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Taking Up Space: A Phenomenological Study of the Shared Experiences of Black  
Women in STEM Graduate Programs at Predominantly White Institutions

A Dissertation

Submitted to the Graduate Faculty of the  
University of New Orleans  
in partial fulfillment of the  
requirements for the degree of

Doctor of Philosophy  
in  
Educational Administration  
Higher Education

by

Ebony Chontae Blackwell

B.S. Biological Sciences, 2008

M.S. Biological Sciences, 2012

December, 2020

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## **Dedication**

This dissertation is dedicated to my daughter, Charm Blackwell; my number one fan, my motivation for everything I do, and the person I have learned the most from. Charm, the light and energy you radiate is infectious. You're the best thing to ever happen to me. Before you were born, I would daydream about all of the possibilities for your personality; I wondered about all of the ways you could turn out. When it comes to your empathy, compassion, humor, and intelligence – you've already far exceeded my expectations. I hope the work I do shows you that you're capable of whatever you set your mind to. I'm excited to watch you navigate life. Thank you for always being the light I need to see the path.

I'd also like to dedicate this to my mother, Peggy Sue. The last fifteen years without you have been hard, and I'm sure the next fifteen will not be any easier. Nevertheless, thank you for being the best momma you could be. I love you, miss you, and love telling Charm stories about you. Last but not least, I'd like to dedicate this to my two sisters, Akeeshia "Keesh" Brown and Brianna "Nana" Simmons. Keesh, you were my first best friend; Nana, you will always be my big baby. I love you both.

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Thank you to my friends and family that have supported and cheered for me throughout this process. In particular, Erin Wheeler for being not just a best friend, but a role model, mentor, confidant, and committee member; Latrina Ray Raddler for being one of my biggest supporters for the last fifteen years; Jennifer "Ashley" Coleman Haley, Ashantae Groomes, Keandra Ratcliff, Loraine Madueno and Crew, Gessica "Leejay" McNair, and Whitney "Dougie" Douglas, for being the family I was able to choose; and Kevin McClain for supporting Charm and I throughout this process.

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## **Abstract**

In the U.S., marginalized populations are underrepresented in STEM. Specifically, there is a disparity in the number of Black women attaining STEM graduate degrees and entering the STEM workforce. The purpose of this qualitative, phenomenological study was to examine the essence of the shared experiences of Black women currently enrolled in STEM graduate programs at predominantly White institutions (PWIs), in order to increase retention of Black women through STEM graduate programs and into careers; as well as to use participant's experiences to expose any barriers they encountered related to their educational pursuits, and examine how they were able to navigate those barriers. Critical Race Feminism and Social Cognitive Theory were used as the guiding theoretical framework for this study. Due to the fact that Black women are typically marginalized or excluded in STEM, a critical feminist lens was used to ensure their voices were centered as the focal point of this study. While focusing on Black women in graduate programs, this study comprehensively explored the PK-16+ experiences of Black women and found that: 1) Black women in STEM benefit from opportunities to engage in positive undergraduate research experiences; 2) Black women benefit from opportunities to participate extracurricular activities that foster a sense of belonging and community; 3) Black women are often impacted by the quality of interactions with faculty and mentors, as well as the lack faculty and mentors that they share race and gender identities with; 4) and that there is a need for institutions to embrace a transformational change outlook that ensures STEM learning spaces are diverse, welcoming, inclusive, equitable, and supportive of Black women.

*Keywords:* Black women in STEM, intersectionality, STEM, STEM graduate programs, critical race feminism

## **Chapter 1**

### **Introduction**

In an era dominated by technology, nations all over the globe are contending to be leaders in innovation through advancements in Science, Technology, Engineering, and Mathematics (STEM) fields. Hossain and Robinson (2012) state, “most new developments that are making the world a better place to live in are from the contributions of STEM fields” (p. 442). Yet, the United States is falling short at supplying qualified STEM graduates to enter the workforce and is “largely dependent on foreign-born STEM workforce” (Hossain and Robinson, 2012, p. 442). Where countries such as China graduate 50% of their bachelor’s degree students in STEM fields, the United States (U.S.) graduates less than 16% (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). The lack of qualified STEM workers can be linked to various disconnects in the PK-16+ STEM education pipeline. According to Belser, Prescod, Daire, Dagley, and Young (2017), nearly half of the U.S. STEM undergraduates end up either changing their major or withdrawing from school. Other major disparities in STEM education are inadequate K-12 academic preparation, high attrition rates in higher education, poor student-faculty relationships, lack of research opportunities, and low representation of women and students of color (Espinosa, 2011; Gayles & Ampaw, 2014; Johnson, 2012; May & Chubin, 2003; McCoy, Luedke, & Winkle Wagner, 2017; Ong, Wright, Espinosa, & Orfield, 2011; Palmer, Maramba, & Dancy, 2011; Perna et al., 2008).

As an additional layer, minorities are considerably underrepresented in STEM education and the workforce. According to a 2017 report co-authored by the National Science Foundation (NSF) and the National Center for Science and Engineering Statistics (NCSES) on women, minorities, and persons with disabilities, even though Black people made up 12.3% of the

population, Black students were only earning 8.2% of STEM Bachelor's degrees, 6.7% of STEM Master's Degrees, and 3.6% of STEM Doctoral degrees. Additionally, according to the NSF report, only 7.4% of the STEM workforce was composed of Black people. This report shows that other minority groups such as Hispanics and American Indians experience similar under-representation. Traditionally, minority students face several academic obstacles, such as an inadequate academic background and exposure to STEM programming, that hinder their ability to develop strong academic foundations in STEM (Charleston, Adserias, Lang, & Jackson, 2014). It is reported that by the year 2050, minority populations, such as African Americans, Native Americans, Hispanics, and Asians, will make up 50% of the U.S. population (Palmer et al., 2011). This is a considerable portion of the population and the future workforce. If the U.S. is to meet the demand for qualified STEM workers, pathways for non-white students into these careers must be established and strengthened.

Even though women have higher college enrollment rates and earn more bachelor's degrees than men, when it comes to STEM, men tend to earn twice as many STEM degrees compared to women (Gayles & Ampaw, 2014). Recently, representation of women has increased in fields such as psychology, biological and agricultural science, and social sciences; however, women are still underrepresented in fields such as mathematics, computer science, and engineering (Gayles & Ampaw, 2014; Zeldin & Pajares, 2000). According to Charleston, George, Jackson, Berhanu, and Amechi (2014), while fifty percent or more of the bachelor's degrees awarded in fields such as psychology, biology, and social sciences are earned by women, men are earning 79% or more of degrees awarded in fields such as engineering, computing sciences, and physics. These rates are important as the U.S. Department of Labor predicts a need for an additional 1.6 million qualified workers with degrees in computer sciences, alone

(Charleston, George, Jackson, Berhanu, Amechi, 2014). Even still, minority women are considerably underrepresented in comparison to the representation of White females (Johnson, 2012). According to a 2006-2016 NSF report, while White women earned 27% of bachelor's degrees, 18% of master's degrees, and 18% of Doctoral degrees in STEM disciplines in 2016, Black women are merely earning 5%, 4%, and 2%, respectively. Similarly, Black women only made up approximately 2% of the STEM workforce (Charleston, Adserias, Lang, & Jackson, 2014).

When it comes to the presence of underrepresented minority groups in STEM degree programs and career fields, there is a great deal of literature that centers the significance of harnessing these populations in STEM as a means to meet the demand for qualified STEM workers. Additionally, the literature emphasizes the importance for the U.S. to improve STEM graduation rates for minority populations if the U.S. is to retain “global leadership in technology and innovation” (Hossain and Robinson, 2012, p. 443). Yet, it would be a great disservice to minority populations to not also focus on the power dynamics at play when it comes to historically inequitable education of Black and Brown people in the U.S. that directly contributes to the deficits at hand (Evans-Winters & Esposito, 2010; Ladson-Billings, 1998; Pace, 2004; Thelin, 2004). Expanding the diversity of the STEM pipeline is not simply a matter of persuading students to apply to STEM majors, though that is an important step. STEM majors need to be places where women of color are supported academically and socially, held to high expectations, and integrated into the daily life of the program. Black women face several barriers when it comes to pursuing STEM education including acts of racism and sexism, poor faculty interactions and relationships, and lack of enhanced academic opportunities (Ong et al., 2011).

