emerged as subcategories for this theme. Emotional comfort meant participants felt they could speak and act authentically, connect and build relationships with others, and feel more at ease and comfortable in the presence of their peers and staff. Intellectual validation meant feeling scholastically valued and affirmed in their programs amongst their peers, program staff, principal investigators, internship supervisors, and mentors. Unlike within their classroom and course-related lab environments, they did not need to second guess or prove themselves within their STEM-enrichment programs.

The final theme, "*Never once doubted me*": *Development and support*, captured elements of environmental dimensions (e.g., organizational, physical, and socially constructed) of their STEM support and enrichment programs. For example, participants felt support, belonging, affirmation, and validation within support and enrichment programs that contributed positively to their academic, social, and professional development. Mentorship, academic, and professional development were subthemes for the support and development theme. Participants gained access to mentors in the professional and academic areas. Participants also developed their capacity to mentor others through involvement in STEM-enrichment peer and research programs. Academic and professional development represented access to opportunities that would aid in STEM student experience and future aspirations. Table 1.2 illustrates themes and sub-themes that emerged from the data.

Language Distinctions

To honor the words of the participants but also be cognizant of the most inclusive and contemporary terminology, an overview of a language distinction provides context to the findings of this study. First, the participants in the study often used the term "minority" to refer to other Black students and people of color. Further, participants also used the phrase "People of Color" interchangeably with "Black." Because participants used "Black" and "African American" interchangeably, the presentation of the findings does as well to honor the words used by the participants. Finally, the pronouns *her* and *they* will be used throughout this chapter to describe the participants' gender identities; however, all the participants noted in the demographic survey they used *she and her* gender pronouns. *They* is representative of the participants as a collective based on their shared experiences and in reference to the embedded units of analysis in which

they represent. The distinction of the language used throughout this chapter provides credence to the participant's lived experience and contribution to scholarship.

Participants

The student participants in this study included six racially and ethnically representative cis women across the Black diaspora. All participants in the case study were enrolled at Upper State University. The classifications of the students ranged from second-year undergraduate students to final-year students. Participants had at least two years of participation within their STEM co-curricular program at Upper State University. Some participants were engaged in peer-focused and research-focused programs. In contrast, others only participated in one programmatic type: three participants participated in only peer-focused programs, one only engaged in a research-based STEM co-curricular program, and two participants engaged in both. Participants were enrolled in a variety of science-based ¹majors. All the participants were also self-reported high-achieving students (3.5 or higher grade point average), each with impressive career aspirations. However, due to the underrepresentation of Black women enrolled in STEM majors at Upper State university, this study will not disclose the participants' specific individual majors or co-curricular programs to honor an attempt at anonymity.

Table 1.3 provides an overview of each of the six participants. Additionally, I briefly described each participant's background, area of study, career aspirations, and other essential details to contextualize their experiences. Each participant's experiences provided significant insight into each embedded unit of analysis within the case study. Furthermore, each participant's

¹ Science-based major used to identify majors that are not classified as engineering, technology, or mathematics

engagement and involvement roles within their respective research-focused and peer-focused programs are outlined in Table 1.4.

Table 1.3

Student Participant Profile

Participant Pseudonym	Self-Identified Racial/Ethnic Identity	Years of Engagement	Major	Program Type
Adazumanee	African (From the continent)-American	Four	Science-Based Major and Social Science Major	Research
Charlotte	African American	Two	Science-Based Major	Peer
Desiree	African American	Two	[Two] Science-Based Major	Peer
Jay	African American	Three	Science Based Major	Peer and Research
Lily	African American	Two	Science-Based Major and Social Science Major	Peer and Research
Sally Jane	African (from the Continent)	Three	Science-Based Major	Peer

Adazumanee (Ada) was a final year student at Upper State University enrolled in a science-based major and social science major. She was a participant in a research-based STEM enrichment program on campus. She was a continuing generation college student with aspirations for a research lab career. Adazumanee's parents immigrated to the U.S. from a country in Africa, but she and her siblings were born in the U.S. Her mother and father and her siblings all pursued STEM-based careers. She expressed that she has always had an interest in science.

Charlotte was a junior at Upper State University with a science-based major. She grew up close to Upper State University. She was a leader in a peer-based STEM organization on campus. Charlotte has an interest in pursuing STEM-focused professional school after undergrad. She expressed from a young age that her family had instilled the importance of education and enrolled her in various STEM-based summer programs as a child.

Desiree was a sophomore at Upper State University. She was enrolled in two science-based majors and intends to pursue a science-based professional school upon graduation. She moved around a lot as a child and attended an international high-achieving student boarding school until she was in eighth grade. She self-identified as an overly involved student on campus. Desiree also maintains a self-reported 4.0-grade point average. She is involved in a peer-based program on campus.

Jay was a junior in a science-based major at Upper State University. Jay was engaged in a peer-based and research-based program on campus. Jay, however, began to disengage with her peer-based program and primarily engaged within her research-based program. Jay expressed that she was unsure of her career aspirations, but she believed her research-based experience was providing clarity on her future career aspirations.

Lily was a junior at Upper State University, double majoring in science-based and social science-based majors. Lily's parents encouraged her to attend Upper State University, specifically an HBCU. Lily's siblings were also all college students or college graduates. Lily was a leader in her peer-based organization and had hands-on experience in her research activities. She was interested in attending graduate or professional school upon graduation.

Sally Jane was a junior science major at Upper State University. Sally Jane was a first-generation U.S. college student, but her parents completed college in her native country. She and

her family immigrated to the U.S. when she was a kid. She was a leader in her peer-based STEM enrichment program. Sally Jane aspired of attending professional school following graduation.

Table 1.4

Participant Program Type and Engagement Activities

Participant Name	Engagement Activities	Peer-Based Program	Research-Based Program
Adazumanee	Research Assistant		✓
Charlotte	Executive Board Member, Peer Mentor	✓	
Desiree	Participant, Intern	✓	
Jay	Research Assistant, Participant	✓	✓
Lily	Lab Assistant, Executive Board Member	✓	✓
Sally Jane	Peer Mentor, Peer Leader	✓	

Embedded Unit of Analysis: Peer-Based Programs

In the current study, each participant was representative of one or more program types. The delineation of program types as the two embedded units of analysis within this study provided a means for understanding potential key differences between peer-based and research-based programs. For this study, the first unit of analysis, peer-focused programs were defined as professional and social development opportunities or defined qualities of reciprocal dynamics between individuals of comparable status (i.e., peer mentor programs, student organizations, etc.) (Eisen, 2001). While related to their areas of study and disciplinary foci, these programs were centered on enhancing the students' experiences from a social context. Their academic interests and often shared identities catalyzed their engagement and involvement within peer-focused

programs. For example, some participants in this study participated in identity-based student organizations that reflected their academic interests. Participation in these programs directly resulted from their pursuit of social and professional development, which was void within their classroom experiences.

Within the scope of this study, multiple peer-focused STEM enrichment programs were represented. Participants were engaged in student organizations, professional development organizations, leadership programs, and learning communities at Upper State University. Some of the programs represented in the study in which the participants engaged were targeted based on academic discipline (i.e., chemistry). Other programs had an identity-based element to their programmatic initiatives (i.e., gender or race). Each program represented in the study was well-established on campus at Upper State University, which has existed for at least three full academic years. This criterion ensured that participants had access to a full year of academic programming to engage with the initiative due to COVID-19 restrictions. However, the length of the program's existence on campus was analyzed not to impact the participants' experiences.

Embedded Unit of Analysis: Research-Based Programs

The secondary unit of analysis for this study was research-based programs. Research-based programs for this study were operationally defined as initiatives that entail a hands-on systematic study of a topic, usually under the direction of a faculty member or formalized program (Kinkead, 2003). It was important to note that these programs differed from course-related labs and focused on extemporaneous research pursuits. The programs highlighted within the context of this study included undergraduate research experiences (UREs), structured research programs, and independent research laboratories under the direction of a university professor or postdoctoral scholar. Participants in this study pursued research-based programs for

various reasons to supplement their academic pursuits and professional and skill development. Furthermore, the participants in the research-focused programs had varying degrees of experience within the laboratory research context.

This study analyzed three research-based programs: structured UREs, national research programs, and independent study research experience. Each participant within this programmatic scope intentionally sought extemporaneous research experiences to advance their skills and prepare for future graduate study and career opportunities. The context of these programs had a bearing on the student's experiences due to several factors, including the aims and learning outcomes of the programs, access to resources, and the population being served.

Presentation of Findings

In this study, participants expressed their experience of community within their STEM support and enrichment programs. All participants within the scope of the study experienced classroom experiences within science and mathematics courses that prompted their desire to build community and support elsewhere. The overarching notion is the feelings of connection that were not present within their classroom environments amongst their peers. There was little to no distinction between the participants' desires and experience with community, comfort, validation, and support in each programmatic type [peer-focused and research-focused]. Participants in both programmatic types alluded to the negative in-class experiences and validating co-curricular experiences.

The Storm Before the Calm: In-Class Experiences

Consistently unpleasant, isolating, and invalidating STEM classroom environments were common experiences for the participants in this study. The storm [adverse classroom

experiences], before the calm [enriching co-curricular experiences], was a common theme for the Black women STEM majors in this inquiry. Sally Jane shared:

Yeah, [it] never felt like it was a safe space for me. I was so tired all the time because I was just code-switching and just felt like I had to keep up a certain persona like smiling all the time.

However, the negative encounters within the classroom space were provoked primarily by their peers more often than the faculty. When asked who most often evoked the feeling of having to prove herself, Sally Jane stated, "I think it's definitely my peers-- my professors-- I've gotten really lucky...but I think it's definitely my peers and my classmates." Most participants cited vexatious interactions in the classroom environment, specifically with their White and non-Black but of color peers.

Underrepresentation

Further, the lack of representation of Black women in the classroom space promoted feelings of isolation. They felt vulnerable as they contended with hypervisibility and invisibility in STEM classroom spaces. Several participants recalled needing people who shared their racial identities in their classes. Adazumanee stated, "Not a lot of people looked like me." Desiree suggested she "Cannot count more than five Black women [major] students." Jay exclaimed she was the "only Black person in [major] class." and "I kept noticing the fact that I was like the only Black person in the room."

Ultimately, the lack of representation in the classroom space curated an environment of isolation. Jay also recalled:

At least I don't think I have like made a friend, like in class. And I noticed if there are Black people in the class and it's like we are more prone to [like] sit with each other and

help each other. But yeah, a lot of times, there are no Black students in class, so I really don't make friends in class.

The participants were not deluded to the realities of existing as a Black woman in STEM at a PWI. However, this cognization did not mean it was not difficult for them to contend with as they navigated their environments. Like Jay, Charlotte knew seeing other Black students in her STEM courses was not as frequent as it would be for her White peers.

Charlotte provided the following contextualization of her experiences in the [STEM] environment classroom at Upper State University:

It's a predominantly White institution, so they see other students in the class more often than not that look like them. Most of the time, whenever I go into a classroom, especially with like a [STEM] course and there's another Black student in there, the other Black student and I know each other--and we're able to identify.

These specific encounters characterized these experiences of isolation in the classroom setting and the cognizance that the university was not built for them [Black women]. Lily proclaimed, "This college was founded for White men-- like you can tell--even though it's like hundreds of years ago, the 1800s with the White men, but it still is." She reminded herself to remove that fear even though it was present.

Even with the awareness and realization of being at a PWI, the reality was still jarring. Sally Jane recounted when she recognized the realities of her environment at a PWI; she remarked on her time during her summer bridge program at Upper State:

Oh, like all the Black people will come like I just don't see them right now, because I'm here early like what do you...you know for sure? And then, just like realizing that it wasn't going to happen.

The isolation and underrepresentation were accompanied by other disconcerting experiences within the STEM classroom setting at the PWI. Regardless of the programmatic type the participants engaged in, they could not avoid troubling encounters with a lack of representation in the STEM classroom context.

Unreasonable Doubt

In addition to underrepresentation in the classroom environment, these Black women had to contend with provocations from their peers and, unfortunately, from professors at times. The instances of doubt and unprovoked challenges occurred in the classroom and the course-related lab. Desiree shared, "They kind of doubt the answers I've given, especially like the lab assignments or like even in class in general. I just kind of feel like I'm not taken that seriously." She characterized experiences such as this as "annoying" and "isolating," and she "wished they trusted her more." Desiree's instance is representative of the experiences of several other of these participants. Lily also contended specifically with her White women classmates challenging or doubting her; she stated, "Like White [females]--so if there will be talking, or if I want to say something they like trying to challenge you-- challenge everything I said or think it's wrong,"

Although not prevalent, issues with faculty in the classroom did also arise. Lily also recounted dealing with an uncomfortable situation with a [STEM] professor on the first day of class. She shared:

My statistics class--I noticed that, you know, there really weren't many Black people there. I remember on the first day I went up to him [the professor] because, you know, on the first day, you can introduce yourself to the professor or whatever-- so I did that. I was like, oh hey like I'm Lily--he's like, "oh nice to meet you," and then he said, "oh,

are you going to be on time every day?" And I was like yeah-- I'll be on time every day. So, I was like, what does he mean by that after I left?

Lily shared the conversation with her older sister after this interaction with her professor. She said, "I think it's like a microaggression because why would he ask if I would be on time every day?" This interaction was indicative of stereotypes many of the Black women faced within the STEM classroom environments at Upper State University.

Jay, like Desiree and Lily, experienced her non-Black people of color and White peers casting unreasonable doubt on her in the classroom context. Even when she switched [STEM] majors, she had to deal with the challenges and doubts predicated by her peers, and she said, "From [first major] to [second major], it felt no different." Likewise, the prevalence of academic invalidation and unreasonable doubt in the classroom was a factor for all participants, even across assorted majors in STEM.

Culture of Competition

The constant looming of a culture of competition also plagued the participants' classroom experiences. The notion of similar career trajectories and the perpetuation of grade culture catalyzed the culture of competition within their STEM classroom spaces. Sally Jane recalled:

It's just such a competitive environment, especially in [major]. A lot of people are going to the professional schools. So--most of my first conversations with most of my peers are, oh like --Are you going to med school? Are you going to dental school? Are you going to P.A. school? What are your scores? What are your grades? Have you taken this class yet? Did you have to retake it?

Charlotte echoed, "At the end of the day, some people take it as a competition; we're all in [major], we're all wanting to go to [professional] school, and there can only be so many spots." Jay professed how peers would push certain opportunities' competitiveness by saying things such as, "They only take like 15 students" which made her consider not even applying for certain opportunities. Ada addressed how this culture impacted her confidence in some classroom environments, stating, "I stopped believing in my interests." Nonetheless, the notion of competitiveness did not manifest among the Black women themselves; however, it did with other non-Black people of color. Nevertheless, these experiences of isolation, doubt, and competition catalyzed the need to engage in enriching spaces.; which led to seeking community, affirmation, comfort, and support outside of the STEM classroom context.

"If I'm going to eat, we all gone eat": Community

The next theme, "*If I'm going to eat, we all gone eat:*" *community*, addresses the participant's experiences of seeking social and communal relationships within their STEM enrichment/support programs. Experiences with community are characterized by their access to social connections that elicit feelings of belonging. This theme represents their need to seek social support to enhance their experience as Black women STEM majors at a PWI. Participants spoke of needing more connections within their classroom environments. They found these connections in both their peer-centered and research-focused enrichment programs. Key elements such as shared identity, collaboration, and feelings of belonging contributed to the theme of community.

The findings indicated that building social connections outside the classroom was a key element in their experiences. The shared identity and academic backgrounds were distinct

aspects of these community-building opportunities. One participant expressed that she made [actual] friends through her peer-focused program. In her first individual interview, Lily said:

Once you find people on campus like [B]lack women who are in STEM experiencing the same thing, it's like... Okay, I do belong here like I have a right to be here; I pay tuition just like everybody else, so those are the things that help me.

Charlotte shared in her first interview in detail about her peer-focused STEM support program:

And sometimes it can be nice because it's like-- Oh well, I know I have a tight-knit community there supporting each other whenever there's a struggle in a class or problem. I find that I can talk through it better with-other minority students, rather than like White students here at Upper State.

As expressed in their experiences, many were the only ones within their classroom environment, which was isolating. They took advantage of the opportunity to build community connections in another context. To further her sentiments, Lily shared in her interview that she appreciated opportunities to be in a [student] organization with Black women different from a sorority. She shared, "Just having a safe space for Black women it's different from a sorority because we don't charge like dues and stuff like that". With the investment within the community element of their peer-focused STEM enrichment programs, both Lily and Charlotte experienced the desire to see their respective programs continue to grow.

Similarly, Adazumanee, another participant in a research program, discussed her experience within her lab environment related to the community elements of the environment. For many aspects of the research-focused program, Ada enjoyed her P.I., their work, and the community within the lab. However, at times she felt that community did not extend outside of

the lab environment because while she shared many identities with her lab mates, their differences in social interests and hobbies created a divide. Adazumanee stated, "It can feel a little bit isolating sometimes like just because, like you know, even at a PWI [Black people] – is like still not a monolith, so you know, having that expansion to like welcome other people's stuff." Even with this experience, Adazumanee still extended grace to her colleagues within her research-focused program; in the closing of the first individual interview, she imparted the following, "So, like yeah, just coming from that point where it's just like, and we're all like we're all trying our best you know, especially with the pandemic and everything."

Similarly to Adazumanee, Jay also found community in her research-based program. Jay recalled, "I feel more comfortable in that space than in a typical classroom setting." Jay engaged in both programmatic types to give context to both experiences. While Jay did not connect to her peer-based STEM program, she still saw the value. She said:

Being surrounded by women that were also in STEM, I feel like that was also interesting because that's not something I really experienced in high school, so I was just like, I think it would be interesting to see like being a part of the group of people.

Nonetheless, as the participants expressed, a sense of community did not exist within their classroom experiences but was present for them within the co-curricular STEM context on their campus.

Counterspaces

The subtheme representation indicates the participants' experiences within their STEM support organizations and programs, both peer-focused and research-focused, and engagement with other people of color, especially other Black women. The participants in the study expressed feelings of isolation within the classroom context and even other community spaces

(i.e., the residence halls) on campus at Upper State University. Sally Jane asserted, "I mean, the biggest issue, obviously, is like I walk into a classroom-- I'm the only person that looks like me." The lack of representation was not as prevalent within the co-curricular context.

Access to counterspaces provided a sense of community and support in the co-curricular context not present in STEM classroom spaces at a PWI. When asked how the experience differed in the STEM-enrichment environment, Jay reflected, "They support me by allowing me to see all of the people of color involved in STEM and how they are successful... simply allowing diverse bodies into the space is very helpful." This statement, documented in Jay's reflective journal, prompts how her STEM enrichment activities [undergraduate research opportunity] support her as a Black woman in STEM. The research-based enrichment program Jay was engaged in by her account was a very diverse space. She stated, "At the beginning, for sure, when I first like joined the lab, I noticed that there were a lot of women, which was very like exciting to see... it was like a genuinely like of diverse groups of people and not just like diverse because of their race, but also like the things they do." The diversity and shared experiences with other Black women also evoked a sense of belonging within the research environment that was not present in her classes.

The opportunity to share spaces with other Black students, specifically women, provided a space countering their STEM classroom experiences. Access to representation and community with those with shared identities contributed to the initiatives of some of the outlined peer-based programs, as highlighted in the document analysis of two programs represented within the study. Lily shared, "It's just nice to be around people who can identify with me with the same experiences or have very similar experiences." Other participants, such as Sally Jane, shared the same feelings. Responding to 'what she most enjoyed about her STEM enrichment program.'

Sally Jane noted in her journal excerpt, "Also, I appreciate meeting with other African American women in the [program], so we can find people within the [program] as well," access to sharing space with those with shared identities was evidenced by their account to enhance their experiences within their STEM co-curricular environments.

Furthermore, the notion of representation spanned beyond the presence of shared identities with peers, but representation amongst program staff also resonated with the participants. Jay shared her experience with the P.I. of a lab she worked with being a Black woman, as well as the graduate students and postdoctoral scholars. She shared, "It's really nice to see Black leadership as well. I believe that we also share the lab with Dr. [redacted], who is also Black." Adazumanee also worked with a research mentor that identified as Black as well. Charlotte participated in a peer-based program where most of the executive board identified as Black women, and the organization's advisor did as well. Desiree, Lily, and Sally Jane all had co-curricular program advisors identified as Black within their peer-based organizations. The presence of Black-identified individuals provided representation unavailable to the participants within the classroom context.

While representation was visible and salient within many of the STEM co-curricular programs at Upper State University, it was not prominent within other avenues of the campus. Sally-Jane wished she had been made aware of the lack of representation across the campus. She stated in her reflective journal:

I think that we should be better prepared when coming to campus. Experiencing that culture shock alone was enough to make me want to transfer, but I believe that if I had come into that first semester with the expectation that I was going to be the odd one out and I had to stand tall, anyway I would've felt a little less alone. As a [participant], we

move in early for orientation, so if part of that orientation addressed it for even an hour just to say there are spaces where you can find people that look like you or here is how I navigated my first semester, that would be enough.

This sentiment was also echoed by Desiree, a participant in a peer-focused program, in her reflective journal. Desiree stated her STEM enrichment program(s) could support her as a Black woman in STEM at her PWI by "better equip[ping] me to embrace my [B]lackness while navigat[ing] a predominantly [W]hite space.

Furthermore, participants expressed their desire to be exposed to more representation in other avenues of their STEM experiences. Through the connections, their STEM enrichment programs possessed, whether through alum² networks or community partnerships, they desired to see the representation of other Black women within their field, not just within their on-campus communities. Charlotte, who participated in two peer-based STEM enrichment programs on campus, acknowledged vital differences between the two programs. One of the programs in which Charlotte participated was identity-based and discipline-specific; the other program was discipline-specific without the shared social identity component within the organization. While identity-based criteria were not a qualifier for the units of analysis for this study, it is important to note the differences based on Charlotte's experiences.

Within her identity-based program, she spoke of not seeing many people that shared her salient social identities on panels and workshops and how that impacted the information she received about her future. Charlotte shared:

² The use of the word alum is meant to be gender inclusive

Like listening on these panels and getting the same advice over and over and over again from non-minority (read White) students, and then I finally talked to one student that's a minority (read Black), and they'll be like so honest with me so open with me, and I'm like wow.

Lily also shared the primary difference between her experiences within her peer-based program. Lily remarked, "In [redacted program], it was more about people, and I was more comfortable...but we're [redacted] it's the opposite-- like that was really interesting." As mentioned, Lily is a double major in one STEM and one social science discipline. In addition to her research experience, she participated in a peer-based program for both of her academic majors. She was candid about the stark difference in her experiences with each field-specific program. She continued:

I know for a fact I'm a minority or even just like walking around Upper State, you know you're a minority, but especially in those like STEM spaces, I've noticed that a lot more than my humanities spaces, so that's the main stuff, I guess.

Finally, even with the experience of representation, experiences exclusively for Black women in STEM were a desire of the participants. "I think that having the school advertise or be more involved with programs that focus on Black women would improve my experience within my STEM enrichment programs," shared Desiree. Sally Jane also reflected a similar sentiment in her journal as it related to ways her experiences could be improved within her STEM enrichment program:

I am not sure what would improve my experience, maybe a mentorship program with Black women in STEM that work on campus or are alumni in [local community]. They

wouldn't even have to be in the same major, just someone to talk to that has navigated the same space.

The participants were conscious of their unique experiences as Black women compared to their Black men or non-Black women of color counterparts on campus. Lily reflected in her journal, "They could support me as a Black woman in STEM at a PWI by providing a space where fellow Black women could talk about things that only Black women in STEM at PWIs will understand." Even with appreciation and reverence for their STEM enrichment programs, they were not void of critique of how they could holistically support Black women participants.

Collaboration

The notion of collaboration was saliently present throughout the participants' experiences of research-based programs but not void in the experiences of peer-focused programs. The experience of collaboration within co-curricular environments was different from their classroom experience. Even within course-related labs, participants felt undermined, isolated, and excluded. As previously mentioned, most of the participants shared the presence of a culture of competition within the classroom context. The culture of competition was present across all the majors of participants represented in the study. It manifested in the classroom, course-related lab space, and peer interactions outside the classroom.

The nature and environment of a "lab" facilitated these experiences; nonetheless, the participants saw collaborative and team-oriented work as a valuable aspect of their experiences.