There are racial and gender power dynamics at play when it comes to the education of Black women in America deeply rooted in both the history of K-12 and collegiate education systems (Ladson-Billings, 1998; Pace, 2004). It has been a historical battle to create equitable education opportunities for students of color. Evans-Winters and Esposito (2010) stated, “because of racism, sexism, and class oppression in the U.S., African American girls are in multiple jeopardy of race, class and gender exclusion in mainstream educational systems” (p. 13). As for higher education, Thelin (2012) points out that at the onset of higher education “black higher education was not preparing alumni for professions and fields associated with leadership and genuine power” (p. 102). Rather:

Segregated black institutes and colleges curricula offered preparation for skilled crafts and trades, all designed to make education for African Americans part of a plan for regional economic development within the confines of a conservative, racially segregated social and political structure...[with] less emphasis on bachelor’s degree programs in the arts and sciences, on preparation for the learned professions of law and medicine, or on training for future political leaders (Thelin, 2012, p. 102).

Much like higher education, STEM has traditionally been a White male dominated field (Carlone and Johnson, 2007). Due to the racial and gender discrimination that is deeply intertwined with higher education and STEM fields, such as the abrasive and dismissive climate of many STEM environments characterized by women being treated differently from men (Ong et al., 2011), it is important to keep these power dynamics at the center of discussion when exploring the importance of creating space for minority populations such as Black women in STEM degree programs and careers.

### **Problem Statement**



While there is research available examining the experiences of Black women in undergraduate programs, as well as what factors play a role in them deciding to pursue STEM degrees (Beasley & Fischer, 2012; Borum & Walker, 2012; Charleston et al., 2014; Espinosa, 2011; Ong et al., 2011; Palmer et al., 2011; Perna, Gasman, Gary, Lundy-Wagner, Drezner, 2010; Soldner et al., 2012), most of the research available discusses all women in STEM as a population without breaking the research down into the experiences of a single ethnic category. For example, Zeldin and Pajares (2000) attempted to understand what role Social Cognitive Theory and self-efficacy play in the career persistence of women with mathematical, scientific, and technological degrees. Rosenthal, London, Levy, and Label (2011) conducted a study that examined how women developed in STEM programs within a single-sex program, and Ramsey, Betz, and Sekaquaptewa (2013) conducted a two-tiered study that compared academic environments that were welcoming to women in STEM to traditional (non-welcoming) STEM environments in order to develop interventions for traditional environments. Research that clusters the experiences of all women together typically does not have adequate representation of minority women within their study. For example, Zeldin and Pajares (2000) conducted their study with 15 women: thirteen White, one Japanese American, and one Latin American; the lived experiences of Black women are completely excluded from this study.

Similarly, there is a great deal of research that explores the success that Historically Black Colleges and Universities (HBCUs) have had when it comes to graduation of minorities, including Black women in STEM (Charleston et al., 2014; Kendricks, Nedunuri, & Arment, 2013; Ong et al., 2011; Perna et al., 2008; Perna et al., 2010). In 2016, the Department of Education released a fact sheet that reported that even though HBCUs only make up three percent of colleges and universities, they awarded twenty-seven percent of STEM degrees to

Black students (Kendricks, Nedunuri, and Arment, 2013). In 2006, one-third of Black students who earned doctoral degrees in science and engineering received their bachelor's degree from an HBCU (Perna et al., 2010). However, HBCUs are an extremely small portion of higher education institutions available to students, with PWIs making up the vast majority of colleges and universities. There is a lack of research that explores the experiences of Black women pursuing STEM degrees at predominantly White institutions. Palmer, Maramba, and Dancy (2011) examined what factors influence retention of students of color that were enrolled in STEM disciplines at predominantly White institutions (PWIs). This study was able to identify three themes that supported student retention: peer group support, involvement in STEM related activities, and strong high school preparation. The research participants for this study included three Black men and three Southeast Asian women. Like other studies, this research lacks representation of the experiences of Black women. Because of these trends, and the large amount of research on HBCU success, it is relevant to examine the experiences of Black females at PWIs.

There is a gap in the literature when it comes to research that specifically sets out to understand the experiences of Black women pursuing STEM graduate degrees. Between 2006 and 2009, Ong et al. (2011) conducted a study that surveyed and summarized the empirical research available on the postsecondary and career experiences of all women of color in STEM to identify “factors that play significant roles in the persistence or loss of underrepresented minority women in STEM at the undergraduate and graduate levels” (p. 177). Of over 100 works in their study, only 40 of them focused on women of color in graduate school, and the studies only “occasionally focused on a single race/ethnicity” (Ong et al., 2011, p. 178). It is important to explore the experiences of Black women in STEM graduate programs because there is a clear

drop-off in the number of women graduating with advanced STEM degrees, both in comparison to the number of Black women graduating with STEM bachelor's degrees and the number of women enrolling in STEM graduate programs. For instance, according to the previously mentioned NSF report that explored STEM demographics in the U.S., while Black women are earning 5.1% of STEM bachelor's degrees, they are only earning 4.3% and 2.2% of STEM master's and doctoral degrees. This number is much lower than the 6.7% of Black women who are enrolling in STEM graduate degree programs. These numbers indicate that Black women are not persisting in STEM graduate programs.

It is evident that there is an underrepresentation of Black women in STEM education, even more so as degree level advances and within the workforce. It is important to understand why the already low portion of Black women in STEM gets even smaller as degree level advances. This potentially could also inform why there is a tremendously low representation of Black women in STEM careers, as many careers may require advanced degrees. A potential critical component of this is scientist identity development for Black women. The literature suggests that many Black women do not feel recognized as members of the STEM community (Carlone & Johnson, 2007; Ong et al. 2011). Carlone and Johnson (2007) posit that scientist identity development is largely influenced by recognition from other individuals in the scientific community, which is often white men due to the fact that STEM field are historically white male dominated. Further, there are a number of factors identified in the literature that play a role in the low number of Black women pursuing STEM degrees to include supposed lack of aspirations and intentions; low academic preparedness; intersectionality of race and gender; types of higher education institutions and their abrasive climates; and self-efficacy, which is an individual's personal beliefs in their own capabilities to be successful at a given task (Bandura, 1997; Bielby,

Posselt, Jaquette, & Bastedo, 2014; Charleston et al., 2014; Kendricks et al., 2013; Ong et al., 2011; Palmer et al., 2011; Perna et al., 2008 Soldner et al., 2012; Venezia & Jaeger, 2013; Zeldin & Pajares, 2000).

### **Statement of Purpose & Research Questions**

The purpose of this phenomenological study was to examine the essence of the shared experiences of Black women currently enrolled in STEM graduate programs at predominantly White institutions (PWIs). This study sought to expose how Black women were able to successfully navigate barriers they encountered related to their STEM educational pursuits, specifically exploring: (1) engagement with curriculum; (2) interactions with faculty, staff, and peers; involvement in extracurricular activities and research; and (4) the impacts of outside factors such as family and obligations. According to Verjee (2012), “universities are premised on the ideologies of whiteness, patriarchy, and classism as the dominate culture, which functions to colonize, marginalize, and silence racialized students, non-academic staff, and faculty” (p. 59). Because of this, institutions cannot place the burden on the shoulders of the students to find ways to navigate STEM education environments that have a trend of being racist, sexist, and exclusionary towards Black women. The lack of Black women in STEM education is a multidimensional issue that does not have a one size fits all solution. Different issues need to be addressed at all levels of education. Black women cannot be expected to navigate these issues all on their own.

Johnson (2012) discusses the idea of transformative practice, which “puts the responsibility of change on institutions and their agents rather than on students who hold relatively little power in the educational environment” (p. 344). According to Patton (2016), outside of HBCUs and minority serving institutions, 79% of college and university faculty,

including professors, endowed chairs, presidents, and trustees, are White men. Patton (2016) continues, “consumers of higher education can anticipate that little change will occur in the functioning of higher education given the stagnant nature of leadership, policies, racial climate, curriculum and culture, which are deeply rooted in Whiteness” (p.324). Patton (2016) further states that higher education curriculum “excludes diverse perspectives” which perpetuate learning through a “Eurocentric lens that aligns more with White people’s experiences...ensuring Whiteness remains embedded regardless of subject matter” (p. 320). Nevertheless, many institutions need gender and racial transformation of their STEM environments, and it is up to the dominant groups to initiate change (Johnson, 2012). Otherwise, Black women, and other minority groups, do not have the power to implement the changes that need to occur on the faculty and staff level; such as developing quality student-faculty interactions, creating opportunities for mentorship, providing students with research opportunities, and creating opportunities to build self-confidence (Johnson, 2012). It is important that institutions develop programming and create opportunities to help students navigate the obstacles they encounter, as well as work to remove these obstacles.

Gayles and Ampaw (2014) discuss the leaky pipeline metaphor. The leaky pipeline metaphor posits that leakages, or loss of students, occur throughout the education pathway tracing from secondary education, to postsecondary education, to graduate school, and ending at a career point. Leakages range from students with STEM aspirations not declaring a STEM major when they enter higher education to students switching to different majors to students earning STEM degrees but choosing to go into a different career field. The obstacles discussed in this paper can contribute greatly to these leakages, and if left unaddressed, students will continue to leak from the STEM pipeline. There are a number of reasons why Black women are choosing

to leave STEM such as low self-efficacy, poor interactions with STEM faculty, and conversations with poorly trained advisors which could result in encouragement to change majors (McCoy et al., 2017). Other students may merely need to know the right faculty member to partner with for research opportunities, but the student is unable to make a connection on her own. These are just examples of how important it is to address obstacles that Black women are facing in STEM education.