Jay graciously shared how collaborative her research-based experiences were; she shared what she enjoyed most about her program in her reflection journal: "I enjoy the activities in relation to the [redacted] program because of how collaborative they are. I feel like by going to these different activities helps me be more social and find people that are working on cool

projects." When reflecting on what would make her improve her experience in the program echoed the environment of collaboration; she stated, "Continual collaborative events, days where we observe another lab and what they're doing just to learn more, setting up a large group chat separated by students in the [redacted] program, postdocs, etc." The theme of collaboration was also present across campus between multiple STEM-enrichment programs. This experience was explicitly linked to identity-based programs.

The notion of collaboration was linked to building a network of other Black women in STEM across campus at Upper State University. Specifically, participants expressed they did not even have to be in the same major. Even further, having access to other professors and researchers that were also people of color was valuable to their experience within co-curricular STEM activities. Document analysis revealed that collaboration was key to peer-based and research-based programs. A unique aspect of one other program was the collaboration between faculty and the program and their link to the students. The collaboration that aided in the student experience spanned beyond their collaborative efforts.

Free to Just Be: Comfort and Validation

The theme, *Free to just be: Comfort and validation*, highlights the participants' feelings of comfort, security, and affirmation within their STEM support and enrichment programs. Participants shared experiences within their classroom and course-related lab environments that were mentally distressing and emotionally damaging. Adazumanee said, "I don't want to say hostile because that's extreme, but...but it did feel like, you know-- isolating." The participants' experiences with being academically invalidated and unable to show emotional vulnerability when overtly offended evoked feelings of isolation, imposter syndrome, annoyance, anger, and

sadness. These occurrences catalyzed participants to seek out safe campus spaces that aided their academic, professional, and social development within STEM.

Their support and enrichment programs were a refuge from chilly and isolating environments. The theme of *freedom to just be* is operationalized as minimizing the feelings of risk and experiencing a sense of security. Emotional comfort and intellectual validation were sub-themes that emerged as they described their feelings of emotional security and academic affirmation when interacting with their peer and research-focused groups. The risks associated with their student's experiences include feelings of unprovoked experiences with stereotypes, microaggressions, and isolation that manifest into feeling annoyance, hurt, and anger. Lily Further, document analysis revealed that the program focused on "supporting students holistically." Emotional comfort meant participants felt they could speak freely, connect and build authentic relationships with others, and feel more at ease and comfortable in the presence of their peers. Intellectual validation meant feeling academically valued and affirmed in their programs. Feelings of emotional security and academic validation were differentiated from how they felt within their classroom environments. In their co-curricular peer-focused and research programs, they felt "safe." They experienced belonging, acceptance, and comfort within their STEM support and enrichment environments among the staff and peers.

As mentioned, all six participants shared experiences of feeling isolated from their peers in the classroom. This isolation manifested from identity differences and a lack of peer interactions. They also expressed a culture of competition that existed among their White and non-Black people of color peers, but their [non-Black peers] did not view the [Black women] as their competition. There were experiences where the participants' peers referenced diversity quotas to explain their presence in the classroom spaces. Charlotte recalled a zoom meeting

where an individual blatantly said, "Ah, so we have to make sure, like in most programs, that we have our 15% minorities acceptance." Charlotte goes on to say:

I just felt my heart [like] drop in the middle of the meeting... When they [read: White peers] realized that I was on the Zoom call with them-- and so I'm like wow-- How many times has this conversation happened within other spaces?

She internally reflected and then shared how she thought her peers perceived her, saying:

People hear this information [about diversity quotas] and immediately think, 'Oh wow, she doesn't work hard to be like where I'm at right now.' She doesn't have to do as much--she's one of the only Black applicants on the applicant list and everything like that.

Being subjected to this treatment overtly and covertly, from peers and sometimes professors, Charlotte shared, "it kinda hurts." However, these implicit and explicit conversations didn't often occur in the co-curricular space unless the Black women validated each other's experiences.

Feelings of security, belonging, and affirmation manifested in the participants' peer-focused and research-focused STEM co-curricular environments. The physical environment, the objectives, and the people involved also contributed to their feelings of safety and security. One of the peer-based organizations represented a "safe space for Black women". Most participants echoed feelings of security and belonging within their lab spaces, meeting spaces, and even conferences related to their student organizations. Charlotte shared:

Most of the time, whenever I go into a classroom, especially with like [major] course and there's another Black student in there, me and the other Black student know each other, were able to identify" but contrary when in spaces with her peer-based student

organizations it's a space where they (other Black women in STEM) can vent their "frustrations within like a safe environment.

These spaces reflect the respective support and enrichment programs' outcomes and objectives.

Emotional Comfort

The subtheme of emotional comfort characterized how participants felt they could speak freely, connect and build relationships with others, and feel more at ease and comfortable in the presence of their peers. In a sentiment representative of several participants, Charlotte expressed it was nice to share their frustration in a "safe environment." Charlotte, who participated in a peer-focused environment, shared the following related to her experience with her student organization,

I really, really have enjoyed [my student org] so far, [my student org] has been a nice like a breath of fresh air; whenever I go to the different meetings where there's a board meeting or club meeting, I'll just walk in the room, and we're already like laughing with each other, simply because, like wow. We're all [in the same major], for the most part, and we're all, like, here in the same environment together. We don't even have to be doing anything; we will have icebreakers at the beginning of our meeting and get so sidetracked and have such a great time with each other.

This security was vital to their enjoyment within the [peer-based] student organization. It was also a safe environment where they could express their frustrations about their negative classroom experiences and course-related labs. Lily shared in her journal response, "I enjoy the fact that they make me feel not alone, they allow me to meet fellow Black women who understand exactly what I am going through, and I enjoy that they give me a chance to not worry

about code-switching." Desiree shared a similar stance regarding her peer-based program, "It creates spaces for us to come together as [B]lack women and talk about our experiences." Furthermore, these programs' mission centered on promoting diversity and empowering [marginalized] students, providing them space to feel accepted and secure.

With the constant onset of feelings of isolation within their STEM class environments, participants found emotional support and comfort within their programs. Lily continued her previous sentiment of emotional support, stating:

It's been helpful to me-- by like-- it can feel like or remind me I'm not alone; a lot of people are going through the same struggle like imposter syndrome is big because it feels like we have to be a certain way or ever it's like [they're] smarter than us and stuff like that...And it helps me remind myself that I can actually do it and belong here because sometimes I walk on campus, I feel like I don't belong here because I don't feel like I do.

As previously stated, Lily expressed relief at not having to "code-switch" within her peer-based programs. The act of not employing this defense mechanism further reiterates the freedom to just be within peer and research-based STEM co-curricular environments.

The data revealed that peers provided emotional and intellectual security to the participants within research-focused and peer-focused programs, and program staff also contributed to the feelings of comfort and validation. Access to people within their STEM co-curricular environments provided a sense of security that was generally absent within their classroom environments. Sally Jane recalled experiencing some personal challenges she encountered throughout the academic year. She shared the support and encouragement she received from the program staff. Sally Jane spoke of an experience where she did not think she could fulfill the requirements outlined by her co-curricular program, causing her emotional and

mental turmoil. However, Joe [pseudonym] reassured her that she would satisfy the requirements. She recalled, "Yea, so he kinda gives me grace."

To this end, emotional comfort concerned by the STEM support and enrichment environments brought about a sense of reassurance, security, and affirmation that was not as readily experienced outside of the STEM co-curricular space. Jay said, "I feel more comfortable in that space."

Intellectual Validation

Intellectual validation and affirmation within the scope of this study represent feeling scholastic valued and affirmed in their programs. They did not need to second guess or prove themselves within their STEM-enrichment programs. Adazumanee deemed this the "gatekeeping effect" because it made it hard to feel comfortable and confident in specific spaces. The theme of intellectual validation is more prevalently represented among students participating in research-focused and academic adjacent activities (i.e., scholarship communities). Within co-curricular STEM spaces, participants felt affirmed scholastically and intellectually.

Intellectual validation allowed participants to share their knowledge and ideas or ask questions without fear, anxiety, or embarrassment. Asking questions in class felt like a risk because they already felt like their classmates doubted their abilities and were deserving of being at Upper State University in a STEM major. Concerning her classmates underestimating her in STEM courses, Desiree said:

So, here's that I actually have to prove to them that I was as smart as I was. It gets me pretty annoyed-- but it's like kind of okay--I can use that to my advantage because if you really don't think I'm as smart as them [they] wouldn't bother --like well then you wouldn't bother asking me for answers.

Charlotte echoed, "I would definitely say the biggest challenge is people underestimating your [like] ability."

In their co-curricular lab spaces and professional development spaces, they felt intellectually affirmed and safe to express their scholarly contributions and thought they provided value to the space. Jay shared, "she [just] felt more comfortable in the [program lab] setting than the classroom. The isolation they all expressed from their experiences in class also took a toll on them mentally and emotionally, but this dissipated within STEM-enrichment environments.

Adazumanee felt that engaging in her research-based experience reignited her love of science. She said she "understood the material" and "felt empowered" within her co-curricular research spaces.

"Never Once Doubted Me": Support and Development

The final theme that emerged from the data was experiencing an environment of tangible support and authentic development for Black women in research and peer-focused STEM support and enrichment programs. Environment operationally includes the organizational, physical, and socially constructed (Strange & Banning, 2015). As discussed by the participants, the climate of development and support highlights their experiences of encouragement, growth, and affirmation through engagement within these programs with peers and staff based on what they shared. Furthermore, mentorship and academic and professional development were the subthemes that materialized within these support and development environments. Participants in research and peer-focused programs recount gaining access to mentors in professional and academic areas. Participants also wanted to pay it forward through involvement in STEM peer and research-focused programs. The final subtheme, academic and professional development,

reflected on the experiences of having access to research and practical opportunities to prepare for graduate and professional school. These programs also provided access to study abroad, networking, and leadership opportunities to build their professional and academic portfolios.

Many participants pursued co-curricular opportunities due to non-supportive classroom experiences and even negative experiences with their academic advisors. Desiree, Charlotte, Lily, and Adazumanee all cited experiences with their academic advisors questioning their abilities to manage their studies, even with nearly perfect grade point averages. When asked what one of her biggest challenges of being a Black woman in STEM at a PWI is, Adazumanee said, "...It can be [like] exhausting on top of like the other things we have to balance as a college student, so I would say that's one thing. And then the second thing would be the advisors." In relation to her academic advisor interactions, Desiree shared, "I think I wanted to take physics, organic chemistry, and then one other class-- maybe stats-- basically all three of them together, and she [the advisor] was like no, you're not going to be able to do it." Similarly, Lily stated, "It's just interesting how sometimes she [the advisor] would tell me like-- Oh, maybe you shouldn't have two majors, maybe you should just get like one major."

Contrarily, they felt affirmed and supported within their STEM enrichment programs, and stakeholders such as their peers and the staff were invested in their success and development. Sally Jane recalled how challenging the academic year had been for her, but she felt directly supported by the program staff of her peer-based program. She recalled:

[Staff member name! I love him-- he's so great! Especially this past year, I feel like it was just really hard my junior year, and it was just a stressful time both like familywise and then also school and academics just trying to balance everything. It was just a lot for me to take in, and he never once doubted me throughout the entire time.

Through their accounts, these women noted a culture of support and belonging through active participation in their programs. Furthermore, this culture of support was also evident through document analysis of research and peer-focused programs. The participants' experiences with support were two-fold. Participants expressed feeling supported by organization advisors, program staff, PIs, and their peers within their peer-focused and research-focused organizations. This support manifested academically, professionally, and socially through various programmatic initiatives and relationships. Sally Jane shared, "I love all the events put on by the department and how open their space is to minorities. Creating that positive environment even just to sit and work in." This sentiment was echoed by Charlotte, another student participating in a peer-focused program, by saying, "I [also] enjoy being able to have these experiences surrounded by other ambitious [shared major] students working toward the same goal as myself."

As highlighted in the program documentation, the learning outcomes illustrated that program participants would be integrated into the campus community. The integration includes engaging in academic and research enhancement workshops, building a mentoring network, and honing professional development and leadership skills to pursue STEM careers. The participants were presented with these opportunities through peer and program staff support, mentorship access, and other holistic development opportunities.

Support and development within the environment were facilitated through peer and staff relationships. Participants also developed social relationships by participating in their campus STEM co-curricular programs. There were instances when participants recounted just being in community with their peers as means of support. Charlotte said, "It felt like we were supporting each other; we would find time to come into our office shift, and we were just there." In context,

Charlotte discussed the support her and other executive board members within her peer-based organizations provided to each other.

Participants recounted positive experiences with program faculty and staff that worked directly with their STEM enrichment programs. As previously mentioned, shared identity added to these feelings of support; however, their interactions with program faculty and staff confirmed the support they encountered. Within the research environment, participants reflected on how their Principal Investigators (PIs), lab supervisors, and researcher mentors were intentional about their skill development and access to opportunities.

Adazumanee discussed the connection between her and the P.I.s and graduate students she could work with within her research experience. She expressed, "Dr [redacted], it was good working with them; I got to learn more about [subject]" and "Dr [redacted], she was also another woman of color; it was helpful talking to her." Other participants in research programs, such as Jay, recalled the connection and encouragement she received from faculty and staff in her research-based experiences. Jay recalled:

She... you know, asked if I wanted to join her. So, it was very unexpected, but I believe I told her, " Yeah, like I'll, you know, think about it, or whatever, and like, you know, get back to her. And so, essentially, I thought about it, and then I was like can I join your lab essentially for the spring because I was in the Fall semester sophomore year? And then that's essentially how I joined her lab in the spring semester of that year, and essentially from there, I was in her lab for credit. And you know, just learning different things, and it was like my first lab experience, and then that was when he also told me about the [research] program. She encouraged me to apply.

In essence, the experiences with faculty and staff outside of the classroom context were supportive and attributed to the student's self-proclaimed access to opportunities because they recounted times when these interactions encouraged them and were helpful.

Mentorship

Mentorship was vital to the participants' experiences within their STEM co-curricular environments. Adazumnae recalled that her first "real" mentor was a Black woman in terms of learning about a role in a STEM career outside of her family member that was in STEM. From that experience, she knew she wanted to pay that mentorship forward. The participants expressed in multiple accounts how mentorship plays a role in their experience within their STEM co-curricular experiences.

Some of the programs provided a formalized peer or faculty mentorship experience within their program. The website of one of the research-based programs discussed their model of faculty mentors providing research experience, guidance, and assistance to prepare scholars for graduate study. In addition to the faculty mentorship model, this program also provided students with peer or graduate student mentors. Some of the peer-focused programs provided a mentor structure as well. This structure focused on a peer mentorship model. Jay, Sally Jane, and Charlotte had experiences with formal mentor experiences within their STEM programs, specifically peer mentor experiences.

Peer Mentors. Data across the peer-based and research programs showed peer mentorship was a core value of their program initiatives. One of the peer programs illustrated that their peer mentors serve and support new incoming transfer and first-year students through one-on-one meetings, small group events, and various social and cultural programs. Other program models entail upper-class mentors who will assist first-year students in transitioning to

life at an Upper State University. When participants elaborated on their experiences in peer and research-focused STEM enrichment programs at Upper State University, many gave ample access to peer mentors. Sally Jane spoke about her experiences early on with upper-class mentors and role models when she first became engaged with her program:

I looked up to the upper-level students like they were my role models, they did everything, and I was like, I can't believe this- in two years, and you've done all these things, and now they're about to graduate, and all that stuff. I would do anything for them; they're amazing, just to see their hard work.

Charlotte also engaged with peer mentors in her peer-based STEM co-curricular program on campus; later, she became a peer mentor. She shared how she learned about different aspects of preparing for her desired career from peer mentors. Furthermore, her peer mentor program also had a pipeline element, meaning students who participated as students could serve as peer mentors in the later years. Jay had a different experience with peer mentors in her program but not necessarily a negative experience. She did not feel like she genuinely developed a relationship with her assigned peer mentor but stated, "she was pretty nice." The lack of congruence with identity plays a part in their diminished connection.

Paying-it-forward. As a by-product of positive experiences with peer mentorship within their STEM peer-based and research-based enrichment programs, they desired to pay it forward by serving as mentors in formal peer mentoring roles within their co-curricular programs. In her peer-focused program, Sally Jane wanted the opportunity to pay it forward for those who came behind her. She shared that she asked herself, "Why don't I become a mentor... [and] I was a mentor for the [redacted program]". Sally Jane expressed that after she went through the program, she felt like this was a great opportunity to give back.

Following her initial engagement with her peer-based program, Charlotte was given the opportunity to serve as a leader within the organization. She recounted:

That put me in the role where I had to make sure that I knew everybody that was coming to [name of program], try to encourage people continuously coming to [name of program] as well as the social fun aspect of the different meetings.

Additionally, Charlotte became an executive board member and peer mentor within another program explicitly related to her major. When she first began the program, she was the only Black member serving in a mentor capacity, but she enjoyed being a resource to others who shared her identities. Charlotte shared, in her both of her interviews:

And it just felt nice to be able to help other students. Also, at times there would be some minority students that would come in for appointments very few. And stuff like that, and I've definitely seen more students that were minorities apply for the internship program now. Even at times, different minority students look at me for reassurance or something like that during the camp, like, oh wow, there is somebody.

As mentioned, Adazumanee first encountered authentic mentorship while engaging in STEM enrichment activities. She recalled, "Dr [redacted] was like-- I really think--like the first real mentor for me in terms of like what she did for me." From this experience, she also wanted to serve in a mentorship capacity. She recounted when she took the opportunity to assist a first-year Black woman student coming into Upper State University in a STEM major. Following a retreat on campus, Ada was introduced to this student. She spent time sharing her experiences, preparing her for the demands of collegiate-level STEM courses and general advice.

Adazumanee shared, "Yeah, she ever needs anything, you know for advice or just staying in the classes because they're hard-- like I would be lying to her if I didn't tell her that." She hoped to

continue cultivating this relationship as a means of continued development. "You know, be there for her and stuff like that," Adazumanee stated.

Academic and Professional Development

Access and availability of professional and academic development opportunities were salient throughout these women's experiences within their STEM-enrichment environments. Two of the participants, Sally Jane and Desiree, gained access to internship opportunities by engaging in peer-based STEM enrichment activities on campus. Sally Jane shared that she was able to work as a clinical assistant intern at a local clinic. Desiree explored her professional interests through an internship in the community.

As cited on many of the program websites and promotional materials, they are committed to "providing out-of-class experiences," "An environment of support...", and "promoting academic success." (Program Website, nd.). Other programs represented and promoted messages related to professional and academic advancement, academic excellence, and professional success (Program Website, n.d.). Additionally, events, initiatives, and opportunities such as conferences on campus, regionally, and nationally highlighted on program social media pages and university and national webpages supported these ideals.

Despite ample academic and professional development opportunities, participants desired more targeted efforts for Black women. Charlotte's journal reflection indicated:

By offering more student shadow programs, internships, or even offering panelist groups that include [B]lack women in STEM leading some of these opportunities, we will continue to be motivated to continue working towards our future goals as we will have individuals above us that can inspire us and provide us with that necessary guidance and mentorship.

When I asked Charlotte to elaborate on this, she talked about the differences in experiences of non-Black people of color. She said it should not be a "competition" of who has it worse or needs more help, but she knows how hard Black people must fight to have a space. Overall, like the other participants, she was grateful for her experiences and opportunities. Similarly, Jay shared ways in which her research program could offer more access to academic and professional opportunities, suggesting, "By offering more student shadow programs, internships, or even offering panelist groups that include black women in STEM leading some of these opportunities." She shared that this would continue to motivate her and other Black women in STEM at her PWI to continue working on their goals and provide them with much-needed guidance and mentorship.

Participants also expressed their ability to engage in other academic and professional development related to their STEM enrichment programs, such as study abroad opportunities, professional conferences, and networking opportunities. Charlotte was able to study abroad in South Africa as a supplement to one of her STEM enrichment experiences. She could also attend a professional conference related to her peer-based STEM enrichment activities. Adazumane presented her research at a research symposium on campus. These supplementary opportunities resulted from engagement within their research and peer-based STEM co-curricular programs.

Internships. Participants were afforded internship opportunities through involvement in their STEM co-curricular programs. Charlotte, Desiree, and Sally Jane all recalled their experiences with internships both during the academic year and summer. These internships originated from connections with their peer-based programs. Each of them participated in internships directly related to their future career goals and other professional and academic goals they desired.

Sally Jane was able to intern locally in the Upper State University community. From connections with staff in her peer-based program, she connected with a math tutoring role and a local internship. The internship fulfilled some of Sally Jane's academic and professional goals and gave her access to diverse bodies in the STEM space. The internship setting served underserved populations in the community, which is a current and future goal of Sally Jane. It's also a space where she can practice her second language when interacting with individuals at her internship. Sally Jane shared:

It's a very inclusive space. There, some people just aren't meant to teach, but you shadow anyways at their office just because you need those hours. But I've gotten lucky with this internship. They're very willing to teach there and inclusive.

She also discussed how the internship targeted people with her intended career goals, which is why she initially connected with the program. She stated, "It definitely prepares me in terms of hours; also, I just feel like I've gotten lucky." Desiree also earned an internship opportunity through networking within her STEM co-curricular space. She also interned in a place closely aligned with her future professional and academic goals. She stated:

I have been volunteering at a [space] right now that is geared towards [career goals], so kind of interested in that too, as well, so right now, I have like a million interests but not dead set on something yet, but this is giving me an idea.

Even so, she wanted to take advantage of all opportunities allotted to her because she stated she did not want to be "stuck."

Charlotte also secured an internship through engagement with one of her peer-based programs on campus. Charlotte was keen on taking advantage of any opportunities available to her. Charlotte spoke of a particular person within her peer-based program, "Like if you know me,

I can help you. I got some connection." Through that connection, Charlotte earned her internship and in community with many people who shared her interests and future goals. Further, she spoke of how obtaining this internship was a big goal. While at Upper State University, she shared, "I hadn't really seen a minority participate in the internship program." Charlotte and the other participants were grateful for the access and opportunities for themselves and others.

Summary of Findings

Within this chapter, the data demonstrated that Black women undergraduate STEM majors engaged with research-focused and peer-focused STEM enrichment programs at their predominantly White institutions. Through engagement within these programs, they had experiences with the community, safety, and holistic support. Regardless of the program type, these STEM-based enrichment programs provided support that Black women were not getting within the STEM classroom environments.

The first theme, *the storm before the calm*, contextualized the participants' unpleasant STEM classroom experiences. Participants shared their bouts with underrepresentation, being challenged, doubted, and underestimated by their peers. Finally, within the classroom context, a culture of competition manifested among their peers as they were all vying for spots in competitive graduate and professional school programs. This competitive nature and unprovoked challenge specifically were marshaled by their White and non-Black peers of color.

The following finding, *If I'm gone to eat, we all eat*, recognized the element of community that was present for Black women in research-focused and peer-focused enrichment programs. Namely, this sense of community manifested from representation and collaboration. Within the classroom, Black women were consistently surrounded by White and non-Black people of color peers. However: within their peer and research-based organizations, they were

able to interact with other Black students more often. Representation was present within the student populations of the STEM enrichment programs and, in some cases, the program staff. They also felt more connected and collaborative with peers within the STEM co-curricular programs as opposed to the isolation they often felt in the classroom context.

The third finding, *free to just be*, revealed that participants within co-curricular STEM programs felt safe within the peer and research context. The participants often felt fearful in the classroom or risked embarrassment by asking questions or sharing their knowledge. While physical safety was not a concern in the classroom context, emotional and mental safety was at risk. However, participants felt emotionally and intellectually safe within the STEM enrichment environment. They were able to be authentic, build connections, and share their knowledge without fear of judgment or backlash from their peers.

Finally, *never once doubted me*, showed that participants within peer-based and research-based programs engaged in environments of authentic support and development within their programs. The support and development manifested through a variety of professional and academic development opportunities as well as mentorship. The support they experienced was holistic and was present within their peer relationships and connections to program staff.

Taken together, these findings suggest that overall, the experiences of Black women undergraduate STEM majors involved in peer and research-based STEM enrichment programs are experiences that are contrary to their classroom experiences. The classroom experiences are often isolating, chilly, and tokenizing; however, within their STEM-enrichment experiences, they feel safe, represented, and supported. Together these findings reveal implications and recommendations for the out-of-classroom experiences for Black women undergraduate STEM majors participating within these program types.

CHAPTER FIVE: DISCUSSION, IMPLICATIONS, AND CONCLUSION

In this chapter, I will overview the research study's purpose, discuss the significant findings and themes, and provide recommendations for future research, policy, and practice. Additionally, I contextualize the two embedded units of analysis in this case: peer-based and research-based STEM co-curricular programs. The discussion of the findings is organized by significant themes and highlights the embedded units of analysis of the case study. Finally, I offer implications, recommendations, directions for future research, and a study conclusion.