By not adequately developing Black women in STEM fields, a large source of human capital is being left undeveloped (Ong et al., 2011). Black women have their own unique perspectives and life experiences that will make contributions to the world's technological advances. As stated by Ong et al. (2011), their "unique backgrounds, cultural traditions, perspectives, and experiences could bring dramatically new approaches to scientific discovery and innovation" (p. 176). Their life experiences will revolutionize the way the world approaches medicine and develops technology. Research needs to closer examine what encourages Black women to pursue and persist in STEM. The following research questions were used to guide this study:

1. What are the shared experiences of Black women in STEM graduate programs at predominantly White institutions?
2. How does the intersectionality of race and gender affect the development of self-efficacy of Black women in STEM; in turn, how does self-efficacy affect scientist identity development of Black women in STEM fields?
3. How do Black women's experiences in STEM education impact their decisions to persist and/or pursue STEM careers?

### **Definition of Terms**

**Historically Black College and University (HBCU):** HBCUs refer to minority serving institutions of higher education where the dominate student population are Black and non-white students.

**Predominantly White Institution (PWI):** Predominantly White Institutions, or PWIs, refer to institutions of higher education (universities, colleges, community colleges) where the dominate student population are White.

**STEM:** refers to Science, Technology, Engineering and Mathematics academic disciplines and career fields.

**Black Women:** can be used interchangeably with African American. Refers to cis-gender, non-white, women whom identify as a Black or African American; can also be of mixed heritage.

**Minority:** refers to any population of non-white people of color.

**Scientist Identity:** refers to an individual's identification as a scientist once they are recognized as a science person by other meaningful people within the science community.

**Primary Investigator (PI):** refers to the primary researcher that serves as a lead in scientific laboratories.

## **Chapter 2**

### **Introduction**

There is a documented disparity of Black women pursuing and persisting in STEM graduate degree programs. Simultaneously, there is not a great deal of research available that hones in on the lived experiences of Black women within the STEM pipeline. In order to address this disparity and increase the number of Black women pursuing and persisting through STEM graduate degree programs, and into careers, the literature that does exist needs to be unpacked and used to determine the direction of future research and program development.

### **Literature Review**

The existing literature explores a number of factors that influence Black women's experiences in undergraduate STEM degree programs that also potentially impact their decisions on whether or not to pursue STEM graduate education. There is a gap in the literature when it comes to the experiences of Black women enrolled in graduate STEM degree programs. It is valuable to explore the experiences of these women in order to better understand the decline in Black women pursuing, persisting, and graduating from STEM graduate programs. For the purpose of this research, three major themes within the literature have been identified to further breakdown those factors: academic experiences, identity, and academic climate. These themes, and the factors that fall into them, will be discussed further in the following sections.

### **Academic Experiences**

Recent literature suggests that the lack of Black women in STEM degree programs and careers is not due to the lack of interest in pursuing STEM, Black women do aspire to attain a post-secondary education and to learn about the sciences (Charleston et al., 2014; Perna et al., 2008; Venezia & Jaeger, 2013). According to Ong et al. (2011), minority women are just as



likely as their white female counterparts to intend to declare a STEM major. Yet, these aspirations are not translating to attainment at rates comparable to their white counterparts.

As a whole, more women are enrolling and graduating from college than males (Bielby, Posselt, Jaquette, & Bastedo, 2014; Espinosa, 2011; Venezia & Jaeger, 2013; Zeldin & Pajares, 2000). According to the 2017 NSF report on Women, Minorities and Persons with Disabilities in Science and Engineering, 40.4% of undergraduate Black students had intentions on declaring a STEM major. Even though there is a high number of minority students that express interest in majoring in STEM prior to college, Beasley and Fischer (2012) reported that only 34% of African Americans actually declare a STEM major. Furthermore, as previously mentioned, Black students were only earning 8.2% of bachelor's degrees, 6.7% of master's Degrees, and 3.6% of Doctoral degrees in science and engineering fields in comparison to 56.3%, 36.7%, and 41.7% of their White counterparts. More specifically, 39.8% of Black female, undergraduate freshman intended to declare a science or engineering major; this average was higher than both the White female and overall female averages of 35.3% and 37.5%, respectively. Even though nearly 40% of Black women intended to major in STEM fields entering college, only 5.1% of Black women would go on to earn a science or engineering bachelor's degree in comparison to 26.7% of White women. These numbers highlight a considerable drop in the number of Black women that actually graduate with a STEM in comparison to those that intended to major in a STEM field. Additionally, their white female counterparts do not exhibit such a drastic drop from intention to declare to actual attainment. Taking this into consideration, it highlights that Black women must be experiencing STEM in a way that their White female counterparts are not. The following sections discuss the experiences of Black women when it comes to discrepancies in academic

preparedness, undergraduate research opportunities, and other academic enrichment opportunities.

**Academic preparedness.** The literature suggests that a lack of academic preparedness, early STEM exposure, and positive STEM experiences of Black female students while in K-12 schools hinders Black females from being successful in STEM degree completion; more so in technology and math related subjects (Charleston et al., 2014; Ong et al., 2011; Palmer et al., 2011; Perna et al., 2008; Soldner et al., 2012; Venezia & Jaeger, 2013). Traditionally, minority students tend to underperform their white counterparts in subjects such as math and sciences, on national assessments such as the SAT and ACT, and tend to take fewer Advanced Placement courses in high school (May & Chubin 2003; Reid & Moore, 2008; Venezia & Jaeger, 2013). According to a 2017 report by the National Center for Education Statistics (NCES), Black students underperformed their White counterparts in both the ACT and SAT. While Black students scored averages of 17.1 and 941 on the ACT and SAT, White students scored averages of 22.4 and 1118.

The obstacles Black women face prior to college potentially lend to the reasons there is a disparity of Black women that enter college majoring and persisting in STEM programs. Yet, while K-12 education experiences and preparation could help explain the low persistence of minority students in STEM undergraduate majors, it does not explain the tremendous gap that is present in attainment of STEM graduate degrees and transition into STEM career fields. As previously mentioned, Black women make up 6.7% of enrollment in STEM graduate programs; yet, Black women are only earning 4.3% and 2.2% of STEM master's and doctoral degrees. Research must turn to undergraduate and graduate school STEM experiences of Black women in

order to understand what factors potentially discourage them from furthering their education and careers in STEM.

**Undergraduate research opportunities.** The literature highlights the importance of undergraduate research opportunities for students, including Black women (McCoy et al., 2017; Ong et al., 2011). Research lab experience gives students opportunities to gain STEM experience, to participate in constructive mentorship relationships, to explore career options, and prepares students for STEM graduate school programs (McCoy et al., 2017; Ong et al., 2011). According to Palmer et al. (2011), research opportunities not only enhance understanding of STEM disciplines and create greater contact with faculty, but also “foster problem solving, technical and presentation skills, facilitate self-confidence, and provide greater insight and clarification of career goals” (p. 493). McCoy et al. (2017) shared the experience of a Black male student, Hermes, struggling to find a faculty member to conduct research with at a PWI. Several faculty members ignored Hermes’ attempt to work in their lab; the one faculty that did respond to his inquiries, merely told him it was a possibility “if he had room available” (p. 665). Even though this is the experience of a Black male, Black women can have similar experiences worth exploring.

In a study that explored the opportunities and support available to students attending HBCUs, Gasman and Nguyen (2014) highlighted the importance of opportunities for students to participate in undergraduate research. HBCUs such as Hampton University, Prairie View A & M University, Morehouse College, and Xavier University of Louisiana provide their students the opportunity to participate in STEM research days where faculty and students have the opportunity to both explore the research of others and share their research projects (Gasman and Nguyen, 2014). According to Gasman and Nguyen (2014), these opportunities “created a passion

for scholarship” and “built students skills, important relationships, and provided much needed income to support the costs of education” (p. 83). Not only were HBCUs providing their students with these opportunities, but they would also create partnerships with other research institutions with research programs that students could potentially participate in (Gasman and Nguyen, 2014). If Black women are to progress into STEM graduate programs, and eventually STEM careers, research experience is important. Institutions need to put intentional efforts into creating research opportunities for students, not leaving it solely up to students to search for faculty members that may or may not allow them in their lab.