This single-embedded case study aimed to explore Black women's experiences in undergraduate STEM majors from two embedded programmatic types: peer-focused and research-focused STEM co-curricular programs. Literature indicated that Black women experience negative, invalidating, and tokenizing STEM classroom experiences based on their racial and gender identities at predominantly White institutions (Fletcher et al., 2017; Johnson, 2007, 2012; McGee & Bentley, 2017). These experiences impede their sense of belonging, catalyzing their desire to seek out environments of belonging outside of the classroom within co-curricular spaces (Lane, 2016; McGee & Bentley, 2017).

Another distinguishable factor of this case study was the two embedded units of analysis to further nuance the experiences of peer-focused programs (student organizations, professional organizations, and leadership programs) and research-focused programs (faculty-led research, nationally sponsored research programs, and undergraduate research experiences (URE)). Using tenets of sense of belonging and intersectionality to frame the study, the following research questions guided the study: How are Black women undergraduate STEM students engaging in STEM co-curricular programs at Predominately White Institutions (PWI) in the Southeast?

Additionally, the following sub-questions also guided the study: 1) What are the experiences of Black women undergraduate STEM students in peer-based program STEM co-curricular programs? and 2) What are the experiences of Black women undergraduate STEM students in research-based STEM co-curricular programs? For context, this institution was chosen because of its strong reputation for academic programs and co-curricular opportunities in Science, Technology, Engineering, and Mathematics. The institutional website states, "[Upper State University] is a powerhouse in science, technology, engineering, and math," which aligns with the land and sea-grant mission." (University Website, n.d.).

This chapter discusses the significant findings concerning the research inquiry and relevant themes. Furthermore, the evidence presented from this case will inform practice and future research on how stakeholders can understand and support the experiences of Black women undergraduate STEM majors at Upper State University (USU), but potentially in a broader context. Finally, this chapter will conclude thoughts on Black women's experiences within peer-based and research-based co-curricular programming at Upper State University, a Predominately White Institution in the Southeast.

Case Units of Analysis Contextualization

As mentioned throughout this research study, the case consisted of two-embedded units of analysis. The inquiry was structured in this way to highlight the key distinctions between the missions of the different programmatic types: peer-based and research-based programs. Table 2.1 provides an overview of this study's peer-based and research-based programs. As defined by Eisen (2001), peer-focused programs are designed as professional development opportunities or defined experiences with respective reciprocal dynamics of individuals with a comparable status.

Within the context of this study, these programs were represented by learning communities, student organizations, and leadership programs within the STEM context.

The second embedded unit of analysis, research-based programs, are initiatives and programs that systematically study a problem under the direction of faculty or formalized programs (Kinkead, 2003). This study included undergraduate research experiences, structured research programs supported by national organizations, and lab assistant opportunities. While the objectives and aims of these programs are different, they are targeted to serve similar student populations based on their goals and interests, which prompted this inquiry. This distinction was significant for Black women in STEM majors because literature supports that they have difficult experiences within STEM disciplines due to many factors, including chilly climate, isolation, and stereotype threat due to gendered racism (Fletcher et al., 2017; Johnson, 2007, 2012; McGee & Bentley, 2017).

Peer-Based Programs

Participants represented various peer-based programs at Upper State University within this study's scope. Each of these peer-based programs had a well-established reputation at Upper State University. In order to protect the participants' identities, the programs explored are not explicitly named; however, the following section provides descriptions of the objectives and missions of the programs represented within the study.

Three different program types were present within the context of this inquiry. First, student organizations with affiliations with professional organizations were present in the context of the study. These programs were typically disciplinary-focused and possessed an identity component but were open to all students on campus regardless of area of study and social identity. Secondly, a STEM-based program designated for high-achieving students with a

leadership component was highlighted. Finally, this embedded unit of analysis also represented a learning community [village] with a live-in option to support student engagement. The programs represented were missioned and oriented to focus on the professional, academic, and social aspects of the student's college experience related to their academic disciplines.

Research-Based Programs

As a Research I, land and sea grant institution, research is a revered practice at Upper State University; therefore, a variety of research-focused programs were represented in this study. The research programs present within the bounds of this case study were representative of different disciplinary areas within STEM. Again, to honor the confidentiality of the participants, the specific programs, academic colleges, and funding organizations will not be named.

First, a nationally recognized and government-supported research initiative for students across various social identities was included in this study. Next, different faculty-led research initiatives supported by national and university funding bodies were present within the scope of the unit of analysis. Participants in these research-based programs held several positions within the "lab," including research assistant, laboratory assistant, mentor, and apprentice.

The descriptions of these embedded units of analysis, peer-based and research-based programs, provide context to the discussion of the results of this study and the implications. This typology will be further discussed and analyzed when addressing the research questions that guided this study (see Table A). Finally, the term 'focused' and 'based' were used interchangeably to describe the aims of the programs through the discussion.

Table 2.1*Typology of Programs*

Peer-Based Programs	Research-Based Programs
Student organizations/ Professional Organizations with a chapter on campus at Upper State University	Undergraduate Research Experiences (UREs)
Living Learning Villages	Structured Research Programs (National, Regional, or Institutional)
Leadership Programs	Research or Lab Assistant

Discussion of Findings

The purpose of this study was to decenter the STEM classroom experiences of Black women undergraduate STEM students at a predominantly White institution in the Southeast and focus on their disciplinary co-curricular experiences. Little research has been done to address the co-curricular STEM experiences of Black women in the collegiate context. Through this inquiry, I focused on how Black women undergraduate STEM majors at a PWI in the Southeast engaged in STEM support and enrichment activities. The findings indicated that contrary to their negative experiences within the classroom as Black women in STEM, the participants had positive experiences within their co-curricular programs. The following table provides an overview of the organization of the discussion of the findings (see Table 2.2):

Table 2.2*Discussion of Findings Organizational Table*

In-class experiences	<ul style="list-style-type: none"> • Underrepresentation, • Unreasonable Doubt, • Culture of Competition
Peer-based experiences	<ul style="list-style-type: none"> • Community • Comfort and Validation • Support and Validation
Research-based experiences	<ul style="list-style-type: none"> • Community • Comfort and Validation • Support and Validation

Within the scope of this case study, the term engagement is defined conceptually as the amount of time and effort a student devotes to their academic and social activities that lead to the experiences and outcomes that constitute perceived student success (Strayhorn, 2018; Wolf-Wendel et al., 2009). Moreover, when examining their engagement experiences, it was revealed that participation translated to involvement. As defined by Astin (1984), involvement on campus directly impacts the learning and personal development of the student. Later corroborated by Strayhorn (2018), involvement is the investment of a student's energy into activities based on the time and quality of a student's engagement in experiences designed for specific desired outcomes. As evidenced by this study, a positive relationship exists between student involvement experiences within co-curricular activities and a sense of belonging (Strayhorn, 2018). The nuances of centering this inquiry on Black women had implications on their engagement and involvement experiences within STEM enrichment programs due to racial and gender identities that historically impact their STEM experiences.

The valuable involvement experiences of the six Black women participants coincide with literature regarding a sense of belonging. Co-curricular programs are evidenced to enhance the

student experience and aid in their feelings of belonging based on the quality and quantity of their involvement (Astin, 1984, 1993; Strayhorn, 2018). For this study, the co-curricular programs paralleled the participants' [STEM] academic disciplines and areas of interest. Regarding their participation within peer and research-focused STEM programs, all six participants in the study were actively engaged and involved in their respective programs. Some participants, such as Charlotte, Sally Jane, and Desiree, were engaged in multiple STEM peer-based programs on campus. Lily and Jay were involved with both research and peer-based programs. Adazumanee was involved solely in research activities. Each participant engaged in various activities within their programs (see Table 1.4 in chapter three).

It is not lost that the racial and gender identities of students impact their experiences as STEM majors at their institution (Johnson, 2007, 2012; McGee & Bentley, 2017; Ong et al., 2018). The six participants in the case identified as cis women across the Black diaspora at PWI in the Southeast region of the United States. Multiple truths emerge when drawing on the participants' intersectional identities within this study's context. Racialized and gendered experiences of Black women in undergraduate STEM majors are two-fold within the curricular and co-curricular context (Ireland et al., 2018; Malcolm et al., 1976; Ong et al., 2011). Further, other elements of their identity, such as being high-achieving (above a 3.5 GPA) and second-generation college students, also had a bearing on their experiences and outcomes. As continuing-generation college students with clear academic aspirations and excellent academic performance, these students were equipped to be successful in the classroom; however, aspects such as their racial and gender identities created barriers to their overall success in STEM (Freeman, 1999; Griffin, 2006). The findings provide concluding evidence of how intersectionality is at play for the participants within their curricular environments as Black

women are contending with their privileged and oppressed identities within systems of power (e.g., STEM majors at a PWI).

Five participants in the case were continuing-generation college students, meaning their parents attended and completed college. However, this history and privileged element of their identities did not insulate them from oppression in their STEM classroom environments (Dancy et al., 2018). Intersectionality goes beyond salient identity markers and involves the contexts in which individuals exist (Griffin et al., 2018). Moreover, participants discussed the notion of code-switching depending on their environment. When in the presence of her STEM-enrichment environments, they did not feel the burden of having to code-switch because they felt safe and supported. Contrary to the classroom environment and advisor interactions, they were tasked with this burden because of previous encounters with microaggressions and stereotyping by faculty and peers. These experiences with microaggression and stereotypes serve as evidence of the importance of identity and cultural affirmations within STEM spaces. Literature posits that shared cultural identity is an important aspect for Black women in STEM environments at PWIs

Table 2.3*Themes, Subthemes, Theoretical Constructs, and Typology*

Theme	Subtheme	Theoretical Constructs	Program Type
Storm before the calm: In-class Experiences	<ul style="list-style-type: none"> • Underrepresentation • Unreasonable Doubt • Culture of Competition 	<ul style="list-style-type: none"> • Intersectionality • Sense of Belonging 	N/A
"If I'm going to eat, we all gone eat": Community	<ul style="list-style-type: none"> • Counterspaces • Collaboration 	<ul style="list-style-type: none"> • Intersectionality • Sense of Belonging 	Peer and Research
"Free to just be": Comfort and Validation	<ul style="list-style-type: none"> • Intellectual Validation • Emotional Comfort 	<ul style="list-style-type: none"> • Sense of Belonging • Intersectionality 	Peer and Research
"Never once doubted me": Support and Development	<ul style="list-style-type: none"> • Mentorship <ul style="list-style-type: none"> ○ Peer Mentors ○ Paying-it-Forward • Peer and Staff Support • Academic and Professional Development <ul style="list-style-type: none"> ○ Internships 	<ul style="list-style-type: none"> • Sense of Belonging 	Peer and Research

Discussion of In-Class Experiences

In-class experiences shaped one element of the Black Women undergraduate STEM major's experiences at their PWI. Before dissecting and understanding the co-curricular STEM experiences of Black women undergraduates at Upper State University, I contextualize their in-class experiences. Previous literature problematizes the challenging classroom experiences of Black women in STEM. Regardless of their STEM discipline and co-curricular program affiliation, they all expressed negative classroom experiences characterized by isolation, being challenged and doubted, and a culture of competition.

Underrepresentation

First, the pervasive and disproportionate underrepresentation of Black women in STEM academic environments represents a barrier to their experience and, ultimately, educational outcomes. Fletcher et al. (2017) addressed how Black women in STEM contend with isolation, tokenism, and a chilly climate in STEM academic environments due to being the only or one of a few. The lack of representation is a byproduct of poor recruitment and retention of Black women in STEM at the faculty and student levels (Drury et al., 2011). Charleston et al. (2014a) discussed how the intersectional identities of Black women impact their experiences in STEM majors, such as computer science, resulting in poor education outcomes such as low retention and completion rates. Johnson (2007) contextualized the absence of a sense of belonging impacting Black women and women of color's STEM education experiences, especially on PWI campuses. However, the underrepresentation of Black women's bodies in STEM spaces is disproportionate depending on their academic major. Black women in engineering majors experience far less gender and racial representation than those in biology or mathematics. Even such, Black women, regardless of major, still find their classroom spaces invalidating and chilly. Underrepresentation often leads to other unpleasant experiences, such as microaggressions and underestimation of their abilities, for Black women in the STEM classroom environment.