**Enrichment opportunities.** Palmer et al. (2011) shared student’s desires to be involved in STEM-related extracurricular activities, such as: STEM student organizations, opportunities to be a teaching assistant, participating in STEM summer programs, and having the opportunity to interact with STEM professionals. According to students in the study, the hands on experiences gave students opportunities to reinforce their skill and encouraged them to persist; and student organizations kept them informed of opportunities available, created opportunities for leadership development, and increased awareness of the career options the students would not have otherwise known about (Palmer et al., 2011). According to Ong et al. (2011), extracurricular programs provide minorities with the opportunities to belong to supportive communities, potentially be surrounded by people that look like them, learn how to validate their identities and reject stereotypes and address microaggressions.

## **Identity**

Minority women are hit with what the literature calls the double bind (Charleston et al. 2014; Ong et al., 2011). The double bind refers to the obstacle’s minority women have to hurdle due to the intersection of sexism and racism in STEM programs and careers. Black women are

faced with fitting into multiple marginalized groups due to their gender and racial identities. The following sections discuss the experiences Black women have in STEM degree programs because of their racial and gender identities; how those experiences impact their self-efficacy and scientist identity development; and, lastly, how stereotype threat could interact with their racial and gender identities, potentially leading to the disparity of Black women in STEM graduate programs.

**Intersection of race and gender.** People are not made up of a singular identity; rather, individuals are made up of intersecting identities that influence their life experiences, and it is important for researchers to understand how an individual's life experiences are a result of their intersecting identities engaging with different environments (Crenshaw, 1991; Museus & Griffin, 2011). According to Museus and Griffin (2011), "an individual's sense of self can be based on many groups with which he or she identifies, and people can be defined simultaneously by their race, ethnicity, class, gender, sexuality, religion, and other aspects of their identities" (p. 7). For instance, Black women simultaneously exist within multiple, equally salient, oppressed racial and gender identities – being both Black and woman. Yet, those identities are seldom captured together to narrate how those identities coincide to influence the experiences of Black women (Crenshaw, 1991). In a study that explored the experiences of Black women Crenshaw (1991) stated, "the intersection of racism and sexism factors into Black women's lives in ways that cannot be captured wholly looking at the race or gender dimensions of those experiences separately" (p. 1244). Society often focuses on one identity or the other through feminist or antiracist efforts resulting in Black women's experiences being conflated with the experiences of all women or all people of color (Crenshaw, 1991; Wing, 2003; Charleston et al., 2011; Ong et al., 2011).

Conflating Black women's experiences with the experiences of people from different racial or gender backgrounds, such as White women or Black men, can be detrimental to organizations or institutions that are trying to develop programming or interventions to enhance the experiences of Black women. In a study that explored the experiences of minority women living in a battered women's shelter, Crenshaw (1991) found that many of the burdens women faced such as childcare, poverty, and lack of job skills were "largely the consequence of gender and class oppression" and are "compounded by racially discriminatory employment and housing practices women of color often face, as well as by the disproportionately high unemployment among people of color" (p.1246). As a result, any interventions provided by the battered women's shelter cannot be derived from the experiences of "women who do not share the same class or race backgrounds" who have not been exposed to the same life obstacles (Crenshaw, 1991, p. 1246).

According to Museus and Griffin (2011), the use of intersectionality frameworks is limited in higher education research, but given the diversity of people enrolled and employed in different types of higher education institutions, it is important to take into consideration how the intersection of various identities affect an individual's higher education experiences. By exploring intersectionality in higher education, research can highlight the vast diversity of people represented in higher education, the voices of marginalized groups, the ways in which inequality issues permeate higher education, and ways to avoid the continuous promotion of said inequities (Museus & Griffin, 2011).

According to Thomas et al. (2009), Black women "tend to encounter higher incidences of negative, race-based stereotypes, more frequent questioning of their credibility, knowledge, and authority, the socio-cultural expectation to advance the African American male while sacrificing

personal achievement and advancement, and a lack of institutional support” (p. 160). Science is known to be a white male dominated field. Because of this, women as a whole face a number of barriers when it comes to acceptance in this field. In addition to battling issues of sexism, Black women are also faced with potential racist acts and climates (Charleston et al., 2014; Ong et al., 2011; Soldner et al., 2012; Thomas et al., 2009). The literature contains experiences of Black women enrolled in STEM degree programs who often have to battle stereotypes and discrimination from primarily White male classmates and professors who question their academic abilities (Charleston et al., 2014). Thomas et al. (2009) referred to these experiences as the “concrete ceiling” effect (p. 159) because the combination of these experiences results in barriers that are hard to break through “without extreme pressure” (pp. 159-160). Unlike a transparent glass ceiling that can be shattered through, a concrete ceiling can potentially create feelings that obstacles are too great to overcome. Specifically examining the experiences of Black women can shed light on how the concrete ceiling effect impacts their persistence in STEM or influences their desire to leave the field.

In general, the experiences of Black women are often overshadowed due to assumptions that the experiences of Black women are the same as all women or all people of color (Evans-Winters & Esposito, 2010). For example, according to Evans-Winters and Esposito (2010), many feminists assume that the “gendered experiences of white women and women of color” are the same; similarly, the collective experiences of people of color are usually dominated by the experiences of men and assumed to be the same for women of color (p.19). Because Black women often encounter double the discrimination when it comes to their presence in STEM, it is important to isolate their experiences from that of White women as well as other people of color.

**Science identity.** Issues of sexism and racism bring rise to the issue of whether or not Black women feel like they belong in STEM disciplines. As previously mentioned, STEM is a White male dominated field, unwelcoming to women and minorities. Given this, it is reasonable for Black women to feel like they do not belong in this arena; which can make it hard for Black women to develop a science identity. Ong et al. (2011) discusses the importance of women of color to “feel recognized as legitimate members of the STEM community” (p. 182). According to Carlone and Johnson (2007), “identity is not simply what an individual says about her relationship to, abilities in, or aspirations, regarding science” rather science identity is achieved when “as a result of an individual’s competence and performance, she is recognized by meaningful others, people whose acceptance of her matters to her, as a science person” (p. 1192). This can be problematic due to the fact that the audience that many Black women seek recognition from and the “historical meanings of being a scientist” is associated with White males (Carlone and Johnson, 2007, p. 1207). Carlone and Johnson (2007) outline a three-dimension model of science identity. In this model, the three dimensions—Performance (skills), Recognition, and Competence (knowledge)—interact with one another in a venn diagram manner resulting in science identity. Independently, each dimension does not result in the development of science identity; rather, their collective interactions are what produces a science identity. Additionally, Recognition is further broken down into recognition from meaningful others and recognition of self as a science person (Carlone and Johnson, 2007).

**Self-efficacy.** Self-efficacy is mentioned frequently in the literature as playing a role in STEM achievement (Charleston et al., 2014; Gayles & Ampaw, 2014; Johnson, 2012; Zeldin & Pajares, 2000). Bandura (1997) defines perceived self-efficacy as an individual’s personal beliefs in their “capabilities to organize and execute the courses of action required to produce given



attainments” (p. 3). Self-efficacy is a central construct to Bandura’s Social Cognitive Theory (Bandura, 1986; Zeldin & Pajares, 2000) which postulates that human behaviors are influenced by various internal, cognitive, and environmental factors (Bandura, 1986). According to Thomas et al. (2009), “self-efficacy beliefs are considered to be the most significant determinants of human behavior and influence whether or not a given task is attempted or how much effort is expended” (p. 161). Four factors influence the development of self-efficacy: mastery experiences, vicarious experiences, verbal persuasions, and physical and emotional states (Bandura, 1971; Bandura, 1986; Bandura, 1997; Zeldin & Pajares, 2000). According to Bandura (1986), people are more likely to attempt a task they have confidence in their abilities to be successful at.

Therefore, there could be a potential link between self-efficacy and Black women’s decisions to pursue STEM graduate degrees. Racial and gender stereotypes, such as women are not good at math, can hinder a student’s self-confidence, which can contribute to feelings of not belonging in STEM fields (Johnson, 2012). The impact of low self-efficacy can help understand why students shy away from STEM majors as well as why they struggle to persist. Understanding how student’s confidence plays a role in their persistence could be important to informing program development that helps students navigate through their program and overcome obstacles that they encounter. The research suggests that students that have positive STEM experiences tend to have a higher perceived STEM self-efficacy (Charleston et al., 2014; Zeldin & Pajares, 2000).

Relationships with individuals such as peers, family, role models, and mentors can play a role in the development of perceived self-efficacy. These people influence the development of self-efficacy through vicarious experiences and verbal persuasions. Vicarious experiences are

experiences a student can gain through another individual, say a mentor or parent (Bandura, 1986; Bandura; 1995; Zeldin & Pajares, 2000). Vicarious experiences allow students to observe others performing tasks. Successful completion of a given task can positively translate as the student being able to also complete said task. Verbal persuasions result from direct feedback. For example, if a parent is consistently telling their child that they can be successful in mathematics, these positive affirmations can help build a student's mathematical self-efficacy. Self-efficacy is critical because if a student does not have confidence that they can be successful in STEM they are not likely to pursue STEM programs and careers (Zeldin and Pajares, 2000).

**Stereotype threat.** Research such as, but not limited to, Beasley and Fischer (2012), Quinn and Spencer (2001), and Fried and Good (2001) turn to stereotype threat to potentially explain issues such as low academic achievement and the disparity of women and African American students in STEM academic disciplines such as mathematics. Beasley and Fischer (2012) define stereotype threat as “the anxiety individuals from stigmatized groups have that their behavior might confirm—to others or even to themselves—the negative stereotypes imposed upon their group” (p. 429). Quinn and Spencer (2001) conducted a study that explored the affects stereotype threat had on the mathematical performance of women in comparison to their male counterparts. During this study, prior to taking a test, both men and women were told that previous test results had shown gendered differences. As a result of this messaging, the women underperformed the men, and a group of women that were not preconditioned with the gendered differences message performed equally to men on the same test. These outcomes led to the conclusion that the pressure women felt from knowing that women have underperformed in the past led to stress that influenced their low test performance (Quinn & Spencer, 2001).

Beasley and Fischer (2012) discuss stereotype threat as a potential explanation for high undergraduate attrition rates of women and minority STEM students; unpacking the idea that stereotype threat has the potential to create a mental anxiety for Black women that perpetuates the idea that they may live up to popular stereotypes such that Black students are not good at STEM or women are not good in math. This has the potential to explain why Black women disengage themselves from STEM programming by withdrawing from STEM coursework, changing their majors, or potentially never declaring a STEM major. In line with that, Quinn and Spencer's (2001) previously discussed study on the mathematical performance of women reported that women must "care about math and believe that they have the skills to do well...for stereotype threat to have an effect on their performance", and that "many women disassociate themselves from math at an early age" (p. 59). Therefore, if women do not care about their performance or have already lost interest in specific STEM subjects, stereotype threat would not be a plausible explanation for their absence in or departure from STEM degree programs. Fried and Good (2001) also discuss disidentification as an additional way stereotype threat undermines academic achievement. Disidentification is a coping mechanism students potentially use to disassociate themselves from subjects that they do not feel they can be successful in; rather, they identify with subjects that they believe they have the potential to excel in (Fried and Good, 2001).

### **Academic Climate**

The environment students are nurtured in can play a major role in how they develop academically. Historically Black Colleges and Universities (HBCUs) are known for developing minority students in STEM programs more effectively than Predominantly White Institutions (PWIs) (Charleston et al., 2014; Kendricks et al., 2013; Ong et al., 2011; Palmer et al., 2011; Perna et al., 2008). According to Reeder and Schmitt (2013), Black students that attend HBCUs

are noted to have “large gains in academic performance, favorable psychological growth and adjustments, and a strong awareness of cultural issues”; whereas Black students that attend PWIs experience “alienation, perceived hostility, racial discrimination, and lack of integration into the broader environment” (p. 29). Rasheem, Alleman, Mushonga, Anderson, and Vakalahi (2018) reported that Black women enrolled in doctoral programs encounter racism-based experiences such as: a deficit in ethnic-gender support systems, tokenism, low expectations, lack of role models and mentors, micro-aggressions, hostile environments, and a sense of isolations and otherness; all of which can contribute to “the unlikelihood of enrollment, retention and graduation” (p. 3). The following sections discuss what roles institutional climate and academic relationships play in helping or hindering the persistence of Black women in STEM graduate programs.

**Institutional type and campus climate.** As previously mentioned, between 2005 and 2008, more than twenty percent of STEM bachelor’s degrees awarded to Black students came from HBCUs; despite the fact that HBCUs only make up three percent of colleges and universities (Kendricks, Nedunuri, and Arment, 2013). In comparison to PWIs, HBCUs are often referred to as being more supporting and accepting of minority students, lack the stigma associated with the need for remedial coursework, and are better equipped to meet the needs of minority student populations with faculty and staff that have a high buy-in to student success (Charleston et al., 2014; Ong et al., 2011; Perna et al., 2008). Additionally, students who start their educational pursuits at HBCUs tend to struggle when they transition to graduate programs at PWIs (Charleston et al., 2014; Ong et al., 2011). These experiences could contribute to the lack of Black students (including women) furthering their education in STEM disciplines after completing their bachelor’s degrees.

According to Gasman and Nguyen (2014), when it comes to teaching in STEM disciplines, many colleges and universities use a “weeding out the weak” approach instead of strategies that could “effectively empower students of color to learn and excel in STEM fields” (p. 76). Some techniques that HBCUs employ to increase the success of their students are: multiple support offices across campus that work together to support students; inclusive curricula that ideally represent their classrooms; interactive, engaging classrooms with real world examples; available mentors and role models; and diverse faculty of color (Gasman & Nguyen, 2014). In a study that examined the characteristics of HBCUs, Gasman and Nguyen (2014) found that HBCUs fostered an environment that groomed their students for the next step – graduate school – and equipped their students with the tools they would need to “balance academics and social responsibilities in order to succeed in their STEM programs” (p. 81). This was even true for underperforming students, where faculty put intentional efforts into identifying struggling students to provide them with the necessary supports and help close any pre-existing gaps from inadequate k-12 academic preparation (Gasman and Nguyen, 2014).

Outcalt and Skewes-Cox (2002) introduce the theory of Reciprocal Engagement to evaluate the difference in achievement and satisfaction for Black students at HBCUs vs PWIs. Reciprocal engagement combines ideas of Alexander Astin’s 1985 theory of student involvement that associates student success with their level of campus involvement (which assumes students who are more involved, invest more energy, and become more engaged and successful at their higher education institution) and the work Bronfenbrenner (which emphasizes the symbiotic interaction between students and their campus environment). Reciprocal engagement highlights the significance of Astin and Bronfenbrenner ideas working together in unison by considering the “mutual nature of the student/campus relationship”, putting responsibility of student success

on the institution environment and not just the student's level of involvement (Outcalt & Skewes-Cox, 2002, p. 333). The theory of reciprocal engagement posits that students need to take steps to be involved in their campus environments, but that campuses must also “embrace their students in their diversity, particularity, and uniqueness” (Outcalt & Skewes-Cox, 2002, p. 334). The latter is something that HBCUs fair better at in comparison to their PWI counterparts where Black students are more likely to encounter racism and feelings of isolation and alienation (Outcalt & Skewes-Cox, 2002; Reeder & Schmitt, 2013). Outcalt & Skewes-Cox (2002) conducted a study comparing HBCUs to PWIs to determine if there was a correlation between student involvement and satisfaction. They found that students at HBCUs had higher level of academic involvement, with students participating in activities such as tutoring peers and turning homework in on time. PWIs had more students that sought out cultural supports such as cultural workshops, ethnic studies courses and cultural organizations; likely due to a less supportive environment than HBCUs (Outcalt & Skewes-Cox, 2002).

Reeder and Schmitt (2013) reported that students that attend HBCUs demonstrate higher levels of academic self-concept and intrinsic motivation, and that faculty encouragement plays a major role in motivation for students. McCoy et al. (2017) conducted a study to compare how minority student-faculty relationships differ at HBCUs in comparison to PWIs. While students at the HBCU reported receiving support in the form of professional opportunities (internships), career advice, and research experience, students at the PWIs reported poor relationships because faculty were hard to reach and uninterested in mentoring them. Additionally, students of color at the PWI shared experiences where faculty were uninterested in assisting students, advisors encouraged them to change their majors, and faculty were unresponsive at helping students find research opportunities. These types of relationships with faculty can have a major impact on

student's retention and future success. According to Lechuga (2011), relationships between faculty and graduate students "play an integral role in shaping a graduate students' research training, their professional identity, and career dedication in addition to providing socialization into academe" (p. 759). Rasheem et al. (2018) suggest that "mentorship is crucial for Black women in doctoral programs as a way to navigate stereotypes that often lead to mistreatment and misconceptions particularly in PWIs" (p. 4). One idea that could be impacting these faculty-student interactions is the fact that PWIs have a lack of faculty of color, in comparison to HBCUs, with only 1.7% of full-time STEM faculty being Black women (Gasman and Nguyen, 2014). The lack of racial and gender diversity among STEM faculty at PWIs can potentially perpetuate stereotyping and mindsets that Black students do not belong in STEM, as well as fails to provide students with role models and mentors that could provide students with experiences and strategies to overcome racism, sexism, and additional roadblocks that White faculty are not familiar with (Gasman and Nguyen, 2014).