Unreasonable Doubt

Consequently, lack of representation in the classroom space leads to stereotyping of Black women in STEM classroom environments. Regardless of their co-curricular affiliation or specific area of study, Black women undergraduate STEM majors at Upper State were dealing with their peer's unreasonable and unprovoked challenges to their contributions in the classroom and lab space. This challenge and doubt align with the literature on racial, gender, and

performance stereotypes of Black women in science and mathematics classroom environments. Gender-based and performance stereotypes allude to the notion that women have less aptitude for science and mathematics due to a lack of gender fit (Buck et al., 2002; Cheryan et al., 2009; Dasgupta & Stout, 2014). However, many participants shared that White women and non-Black women of color also projected this doubt of aptitude onto them. This doubt can be attributed to racial and ethnic identity contributing to these stereotypes.

Black women at USU in STEM class environments were traversing unique experiences due to their gender [and] racial identity. Hyde and associates (2008) and Smedings (2012) investigated how Black women in STEM environments experience stereotypes about academic abilities that White women are not experiencing because of Black women's unique experience with 'double trouble.' The Double Trouble phenomenon by Malcolm (1976) was coined as the price women of color in science must pay due to multiple marginalization. Ong et al. (2011) later applied this concept to contemporary experiences of women of color in STEM and argued for the need to disaggregate the experiences of women of color. This contention with stereotypes contributed to feelings of isolation, at times, negative self-concept, and a diminished sense of belonging in the STEM classroom space (Strayhorn, 2018). Further perpetuation of these negative experiences further contributed to adverse experiences for Black women undergraduates in STEM academic environments.

Culture of Competition

A competitive environment also encompassed the experiences of Black women undergraduate STEM students. A culture of competition existed endemically in their STEM course environments. This culture was apparent in courses where students with similar career interests and professional school goals felt inclined to insulate a competitive environment. The

idea that there were limited opportunities for students pursuing high-performance STEM careers such as medicine, dentistry, or other professional STEM tracks perpetuated this phenomenon (Glass et al., 2013). For the Black women represented in the study, this culture of competition, by their accounts, was accompanied by other elements of discrimination. As they already were underrepresented and dealing with being doubted of their abilities in a competitive environment further marginalized them.

Further, this culture of competition also was plagued by accusations of diversity quotas and affirmative action as the reason for these Black women's presence within these STEM environments. That being so, tokenism was a byproduct of the culture of competition as Black women were often meaninglessly esteemed by their peers because of their racial and gendered identities as perfunctory symbols, not because of their academic aptitudes. Kanter (1977) defined this phenomenon as a sociological concept leading to the meaningless representation of marginalized groups in spaces by being the "token" or "only."

In the STEM context, Fletcher and associates (2017) characterized tokenism in STEM as representative of hypervisibility with negative perceptions; however, this concept is still understudied in the STEM context. Participants such as Charlotte, Lily, and Sally Jane shared that the competitive nature of their peers made their experiences in their STEM class environment unpleasant. All three participants enrolled in different majors, had differing STEM professional interests, goals, and co-curricular engagement experiences, and still experienced this culture of competition.

Summary of In-Class Experiences

We can draw some conclusions from the negative in-class experiences of Black women undergraduate STEM majors at Upper State University. First, the pervasive underrepresentation

of Black women in STEM at USU parallels the overall lack of representation of Black women at PWIs. Moreover, the scarcity or absence of Black women in STEM classroom environments leads to isolation (Charleston et al., 2014b; McGee & Bentley, 2017; Fletcher et al., 2017, 2021). Next, Black women at USU contend with peers and sometimes faculty doubting their abilities, challenging their classroom and lab space contributions. These behaviors constitute stereotypes based on gender, race, and performance highlighted in the canon of literature on women of color and Black women in STEM (Dasgupta & Stout, 2014; Fletcher et al., 2017; Smeding, 2012). Lastly, a culture of competition in STEM classroom environments provokes tokenism and discrimination based on racial and gender identities (Fletcher et al., 2017; Glass et al., 2013).

As demonstrated in the literature and illustrated within this research study Black women in STEM majors cited isolating, emotion-provoking, and challenging classroom experiences highlighted in the subsequent section of this chapter. Moreover, the participants also discussed challenges with their academic environment related to supporting their educational goals and trajectories. Considering these experiences, they sought support elsewhere on campus, such as student organizations or research opportunities to enhance their knowledge related to their STEM goals. Many scholars posit that meaningful engagement with faculty, staff, and peers outside the classroom is advantageous to student sense of belonging (Bae et al., 2019; Gayles & Ampaw, 2011; Strayhorn, 2018). Substantiated by their recollections of engagement within their STEM co-curricular programs, participants felt a sense of community, support, and validation did not present within the classroom and course-related lab context. This phenomenon catalyzed their desire to remain engaged within communities that affirmed them instead of those that isolated and demeaned them.

Peer-Based Experiences

When examining the experiences of peer-based co-curricular STEM programs within this research study, three significant themes emerged: *"If I'm going to eat, we all gone": community*, *"Free to just be": comfort and validation*, and *"Never once doubted me": support and development*. Research posits that universities are making efforts to increase STEM degree attainment for students of color and women through targeted programmatic efforts (Morton & Parson, 2018). With support from the literature, I defined peer-based experiences within the scope of this study as professional development and other opportunities bound by the dynamics of individuals with similar statuses (Eisen, 2001). Within the bounds of this case study, these experiences were categorized by participation and engagement in student organizations, leadership programs, living-learning communities, and other peer-based STEM organizations. These particular programs were highlighted due to the frequent nature of peer interactions and peer lead initiatives.

The literature indicates that peer-based co-curricular STEM activities focus on students' social development. The participants in peer-based programs engaged in various roles and activities within their STEM co-curricular programs (see Table 1.4 in chapter three). Lily, Charlotte, and Sally Jane were leaders or peer mentors within their peer-based programs and organizations. Moreover, their active involvement in these programs positively influenced their collegiate experiences in the social and academic contexts (Baker, 2007, 2008; Budge, 2006; Shook & Keup, 2012; Spaniermann et al., 2013). These experiences speak to how Black women undergraduate STEM students engaged in STEM co-curricular programs focused explicitly on peer-focused experiences and found more affirmative experiences within these spaces.

The individual experiences of each participant were meaningful in the emergence of the themes for the dissertation study; moreover, examining how these programs functioned as programmatic bodies was the main objective of this inquiry. As previously discussed within the unit contextualization, peer-based experiences were examined as an embedded unit of analysis within the STEM support and enrichment context at a PWI in the Southeast to understand how co-curricular programs were concerted with students' academic experiences. Additionally, the aims and objectives of peer-based programs are historically different from research-aimed programs (the other unit of analysis). Since I have previously contextualized the classroom experiences of these women in both programmatic types, the following thematic findings will be discussed concerning the programmatic experiences shared within this research study.

Experiences with STEM Community Engagement and Counterspaces

When consistently plagued with isolation, tokenism, and underrepresentation in the classroom, the experience of counterspaces was salient within the context of peer-based programs. The culminating experience of the participants within these programs revealed a space in which they felt welcomed and united with their peers. Literature suggests that a sense of belonging, a critical element of collegiate experiences, is the feeling of connection and matter (Rosenberg & McCullough, 1981; Strayhorn, 2018). Moreover, Hill et al. (2010) cited that cultural changes to environments aid in increased feelings of belonging for women in STEM. Furthermore, a lack of belonging and community impedes women in STEM's desire to persist within STEM majors (Budge, 2006; Shook & Keup, 2012). However, the community established within the peer-based STEM co-curricular programs gave these women the desire to continue within their majors and pursue their future education and career goals.

Additionally, the community space insulated by these peer-based STEM co-curricular programs provided racial identity-based representation for the participants. Identity-based factors were not required for the scope of these programs within this study; however, the presence of identity-based peer-focused programs provided participants with a community representative of many of their salient social identities. For example, one of the programs within the peer-based unit was led by an entirely Black woman executive board and a Black faculty advisor. This element of the peer-based environments was vital, specifically for Black women. McGee and Bentley (2017), Lane (2016), and Fletcher et al. (2017) all posit that more culturally affirming spaces for Black women combat tokenism and isolation and address their unique needs based on their racialized and gendered identities. This study revealed Black women's need to represent communities to sustain their existence and success within STEM environments.

Within this study, the theme of the community also was related to collaboration. Participants found their classroom environments to be very isolated and individualistic. However, within the settings of their peer-focus STEM enrichment programs, they found that activities were very collaborative. For example, participants cite planning events for program participants through committee and community work. They also used the space to collaborate on understanding complex concepts related to classwork, negative interactions in class, and access to resources and opportunities. Peer-based programs, by nature, are designed to exemplify dynamics between peers and other university stakeholders and resources.

Feelings of Comfort and Validation

The feeling of having access to a safe environment was a factor that was influential on the student experience. As noted within the findings and previously in the literature, Black women in STEM contend with microaggression, stereotypes, and tokenism, specifically in

environments where they are one of few or the only. Several scholars note that for students of color in STEM-- especially Black women, their STEM and cultural identities are often inhibited within the classroom (Dortch & Patel, 2017; Lane, 2016; McGee & Bentley, 2017; and Strayhorn (2012). These contentious environments lead to stereotype threat and potential departure from the field (Perna et al., 2009). Access to comforting and affirming co-curricular peer-based environments within STEM is evidenced to enhance their student experience as a result of this research inquiry.

Namely, this study revealed experiences with emotional comfort and intellectual validation. Within this study, emotional comfort is defined by the ability to speak and act authentically, build relationships with peers, and feel more at ease and comfortable in the presence of their peers within their programs. These feelings refute and dismantle the stereotypes and stereotype threat Black women in STEM environments often face. Cadaret et al. (2017) discussed how stereotype threat directly impacted women's self-efficacy in the STEM context. However, participants within these peer-based environments could build genuine relationships with their peers as their authentic selves, similarly, as highlighted by Perna et al. (2009) related to Black women pursuing STEM at a single-gender HBCU. A positive environment and dismantling of stereotypes contribute to intellectual validation, characterized by feelings of affirmation of knowledge and academic contributions without feeling questioned or second-guessed by their peers. Nonetheless, within peer-based programs examined in this study, participants felt a sense of comfort and affirmation.

Regarding intellectual validation and emotional comfort, the notion of code-switching was mentioned. Code-switching is defined as the practice of switching linguistically depending on the social context or conversation setting (Nilep, 2006; Lin, 2013). However, Black women

are taxed with code-switching not only linguistically but in other ways in which they culturally present themselves. Code-switching is a defense mechanism, especially in the PWI STEM context (Lin, 2013). The notion of code-switching can also be related to stereotype threat for Black women. However, within their peer-based STEM co-curricular programs, participants in this study did not perceive the same risks and fear and felt safe to be themselves. As previously stated, Lily discussed this exact sentiment. She felt the need to code-switch and assimilate within the classroom, but that ceased when she interacted with people in her peer-based STEM co-curricular settings.

Environments of Support and Development

The culmination of community and validation insulated an environment of support and development for students within the peer-based STEM co-curricular and support programs. As a result, in unsupportive and chilly climates within STEM classroom environments seeking support elsewhere was warranted (Fletcher et al., 2017; Ong et al., 2018). The concept of support manifested in various forms ranging from mentorship, academic and professional development opportunities, and access to support staff members. These elements related to the holistic support of participants within these programs resulted in feelings of belonging as Black women in STEM enrichment environments in this context.

Mentorship was a key element in the experiences of Black women in undergraduate STEM participants in peer-based programs. Sally Jane was inspired to serve as a mentor in her peer-based programs because of the mentorship she received from upper-level students early on in her experience. As outlined in previous literature, mentors' shared identity positively impacts Black women's experiences in STEM (Charleston & Jackson, 2011; Fletcher et al., 2017; Smith, 2017). The opportunity to provide mentorship to students who shared her identities and

experiences was crucial to her desire to give the support she received. Moreover, peer mentorship is essential to peer-based student involvement (Maltby et al., 2016; Shook & Keup, 2012). Charlotte held a similar sentiment related to mentorship as to giving back. Even so, Charlotte was able to find mentorship of her own by connecting with Black women via Instagram groups who shared her professional goals. This further solidified the notion that Black women held specific needs within STEM academic and co-curricular spaces.