**Adequate role models, mentors, and support.** For students to be able to navigate the obstacles they encounter, it is beneficial to have support systems in place, including access to role models and mentors that help them overcome barriers. Crawford and Smith (2005) suggest that the role of mentors is to "afford protégé[s] with the opportunities to learn and practice and to reward him or her so that acquired knowledge, performance, and motivation increase (p. 64). Unfortunately, faculty and staff, who typically are positioned to be potential role models and mentors, can often pose as an obstacle to students (McCoy et al., 2017). According to Rasheem et al. (2018), many faculty does not have the "multicultural competence" to serve as adequate mentors that students can rely on during their educational journeys (p. 4). Nevertheless, developing strong student-faculty relationships are important for helping students develop a

sense of belonging in the degree program, which is linked to a “greater likelihood of persisting” (Johnson, 2012, p. 337). Instead of receiving supportive interactions with faculty, female students are often treated as outsiders and do not receive the same benefits of faculty interactions as their male counterparts or credit for their capabilities and contributions. Additionally, women of color report experiencing acts of racism from faculty (Johnson, 2012).

Kendricks, Nedunuri, and Arment (2013) conducted a study at a HBCU to determine the impact a mentorship program had on student retention and graduation rates. 90% of the students that participated in this study stated mentorship had the most impact on their academic performance. According to McCoy et al. (2017), mentoring has been proven to “improve students’ transition to higher education, retention GPA, self-efficacy, graduate student training, career selection and socialization to academic and professional roles” (p. 658). Mentorship opportunities are more powerful when the student and mentor come from similar backgrounds, which is also a reason it is important for Black women students to have female role models and mentors available to them on campus (Gayles & Ampaw, 2014; Kendricks et al., 2013; McCoy et al., 2017). Positive student-faculty interactions are critical for undergraduate students with goals of pursuing a graduate degree, as faculty can provide students with research opportunities and career support (McCoy et al., 2017). Yet, mentorship relationships can be even more critical for Black women enrolled in graduate programs whom, according to (Rasheem, Alleman, Mushonga, Anderson, & Vakalahi, 2018), are in pivotal points of outlining their future research and making critical decisions about potential career paths to follow.

Furthermore, there is a lack of Black women faculty in higher education (Lechuga, 2011). This is problematic for the recruitment and retention of Black female students who typically prefer having mentor relationships with black female mentors (Patton, 2009). According to



Lechuga (2011), Black female graduate students report often feeling “ignored, invisible, and dismissed by their male faculty advisors (p. 760). Unfortunately, due to the low number of Black female faculty members in higher education, acting as a role model can be “time consuming...to serve as mentors to every African American woman that enters an academic program”, adds additional stresses to their responsibilities, and can potentially distract from their “scholarly productivity and career advancement (Patton, 2009, p. 513). According to Munford (1996), some Black women will turn to family and friends as a support network and potential mentors when they lack adequate academic role model representatives. As previously mentioned, role models are important to vicarious experiences that contribute to the development of self-efficacy. Therefore, it is important that Black women are being surrounded with some type of support network or mentorship opportunities to enhance their development with their STEM disciplines.

### **Deficit vs. Anti-Deficit Views**

As documented in the previous sections, much of the literature focuses on the shortcomings of students when addressing the deficit of Black women and other minority students in STEM. Predominantly, research attempts to address why there are so few minority students in STEM, why minority students are academically underprepared, why minority students earn lower grades than their White and Asian American counterparts, why minority students change to non-STEM majors, and why there are low number of minority students pursuing and graduating with STEM graduate degrees (Harper, 2010). According to Harper (2010), fewer researchers attempt to explore the experiences of minority students who are successful in their pursuits of STEM education. Yet, if research is to increase the success of students in STEM, research can greatly benefit from exploring the experiences of students that have been successful in STEM fields.

In a study that examined what role of faculty relationships played in the success of African American undergraduate students, Newman (2005) highlight the importance of anti-deficit perspectives and how detrimental deficit frames can be when exploring research on underrepresented minority students. Newman (2005) reported that deficit frames often place blame on the students or relate underperformance with expected outcomes due to their socioeconomic and education backgrounds. Instead of focusing the blame on the failure of the student, the literature suggests the focus should shift to academic institutions to explore what systemic practices are in place, such as racism and white privilege, that result in inequitable outcomes for minority students (Bensimon 2005; Newman, 2005). When it comes to the students, utilizing an anti-deficit framework to dive into the successful experiences of students such as how they were able to overcome obstacles; how they were able to successfully navigate relationships with faculty, staff, and peers; who supported their efforts; and what types of programming and interventions were helpful to them is more beneficial to developing transformative practices and programming than focusing on why students fail (Harper, 2010; Newman, 2005).

### **Theoretical Framework**

In many arenas of life, women find themselves at the bottom of the totem pole, women of color even more so. According to Wing (2003), women of color “have failed to be successfully integrated into the mainstream, much less the upper echelons, of American economic, political, social, or educational life” (p. 1). In order to address the disparity of Black women in science, technology, engineering, and mathematics (STEM) career fields, researchers must first understand what factors influence Black women to shy away from pursuing and persisting through STEM programs, going on to the next level of degree attainment, and eventually

entering the workforce. The low number of Black women earning undergraduate degrees in STEM is large in comparison to the number of Black women earning STEM graduate degrees and entering the STEM workforce (Ong, Wright, Espinosa, & Orfield, 2011). For this study, Critical Race Feminism and Albert Bandura's Social Cognitive Theory (1986) are used in conjunction to form the theoretical framework used to guide this research design which is aimed at understanding the experiences and decision making processes of Black women when it comes to pursuing and persisting through STEM graduate degree programs at predominantly White institutions.

### **Critical Race Feminism**

According to Patton (2009), a feminist framework “allows for a discourse that de-centers traditionally accepted White, male-dominated power structures and embraces a point of view that places African American women and their numerous experiences in the center” (p. 516).

Traditionally, the lived experiences of women of color, specifically Black women are often conflated with those of Black men or White women, perpetuating the ideal of a “monolithic” woman's experience or a one-size fits all Black experience (Evans-Winters & Esposito, 2010, p. 21). Critical race feminism (CRF) is an “embryonic effort” (Wing, 2003, p. 1) that intentionally focuses on the plights of women of color and is derived from the works of Critical Race Theory (CRT). Originally, CRT evolved to address the issues of law students of color (Evans-Winters & Esposito, 2010). According to Evans-Winters and Esposito (2010), CRT:

- (1) [Posits] that race and racism are central, endemic, permanent and fundamental in defining and explaining how U.S. society functions, (2) challenges dominant ideologies and claims of race neutrality, objectivity, meritocracy, color-blindness and equal opportunity, (3) is activists in nature and propagates a commitment to social justice, (4)

centers the experiences and voices of the marginalized and oppressed, and (5) is necessarily interdisciplinary in scope and function. (pp. 15-16)

According to Charleston et al. (2014), CRF was “inspired by the exclusion of racial and/or ethnic legal women scholars by their male peers [of color] and White feminist legal scholars” (p. 169). CRF was birthed to intentionally give voice to experiences of women of color due to the fact that many theories, such as CRT and other mainstream feminist theories, often focus on the experiences of men of color and White women (Wing, 2003). The CRF framework adheres to an anti-essentialist, or non-additive ideal, where “Black women are not White women plus color, or Black men plus gender” (Charleston et al., 2014, p. 169). In other words, CRF acknowledges the multiple identities of Black women – being black and woman – and acknowledges their resulting experiences.

The experiences of Black women are often categorized with the experiences of White women because they share a gender identity; similarly, the experiences of Black women are often categorized with those of Black men because they share a racial identity (Charleston et al., 2014; Evans-Winters & Esposito, 2010). This trend is evident in a great deal of the research available, where the experiences of Black women are assumed to be the same as the experiences of all women and all people of color (Ong et al., 2011); as well as studies that lack adequate representation of Black women in the research population. In a study done on the lived experiences of faculty women of color at predominantly White institutions, Turner, Gonzalez, and Wong (2011) stated, “women of color fit both racial/ethnic and gender categories, inhabit multiple social identities, experience multiple marginality, and their stories are often masked” in this instance by “‘faculty of color’ or ‘women’” (p. 200). Additionally, according to Ong et al. (2011), the current reality is that majority of programs “intended to serve women

disproportionality benefit White women, and programs intended to serve minorities mainly benefit minority males” (p. 176). Because of these types of trends, it is critical to incorporate theories such as CRF into research studies in order to situate the experiences of women of color as the focal point.

**Differentiation between CRT & CRF.** According to Evans-Winters & Esposito (2010), CRF is rooted in the previously mentioned five tenets of CRT, but expands in the following ways: 1. CRF claims that the experiences of women of color are different from the experiences of men of color and those of White women (anti-essentialist); 2. CRF highlights that women of color simultaneously face various forms of discrimination due to the intersection of race, gender, and class; and 3. CRF advocates for an anti-essentialist lens that acknowledges the multiple identities of women of color (i.e. Black and woman). While CRF is rooted in the same tenets as CRT, it is the “unapologetic examination of race, class, and gender” (Evans-Winters & Esposito, 2010, p. 19-21) that makes it essential to this research. Since this study seeks to explore the experiences of Black women in STEM, it is important to employ a framework that treats their experiences as unique. The following sections highlight the importance of an anti-essentialist lens and intersectionality and why each has to be taken into consideration in this study.