The expressed desire for more targeted support opportunities specifically for Black women was evident in the data and current literature. Even with access to support, the participants yearned for specialized attention targeted toward Black women, which aligns with McGee and Bentley's (2017) ideas about the unique experiences of Black women in STEM. Charlotte and Desiree both discussed having programs specifically designed to support Black women would enhance their experiences within their STEM peer programs. The participants were aware of how their experiences differed from Black men or other non-Black women of color.

Moreover, academic and professional development supported and enhanced students in these peer-based environments. Participants discussed how staff in their programs helped them secure internships to prepare them for their future careers. Additionally, Sally Jane and Desiree's internship experiences gave them tangible skills and insights for their future career goals. These experiences also gave them STEM support and development they were not getting in the classroom. This guidance and skill development aided in the sense of belonging. As denoted in previous literature [STEM], co-curricular programs gave a level of support they were not receiving in the classroom or from their academic advisors (Maltby et al., 2016). From the findings, peer-based STEM programs aided in this phenomenon.

Summary of Peer-Based Programs

Peer-based STEM co-curricular programs were a unit of analysis for this single embedded case study. When engaged in peer-based programming, Black women STEM majors had positive experiences with community, access to comfort and belonging, and support and development. Their experiences within these spaces constitute the value of peer-focused co-curricular programs where identity, community, and support are centered. The study speaks to key factors addressed in previous literature related to the experiences of Black women in STEM; however, this inquiry nuanced how peer-based programming in the co-curricular context enhanced their experiences as opposed to their academic experiences.

Research-Based Experiences

Within this research inquiry, in addition to peer-focused STEM co-curricular programs, research-based experiences were also examined as a unit of analysis of STEM support and enrichment programs. Research-based programs for the scope of this study are defined as initiatives that include hands-on systematic study of a topic or subject, usually under the direction of a faculty member or a formalized program (Kinkead, 2003). Research experiences at the undergraduate level are linked to successful outcomes for students within STEM disciplines. The benefits of participating in UREs include access to more academic resources, increased interest in graduate and professional school, high GPA and graduation rates (Barlow & Villarejo, 2004; Chang et al., 2008; Gasiewski et al., 2010; Hurtado et al., 2010). However, this current study posits that a number of other benefits, such as *community, validation, and support*, are achieved through participation in a research-focused STEM enrichment program. Further, for Black women, it significantly aids in a sense of belonging in activities adjacent to their academic disciplines.

Within the scope of this study, Black women undergraduate STEM majors were engaged in three specific research-based STEM co-curricular activities: undergraduate research experiences, [national and institutional] research programs, and research assistant roles. Like peer-based programming, these activities were vital elements of the student experience, considering undergraduate research-focused programming is foundational in positive academic outcomes for students in STEM (Carter et al., 2016). Existing research underscores that underrepresented students who engage in these structured research programs benefit from increased persistence in STEM disciplines, interest in graduate school, access to more academic resources, higher GPAs and completion rates (Barlow & Villarejo, 2004; Chang et al., 2008; Gasiewski et al., 2010; Hurtado et al., 2010). The participants in this study in research-based programs shared similarities related to their student experiences within the literature regarding co-curricular programs, such as high-grade point averages and interests in graduate and professional school. These engagement activities led to experiences that insulated community, validation, and support and development.

Experiences with Community in Research Environments

The participants described the communities that were present for participants in research-focused programs as diverse, welcoming communities. The participants felt a connection to the research supervisors, PIs, and other students in the lab environments. Furthermore, the participants felt they belonged to a community of scholars that shared their academic interests and goals. Additionally, the presence of diverse bodies in the space allowed participants to see the faculty with similar racial identities in their research-based STEM enrichment environments. Researchers contend that undergraduate research experiences constitute connection points to the

community of scholars within their respective fields, and the participants found this notion representative of their experiences (Bartlett, 2003).

When examining the findings of research-focused STEM enrichment programs, Black women found more of a sense of community within co-curricular research-based environments than in their course-related labs. In alignment with the literature, these experiences enhance the student experience for those with marginalized identities and are essential in cultivating a sense of community and belonging (Johnson, 2007; Strayhorn, 2012, 2018). Further, Adazunamee, a participant in a research program, also found community within her research environment. While she recognized the non-monolithic experience of Black students, she found more community within this co-curricular space than in her classroom spaces. Fletcher et al. (2017) and McGee and Bentley (2017) theorized how Black women find community in STEM spaces where their identities are shared, present, and not tokenized.

Emotional Comfort and Intellectual Validation

The notion of comfort and validation was salient for participants within the research-based co-curricular STEM experiences. As a result of the community established within research-based co-curricular programs, participants felt emotional comfort and intellectual validation. Moreover, intellectual validation contributed to feelings of belonging. Literature denotes that Black women contend with feeling invalidated by faculty and peers within STEM classroom settings (Davis et al., 2016). However, participants felt more intellectually validated and affirmed within the lab environments in the research-based co-curricular context.

Namely, intellectual validation and emotional safety as critical elements in the experiences of Black in STEM co-curricular environments, are also protections from the stereotypes and tokenization often associated with STEM environments for Black women

(Alfred et al., 2019; Fletcher et al., 2017; Perry et al., 2012). Jay recalled experiences of sharing her expertise in the research program and feeling heard and validated. However, instead of being silenced, invalidated, and tokenized within her course-related labs. Other participants recounted similar experiences of feeling *safer* within their co-curricular research spaces. When contending with safety and comfort, the notion of physical safety is often at the forefront; however, for these women, their intellectual affirmation and emotional security were pervasively overtly and covertly threatened in classroom environments at their PWI but protected in the co-curricular spaces.

Academic Support and Professional Development

The notion of support and development as elements of the experiences of Black women undergraduate STEM majors in research-based STEM co-curricular programs contribute to favorable engagement experiences. Out-of-classroom experiences account for essential factors contributing to STEM student success (Bae et al., 2019; Gayles & Ampaw, 2011). As previously mentioned, support and development for students in STEM research-focused co-curricular programs, such as Jay and Adazunamee, developed their scientific skills within their programs. Support and development came from academic development and preparation for future aspirations.

Within these research-based environments, they were given access to the lives of Black graduate students and postdoctoral scholars, thereby strengthening their community of mentors and role models. Jay discussed her interactions with Maya, a graduate student in her lab. Jay and Maya shared some social identities and research interests, which helped cultivate a relationship of support for her. Several scholars posit that access to mentors and role models with shared identities in STEM environments provides affirmation and positively influences women in

STEM (Drury et al., 2011; Hermann et al., 2016; Smith, 2017). Furthermore, the support they received within their co-curricular lab-based experiences provided them with crucial skills that would aid in their development as they prepared for graduate and professional schools.

In terms of development, those within research-based programs were given access to academic and professional development opportunities such as tangible research skill development, the ability to present a research conference on campus, and preparation for graduate school. Adazumane was able to present at a research symposium through her participation in the co-curricular program. This opportunity developed her research skills and increased her confidence, which links back to intellectual validation. Many of these support and development mechanisms aids in increased retention and a sense of belonging for Black women in STEM (Kricorian et al., 2020). Compared to the development in the classroom setting, these research-focused co-curricular programs were enhancements to the student experience.

Summary of Research-Based Experiences

For Black women, undergraduate STEM students participating in research-based STEM co-curricular programs found these environments sufficient for access to community, intellectual validation, and support and development. Engagement and interactions in these programs were insulated by access to resources for academic and professional development, mentorship and role models, and feelings of belonging and validation. Furthermore, being in a community with those of shared identity and interests provided representation and invoked belonging for Black women.

Implications, Recommendations, and Directions for Future Research

As a result of this case study inquiry, I offer recommendations for policy, practice, and directions for future research related to Black women undergraduate STEM majors at PWIs. The

findings from this research have broad implications for practitioners, program stakeholders, academic advisors, and faculty. Further, there are a few to enhance research related to the overall experiences of Black women in undergraduate STEM majors in the curricular and co-curricular contexts. I intentionally reiterate the racial and gender identities of this study's participants as their experiences address a gap within the literature related to their co-curricular STEM experiences. Moreover, even though this research study revealed positive outcomes for Black women undergraduate STEM majors in peer and research-focused programs at a predominately White institution in the Southeast, it is vital to consider intentional and sustainable ways to support marginalized populations within the STEM context.

Recommendations for Policy and Practice

As a result of this research study, it is vital to understand how to cater to and enhance the unique needs of Black women in STEM co-curricular programs for many reasons through policy and practice. Black women in STEM majors desire a sense of community to exist and authentically work in collaboration with their peers. The experiences addressed within the scope of this study reveal that representation based on racial and gender identity positively impacted the experiences of Black women within STEM co-curricular programs. As a result, targeted recruitment of Black women within these programs is vital. The university could partner with school districts, pre-college programs, and organizations in the state with higher populations of underrepresented students to garner more interest in STEM disciplines.

Furthermore, workshops, panels, and mentorship opportunities specifically targeted to Black women in STEM will enhance their experiences. Adequate representation also decreases the potential of isolation and tokenism based on racial and gender identity, which can lead to departure from STEM disciplines. McGee and Bentley (2017) discuss the unique experiences of

Black women within the STEM context and how targeted efforts to engage their racialized and gendered experiences result in the most favorable outcomes for their success within STEM.

Secondly, the intentional structuring of representative community spaces is imperative to enhancing the experience of Black women in STEM co-curricular environments. Rainey et al. (2018) discuss the implications disproportionate underrepresentation of women in STEM environments impacts on their ability to feel as if they belong. In this study, participants were engaged in STEM-based student organizations targeted explicitly at Black students with similar academic or career interests. As mentioned, one of these organizations had an exclusively Black woman executive board and a Black woman faculty advisor. Maintaining community and representation for Black women within the STEM co-curricular context has influenced their desire to remain engaged within the environment. Another example, in this study's context, participants involved in research-based experiences felt a sense of belonging because of the identities of their PIs, peers, and the community insulated by their lab environments.

A shortcoming highlighted within this study has illuminated the need for policies that ensure bias-free interactions with students. Examining and developing the policies related to faculty and practitioner professional expectations and training for working with diverse student populations are warranted. Many of these interactions contribute to the negative experiences of Black women undergraduates in STEM. Furthermore, Upper State University and similar PWIs are responsible for upholding the mission and policies outlined by taking intentional action to increase the number of historically marginalized groups at the institutions.

Most STEM literature related to the experience of marginalized groups centered on classroom and industry experiences. This inquiry informs the co-curricular experiences of Black women in STEM majors. Students pursue co-curricular programs for various reasons, such as

seeking counterspaces from adverse environments and academic, professional, and social development. Finding practices to positively inform these environments are essential to student success.

Recommendations for Faculty and Advisors

There is valuable insight to inform faculty and advisors on ways better to serve the needs of Black women in STEM majors. Participants were representative across various academic colleges and STEM majors; nonetheless, they all cited negative classroom experiences in which they felt invalidated by their peers specifically. In this regard, faculty should establish norms and guidelines related to respect and affirmation within their class environments. Though faculty cannot control the actions and words of their students, they can set a precedent that demeaning and invalidation of others will not be tolerated within their classroom environments. Diversity training and workshops can provide faculty with tools to become more equity-minded within their classroom spaces. Furthermore, more collaborative efforts between faculty and practitioners can create partnerships to aid in student experiences.

As previously mentioned, participants in this research study shared uncomfortable interactions with their academic advisors about their educational trajectories even though all the participants self-reported high-grade point averages and academic achievement. Moreover, academic advisors should recognize their implicit biases when interacting with all students. Coincidentally, the singular participant with a Black woman academic advisor did not recount these same negative advisor experiences. However, it is essential that all practitioners, such as academic advisors, remain abreast of the best practices related to the different student populations they are serving to accommodate their needs more adequately. For example, attending conferences for practitioners, workshops, or diversity training can aid their

professional development. Locally, within the university community at USU, there is a diversity in STEM symposium open to students, faculty, and staff to raise awareness about diversity topics in STEM and the importance of supporting people of color (University Website, n.d.).

Creating a Safe Space for Students

Having a safe and affirming learning environment is essential for student success. As these findings have denoted that Black women in STEM often do not feel a safe, validated, or included in the classroom space. STEM faculty have a responsibility to promote and sustain a safe learning environment for their students, especially those that are marginalized and underrepresented. These practices include navigating difficult dialogues between students in the classroom space; especially when microaggression and disagreeable conversation arise. Building and maintaining with relationships with student beyond transactional interactions.