***Anti-essentialist.*** As previously discussed, CRF was borne from the lack of representation of women of color in theories such as CRT in addition to many mainstream feminist theories. CRT and feminist theories perpetuate gender and racial essentialism: the notion that there is one woman’s experience and that the experiences of people from the same racial or ethnic group are all the same (Wing, 2003; Evans-Winters & Esposito, 2011). CRF rejects most theories from the feminist movement because of the idea that it promotes an essential voice that “describes the reality of many White middle or upper-class women, while

masquerading as representing all women” (Wing, 2003, p. 7). Whereas CRF specifically highlights the lives of women of color whose experiences do not necessarily conform to the essentialist voice (Wing, 2003).

This anti-essentialist stance is important because it is the compounded experiences of being simultaneously Black and woman that make Black women’s experiences unique from White women or Black men. Patton (2009) noted that Black women do share experiences with Black men and White women, but they also have a unique experience because of their dual, intersecting identities. By using a CRF framework to specifically highlight the experiences of faculty women of color, Turner, Gonzalez, and Wong (2011) were able to “make visible the complicated discourses that women of color faculty negotiated with White faculty, discourses that normalized Whiteness as an invisible norm and standard”, and through focus groups, were able to create “a venue for faculty women of color to come together” (p. 209). Similarly, this study intends to utilize CRF as a framework with the objective to expose the experiences and interactions Black women encounter when pursuing a STEM education which requires Black women to navigate a White, male dominated field. Unpacking the unique experiences of Black women is essential if higher education institutions are going to make any strides at meeting their specific academic and programmatic needs instead of merely relying on programs that disproportionately serve White women or minority males.

***Intersection of race and gender.*** An anti-essentialist lens that takes Black women’s multiple identities into consideration is important to this research, which is often limited in higher education research (Museus & Griffin, 2011). For women of color, race and gender are not mutually exclusive factors. Rather, Black women have unique experiences that are derived from the intersection of being both Black and woman. According to Crenshaw (1991), “because

the intersectional experience is greater than the sum of racism and sexism, any analysis that does not take the intersectionality into account cannot sufficiently address the particular manner in which black women are subordinated” (p. 24). For this study, if we are to better understand why Black women do or do not persist within STEM programming, it is critical to employ a framework that elevates the unique experiences they encounter throughout their educational journeys. As mentioned in previous sections, much of the literature available either discusses the presence of women or minorities in STEM, as whole populations, and, in-turn, generalizes how those experiences speak for broad groups of people.

**CRF in education.** Researchers have been using CRT to explore education reform for the last few decades. Although, the predominate literature seems to be focused on legal scholars and K-12 education. Ladson-Billings (1998) used CRT to evaluate the inequities within K-12 education by exploring inequities in curriculum development, instruction, assessment, school funding, and desegregation. While there are a number of notable articles that discuss CRT in higher education, this does not make an effort to specifically hone in on the education experiences of Black girls and women, as highlighted in previous sections.

Due to the fact that CRF as a framework is still in its infancy (Wing, 2003), there is not an abundance of research available the utilizes it as a framework to explore the experiences of Black women pursuing STEM degrees. For example, Alexander-Floyd (2010) utilizes Critical Race Black Feminism but stays close to the legal roots of CRT and CRF and uses it as a framework to focus on “Black feminist legal theorists” (p. 810). Childers-McKee and Hytten (2015) point out that CRF is an “untapped resource in school reform”. In their work “Critical Race Feminism and the Complex Changes in Education Reform”, they use CRF to explore education reform with a focus on K-12 education and highlight “the importance of narratives,

storytelling, and counter-narratives to disrupting taken for granted and normative views about the world” (pg. 395). Additionally, there are a number of articles that explore the experiences of Black women faculty members such as Decuir-Gunby, Long-Mitchell, and Grant (2009) who use CRF to “explore the emotions associated with being underrepresented women professors of color in engineering” and Turner, Gonzalez, and Wong (2011) who explore experiences of Black women faculty members at predominantly White institutions – although, in this study, faculty were not necessarily from STEM disciplines. As for women pursuing STEM degrees, articles such as Charleston et al (2014) use CRF and Black feminist thought as the theoretical framework to explore the experiences of Black women “at various levels of academic status” (pg. 166) pursuing computing science degrees. The lack of exploring the experiences of Black women in STEM graduate programs using a lens such as CRF that elevates their experiences as the critical centerpiece, makes its usage essential to this study if we are to better understand the plights of Black women in STEM and disrupt the norm of a monolithic experience.

**Counter-storytelling.** According to Solorzano and Yosso (2002), “the ideology of racism creates, maintains, and justifies the use of a ‘master narrative’” and that ‘it is within the context of racism that ‘monovocal’ stories about the low educational achievement and attainment of students are told” (p. 27). Because of this, it is important that researchers break away from the stories of the majority to uplift the voices of those that exist in the margins of society. As previously mentioned, one cannot assume that the voice of a person that exists within the majority is representative of minority people of color who often have very different encounters with the world. Solorzano and Yosso (2002) define counter-storytelling as “a method of telling the stories of those people whose experiences are not often told (i.e. those on the margins of society” and state that it is a “tool for exposing, analyzing, and challenging the majoritarian



stories of racial privilege” (p. 32). This research sought to uplift the voice of Black women who often face racial and gender oppression in STEM environments to shed light of their lived experiences.

### **Social Cognitive Theory**

Social Cognitive Theory (SCT) attempts to explain human behavior. SCT utilizes a three-point model where “behavior, cognitive and other personal factors, and environmental events” all interact and affect each other to influence human behavior (Bandura, 1986, p. 18). At the heart of SCT is the idea of self-efficacy and the role it plays in influencing an individual’s behavior. Bandura (1997) defines perceived self-efficacy as the “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3), or more informally, how individuals perceive their ability to complete a task. There is an abundance of literature that discusses self-efficacy as a critical component to STEM achievement for women (Charleston et al., 2014; Gayles & Ampaw, 2014; Johnson, 2012; Zeldin & Pajares, 2000). Research also suggests that women with a higher self-efficacy tend to have better experiences in STEM (Charleston et al., 2014; Zeldin & Pajares, 2000). As related to the four tenets of self-efficacy outlined below, there are a number of opportunities for women in STEM to have experiences that can influence development of high self-efficacy including: personal academic and research experiences, observations of peers and mentors, and verbal interactions with influential people – all of which can impact how an individual develops stress management techniques and coping mechanisms.

Aligned with this theory, this study situates Black women’s decisions to persist in STEM as a human behavior that is potentially influenced by a number of factors that they encounter in their STEM academic environments, related to their learning experiences as well as their

interactions with peers, faculty, and mentors. This theory was used to guide exploration of the experiences of Black women in STEM graduate programs by exploring how their experiences impact their self-efficacy to in-turn determine if those experiences and their confidence impacts their ability to persist within their academic programs.

**Self-efficacy.** In the context of this study, how Black women perceive their ability to be successful in STEM could influence whether or not they persist to pursue a STEM graduate degree, and eventually careers in STEM. Bandura (1986 & 1971) outlines four tenets that have the power to influence self-efficacy development either positively or negatively: mastery experiences, vicarious experiences, verbal persuasions, and physiological state.

***Mastery experiences.*** Mastery experiences are identified as the most important source of self-efficacy. These are gained through first-hand experiences. For example, mastery experiences for black women in STEM could be experiences gained by participating in a STEM course. These first-hand experiences give individuals an opportunity enact their capabilities, and they can result in lessons of success or failure. Successful experiences would result in strengthening an individual's self-efficacy. Likewise, experiences that result in failures have the potential to weaken self-efficacy. Successes are important for strengthening self-efficacy, so that when failures do happen, they do not have an adverse effect on self-efficacy (Bandura, 1986).

***Vicarious experiences.*** Vicarious experiences are gained through observing other people complete a task. Black women can have vicarious STEM experiences by observing people around them who are involved in STEM, such as family members, teachers, or mentors. According to Bandura (1986), self-efficacy can be raised by observing people of similar identities; such as Black women having the opportunity to observe other Black women in STEM. Likewise, observing failures can result in the opposite effect.

*Verbal persuasions.* Verbal persuasions are types of “verbal messages and social encouragement” (Zeldin & Pajares, 2000, p. 217). The manner in which someone talks to an individual can affect their performance. Positive and encouraging talk can build self-efficacy, and negative talk can weaken it. When it comes to Black women in STEM, having a parent or teacher that positively talks to them, encouraging them to believe in the capabilities, can result in them having a stronger self-efficacy; negative talks can have the adverse effect.