Further as most of the professors are White men, this will give them an opportunity to use their privilege and position power to protect and support a marginalized group within their course environments. Importantly setting a positive example for White and non-Black students of color and modeling inclusion within the learning environments. As Black women are severely unrepresented and forsaken within the STEM classroom context the yielding of power and privilege to promote quality and safe classroom environments could enhance PWIs on systematic level. Establishing and upholding these relationships, practices, and environments will provide a sense of safety and comfort the for Black women students.

These policy and practical implications are a charge to practitioners and higher education administrators. The recommendations, as mentioned earlier, address how they can contribute to enhancing the experience of Black women undergraduate STEM majors participating in STEM co-curricular and support programs. Previous research also corroborates these recommendations

to serve marginalized students in STEM better by diminishing biases, providing equitable opportunities, and addressing the unique needs of underrepresented students.

Implications for Theory

Longstanding historical theory in Higher Education does not explicitly center or integrate the experiences of Black women. When reflecting on the theoretical constructs of intersectionality, it is possible to draw parallels to Black women's identities impacting how they can navigate STEM curricular and co-curricular spaces. Intersectionality was established and has been influential in adding context to Black women's experiences. Nonetheless, this dissertation study and previous studies further establish the continual need to center Black women within higher education theoretically. Multiple phenomena, including this case analysis, confirm that Black women, one of the most educated groups and prominent populations at degree-granting institutions, should be at the center of theory. Continuing to placate Black women and their experiences within the educational landscape is a disservice to rigorous and applicable theory.

Concerning sense of belonging, this study continues the discussion in existing research on how environmental factors, engagement experiences, and identity coincide with the feeling of belonging and mattering for students (Strayhorn, 2012, 2018). This study, however, further problematized how the sense of belonging of Black women in STEM is insulated by unique markers related to identity within the classroom and outside of the classroom. For example, the intersectional identities of their peers, mentors, and faculty members contributed to their sense of belonging within STEM co-curricular environments. Strayhorn's (2018) examination of sense of belonging of students of color in STEM unpacks how women and students of color have troubled experiences in STEM. Nonetheless, the current student extends further than two distinct

groups of marginalized populations in STEM and instead focuses on the intersectional experiences of Black women that foster a sense of belonging.

Directions for Future Research

The research study has three considerable implications for future research considerations. Firstly, centering the experience of Black Women STEM students outside the Women of Color and Black Student narrative. Understanding their unique experiences based on intersectional gendered, and racialized experiences is essential. Ong et al. (2018) and Hill et al. (2010) explored the experiences of women of color in STEM-related co-curricular programs; however, there are distinct differences in the experiences of Black women STEM students. As evidenced in the study, they found little connection points to other non-Black women of color in STEM enrichment programs on their campus. Markedly, one participant shared that she felt that the two non-Black women of color within their program would attempt to undermine her experiences in very public ways. Namely, this research study divulged how Black women recognize their existence in STEM environments distinctly differently from non-Black women of color and Black men.

Secondly, this study was conducted at a singular extensive Research I historically White institution in the southeast. Future research into other institutional types, such as smaller, private, and liberal arts institutions, may also be warranted to understand the experiences of Black women in undergraduate STEM majors in co-curricular STEM programs. Even though these institutions are small in population and are not as research-intensive or STEM-focused, Black women are still often underrepresented and may have similar experiences. Future studies can explore their experiences at these particular institutional types to provide credence to their experiences.

Next, the culture of competition that exists in STEM can also be a future examination from multiple perspectives. First, a culture of competition exists between Black women and other non-Black students of color. Participants in this inquiry expressed their belief that other racially marginalized students believe there are limited spots for "minority" students within these spaces. Future research to explore what perpetuates this ideology is warranted to begin to transform this culture.

Moreover, the notion of competition in STEM programs is compounded by the fact that many White students believe that many Black women are there due to fulfilling diversity quotas, not their academic achievements. Griffin (2006) explored the unique experiences of high-achieving Black STEM students. Gayles and Smith (forthcoming) explored these phenomena with high-achieving Black women students using community cultural wealth. This study revealed that this research area warrants continued examination, especially within the predominantly White university context.

Summary of Implications

This dissertation study's practical and theoretical implications will inform practitioners and scholars how they can continue enhancing Black women's experiences in higher education. In this study, results confirmed that centering the experiences of Black women within STEM curricular and co-curricular environments will help practitioners better serve this population to champion student success. Moreover, decreasing and eventually eliminating the culture of competition within STEM environments will provide a more insular space for students to work without the added pressure of stereotypes and disunity. Finally, continuing to center on Black women's higher education experiences, in theory, will warrant understanding existing phenomena inclusively and critically.

Conclusion

In conclusion, this dissertation study sought to understand the engagement and involvement experience of Black women in undergraduate STEM majors in STEM support and enrichment programs at a Predominately White campus in the Southeast. Furthermore, this inquiry examined the experiences of this study's population in peer-focused and research-focused STEM co-curricular programs. Conceptually, a Sense of Belonging and Intersectionality framed this study to explore the phenomenon of STEM co-curricular engagement experiences. The findings revealed that environments of community, comfort, validation, support, and development are imperative to the experiences of Black women STEM majors within their co-curricular programs. Finally, university policymaker, faculty, and student affairs administrators all bear responsible in creating and maintaining safe and engaging environments for Black women in STEM in the classroom and co-curricular spaces.

Finally, for Black women in STEM, I want you to remember, "You're still enough the way that you show up" (Adazumanee, 2022).

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APPENDICES

Appendix A: Recruitment Email

Greetings XXX,

I hope this message finds you well. My name is Chelsea Smith I am a doctoral candidate in the Higher Education Opportunity, Equity, Justice Program at NC State. I am currently soliciting participants for my study to investigate the experience of belonging for Black women STEM undergraduate programs in co-curricular programs related to their major.

Participation in the project would require two one-hour interviews to be conducted via zoom, a demographic survey, and a brief journal exercise. Total time for participation in this should not exceed four hours. Participation in this study is completely voluntary and you may withdraw participation and consent at any time.

If you are interested in participating, please complete this brief demographic survey (will link).

If you have any questions, please feel free to reach out as well. Thank you!

Best,

Chelsea T. Smith,

Ph.D. Candidate: Educational Leadership, Policy & Human Development

Higher Education Opportunity, Equity, and Justice

SREB Doctoral Scholar

North Carolina State University

ctsmi22@ncsu.edu

Appendix B: PROMOTIONAL FLYER

Investigating Belonging of Black Women Undergraduate STEM Students Participating in Co-Curricular Programs at a Predominately White Institution: A Case Study

The purpose of this study is to understand co-curricular experiences of Black Women Undergraduate STEM students

Participants will be asked to complete two individual interviews via Zoom that will last 45-60 mins and one reflective journal activity. Participants will receive \$20 Amazon e-gift cards. Demographic information will be collected prior the the interviews.

Participant Criteria:

- Must Identify as a Self-Identified Black/AfricanAmerican/Caribbean/African/Afro-Latinx
- Self-Identified Cis or Trans Woman
- Current STEM Major (Biology, Engineering, Textiles, etc)
- Current Participants in a STEM Co-Curricular Program
- Must be at least 18 years or older

Appendix C: DEMOGRAPHIC SURVEY

- Chosen Pseudonym (False Name)
- Declared STEM Major
- Self-identified racial/ethnic identity (e.g., Black, African American, Afro-Latinx, etc.)
- Self-identified gender identity (e.g., cisgender, Trans*, etc.)
 - Cis woman
 - Trans*
 - Gender Nonconforming/Non-Binary
 - Other_____
- Matriculation Year
- Current Classification (i.e., junior, senior, etc.)
 - First Year
 - Sophomore
 - Junior
 - Senior
 - Fifth Year
- Type of Program: peer-based or research-based (you may select more than one and must be related to STEM)
 - Peer-Based (programs with a social component, e.g., student organizations, learning village, etc.)
 - Research-Based (programs with a structured research component, i.e., URE)
- Name of STEM support/co-curricular program(s) in which you are currently participating in at Upper State University

Appendix D: INTERVIEW PROTOCOLS

Interview One Protocol and Theoretical Background

Question #	Interview Question	RQ	Theoretical Support
1	Tell me about yourself and your background a. High School experience b. Family c. Influence experiences/people	N/A	Rapport Building
2	How did you become interested in your major?	N/A	N/A
3	What has your experience been like being a Black woman [insert major] student at PWI?	1	Intersectionality
4	How did you become affiliated with your STEM support/enrichment program? Why did you want to join?	1	Sense of belonging
5	Tell me about your experience thus far in your STEM support/enrichment program? a. your peers b. staff/advisors/faculty c. triumphs/challenges	1 (a,b)	Sense of belonging of STEM students
6	Describe your engagement and participation in your STEM support/enrichment program	1	Sense of belonging of STEM students. Engagement and Involvement
7	What are some of your biggest obstacles as they relate to being a Black woman STEM major? (allude back to Q3 if necessary)	1	Intersectionality, Double Bind
8	Can you tell me a story of how being in [insert program] has helped or hindered your success as a Black woman STEM student	1	Sense of belonging
9	As we end...What did I not ask that you would like to share?	N/A	N/A

Interview Two Protocol

Question #	Interview Question	Connection to Research Question
1	Tell me about what you shared in your journals	1 (a,b)
2	What did you mean by _____?	1 (a,b)
3	What did you not share that you would like to share now?	1 (a,b)

Appendix E: JOURNAL PROMPTS

Using the following three guiding questions, please take the time to reflect on your experience within your co-curricular program. All answers will be kept confidential.

1. What do you enjoy about the initiatives/events/experiences put on by your STEM enrichment program?
2. What do you think could improve your experience in your STEM enrichment program?
3. Share how your STEM-enrichment program could support you as a Black woman in STEM.

Appendix F: FOLLOW-UP CORRESPONDENCE

Would you mind sharing this study opportunity with undergraduate Black women in STEM in your college for one of my classmates? Her goal is to collect data over the summer and defend her dissertation at the end of the fall semester.

Thank you in advance and I hope you both have a restful 3-day weekend!

Best,

Chelsea Smith


----- Forwarded message -----

From: **Chelsea Smith** <csmit22@ncsu.edu>

Date: Wed, May 11, 2022 at 2:38 PM

Subject: Seeking Participants for Dissertation: Black Women Undergraduate STEM Student

To:

...

Appendix G: Department of Homeland Security STEM List Snapshot

DHS STEM Designated Degree Program List

The U.S. Department of Homeland Security (DHS) STEM Designated Degree Program List is a complete list of fields of study that DHS considers to be science, technology, engineering or mathematics (STEM) fields of study for purposes of the 24-month STEM optional practical training extension described at 8 *CFR* 214.2(f). Under 8 *CFR* 214.2(f)(10)(ii)(C)(2), a STEM field of study is one “included in the Department of Education’s Classification of Instructional Programs taxonomy within the two-digit series containing engineering, biological sciences, mathematics, and physical sciences, or a related field. In general, related fields will include fields involving research, innovation, or development of new technologies using engineering, mathematics, computer science, or natural sciences (including physical, biological, and agricultural sciences).”

Accordingly, this list designates the following four primary CIP series at the 2-digit CIP code level: Engineering (14), Biological and Biomedical Sciences (26), Mathematics and Statistics (27) and Physical Sciences (40). Any new additions to those areas will automatically be included on this STEM Designated Degree Program List.

This list also includes CIPs from the following 18 related CIP series at the 6-digit CIP code level: Agriculture, Agriculture Operations and Related Sciences (01); Natural Resources Conservation (03); Architecture and Related Services (04); Communication, Journalism and Related Programs (09); Communications Technologies/Technicians and Support Services (10); Computer and Information Sciences and Support Services (11); Education (13); Engineering Technologies and Engineering-Related Fields (15); Military Science, Leadership and Operational Art (28); Military Technologies and Applied Sciences (29); Multi/Interdisciplinary Studies (30); Science Technologies/Technicians (41); Psychology (42); Homeland Security, Law Enforcement, Firefighting and Related Protective Services (43); Social Sciences (45); Transportation and Materials Moving (49); Health Professions and Related Programs (51); and Business, Management, Marketing and Related Support Services (52).

CIP Code Two-Digit Series	2020 CIP Code	CIP Code Title
01	01.0308	Agroecology and Sustainable Agriculture.
01	01.0901	Animal Sciences, General.