*Physiological state.* This can be looked at as a person’s physical and emotional states, and how they handle adverse and stressful situations. People who handle adverse and stressful situations well tend to be more successful (Thomas et al., 2009). A study by Chemers, Hu, and Garcia (2001), found that students with higher self-efficacy, or confidence, were able to tackle stressful academic situations as challenges instead of threats. Therefore, Black women with a strong ability to handle adverse situations have the potential to be more successful because they can navigate obstacles they encounter (such as struggling with certain courses or navigating unwelcoming academic environments).

### **CRF, SCT, and Black Women in STEM**

Understanding the specific experiences of Black women is an important step in understanding what solutions are needed to increase their representation in STEM fields. The purpose of using CRF and SCT together is to provide this research with a lens that emphasizes how Black women’s unique experiences can affect the development of self-efficacy and their decisions such as whether or not to persist through STEM graduate programs and enter the workforce. Alone, SCT does not intentionally account for the specific experiences of Black women in STEM degree programs; and, as mentioned in previous sections, much of the pre-existing literature that utilizes SCT to examine the experiences of women in STEM

predominantly examines the experiences of White women. The four tenants of self-efficacy describe multiple ways the decision process can be influenced. This was beneficial to this study because the self-efficacy tenants served as benchmarks to understanding the lived experiences of the participants. Each tenant served as initial categories when examining the data collected in this study. Simultaneously, it was important to this study to let the participants share the experiences without forcing the data to fall into any preset category. Together, SCT and CRF informed data collection and assisted in developing questions that are tailored towards better understanding the specific experiences of Black women in STEM graduate programs at PWIs.

## **Chapter 3**

### **Methodology**

Research carves out a pathway for us to explore and better understand the world we live in (Van Manen, 1990). Conducting research allows us an opportunity to “always question the way we experience the world” (Van Manen, 1990, p. 5). Qualitative research provides researchers with a means to explore, interpret, and understand the meaning people ascribe to various problems, actions, or experiences (Creswell, 2014). According to Grbich (2013), “research tries to step back from knowledge claims developed through tenacity, intuition and authority, by carefully constructing a question and a study design in order to provide the best views of a particular issue so that conclusions can be derived from available evidence” (p. 4). Qualitative research is interdisciplinary and draws on various approaches, methods, and techniques such as, but not limited to, ethnography, phenomenology, narrative, and grounded theory studies (Denzin & Lincoln, 1994). Whereas quantitative research is “a traditional method of inquiry that includes hypothesis testing, gathering numerical data, and generalizing” (Litchman, 2013, p. 325), qualitative research places “emphasis on processes and meanings that are not measured, in terms of quantity, amount, intensity, or frequency” (Denzin & Lincoln, 1994, p. 4). This study employed phenomenological qualitative research methods in order to understand the shared lived experiences of Black women pursuing STEM graduate degrees at predominantly White institutions. The following sections outline and describe the researcher’s epistemology as well as phenomenological qualitative methodology and the research design utilized to build and analyze this study.

### **Critical Constructivism**

Everyone encounters the world differently which results in their own unique experiences that derive how they perceive and interpret the world. Researchers are guided by epistemological paradigms, which are theories of knowledge that outline their personal “worldviews of beliefs, values, and methods for collecting and interpreting data”, (Grbich, 2013, p. 5). This study put emphasis on the combination of two popular epistemologies, critical theory and constructivism. In this study, the two worked together to gain insight on the experiences of Black women enrolled in STEM graduate programs and predominantly White institutions.

### **Critical Theory**

Individuals that align with a critical worldview place emphasis on power imbalances, oppression, and social justice inequities (Grbich, 2013). Within a critical view, reality is “produced by particular exploitative social and political systems comprising competing interests where knowledge is controlled to serve those in power” (Grbich, 2013, p. 7). Within this worldview, it is important to identify those who are typically being exploited by those in power to highlight their unique experiences in order to transform society (Grbich, 2013). Aligned with this lens, this study specifically highlights the experiences of Black women who regularly experience double marginalization due to the intersection of race and gender. Both higher education and STEM have been historically dominated by White men. A critical epistemology emphasizes the importance of taking race, gender, and the resulting oppression and discrimination into consideration when exploring the unique experiences of Black women in STEM graduate programs at predominantly White institutions. Additionally, the use of Critical Race Feminism as a guiding framework for this study was aligned to this epistemological paradigm, emphasizing the importance of specifically focusing on the voices of Black women to share and understand their stories and experiences.

## **Constructivism**

This world view emphasizes multiple realities and the fact that people experience the world differently, resulting in their own unique experiences. A constructivist position posits that reality is influenced by social and societal interactions (Grbich, 2013). Within this worldview, the “mind is active in the construction of knowledge” (Denzin and Lincoln, 1994, p. 125). Additionally, the researcher and research participants work together to construct knowledge (Grbich, 2013). Constructivists “focus on exploration of the way people interpret and make sense of their experiences in the worlds in which they live” and how the details surrounding their experiences, including societal influences, impact the constructed understandings (Grbich, 2013, p. 7). How Black women interpret and make sense of their experiences of being simultaneously both Black and women enrolled in STEM graduate programs at predominantly White institutions was critical to this study. As a researcher, I promoted a collaborator experience between myself and the participants. The data that was collected from this study was not my story, the experiences belong to the participants. Therefore, emphasis on a constructivism lens allowed me to share what experiences Black women have encountered and what tactics they have utilized to combat obstacles and persist within STEM in order to understand how their reality is influenced and constructed by social and societal interactions.

## **Research Design**

This qualitative study utilized a phenomenological methodology in order to examine the essence of the shared, lived experiences of Black women in STEM graduate programs at predominantly White institutions. Moran (2002) describes phenomenology as, “a radical, anti-traditional style of philosophising, which emphasizes the attempt to get to the truth of matters, to describe phenomena” exactly how the phenomena presents itself to the experiencer” (p. 4).

Through in-depth exploration of the lived experiences of research participants, by way of strategies such as interviews and focus groups, researchers are able to gain insight to the meaning that lies within day-to-day experiences (Van Manen, 1990). Phenomenology has the ability to “offer us the possibility of plausible insights that brings us in more direct contact with the world”, rather than providing us with theories to explain or control the world (Van Manen, 1990, p. 9).

Within phenomenology, any experience we encounter are phenomena, even at the lowest levels such as “sleeping, working, loving, or hating” (Grbich, 2013, p. 93). Phenomenology seeks to study the “lifeworld – the world as we immediately experience it pre-reflectively rather than as we conceptualize, categorize, or reflect on it” (Van Manen, 1990, p. 9); phenomenology gives us a “fuller grasp of what it means to be in the world as a man, a woman, a child, taking into account the sociocultural and historical traditions that we have given meaning to” (Van Manen, 1990, p. 12). In this study, the lifeworld or phenomena that were explored was the shared experience of being a Black woman currently pursuing a STEM graduate degree at a PWI. The goal of this study was to create space for the participants to tell their stories of what they have encountered related to their educational pursuits and how they were able to reach their current level of degree attainment. Additionally, listening to and understanding their stories exposed what positive experiences they had that encouraged them to persist and helped develop their resiliency.

Phenomenological studies do not seek to confine the experiences of the research participants into a theory or pre-existing explanatory structure; rather, phenomenology outlines a means to understand how the world affects different individuals. The combination of phenomenological methods and specifically highlighting the experiences of Black women with a



critical race feminist lens afforded the opportunity to come to a deeper understanding of what the academic lifeworld of Black women in STEM graduate degree programs at PWIs is truly like.

### **Participant and Site Selection**

Purposeful sampling was utilized in order to find participants for this study. Purposeful sampling is used when “the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned” (Merriam & Tisdell, 2016, p. 96). The ideal participants are “information-rich” individuals which “one can learn a great deal about issues of central importance to the purpose of the inquiry” (Patton, 2015, p. 264).

Purposeful sampling was utilized because this study sought to intentionally seek out participants that could contribute rich description and the greatest amount of insight due to their experiences (Patton, 2015). Initial recruitment was done through the professional network of the researcher by asking colleagues to identify participants within their institutions or network. Additionally, snowball sampling was used as a purposeful sampling strategy. Snowball sampling is when research participants are asked for “additional relevant contacts...who would be good sources given the focus of inquiry” (Patton, 2015, p. 270). Snowball sampling was helpful to this study because it gave the participants opportunity to share other individuals they know going through the same experience. Purposeful sample was most ideal to this study in order to find participants that directly fit the essential participant characteristics and those that could share the most insight to the phenomenon being studied.

This study recruited nine research participants that are Black women, enrolled in at least their second semester of a STEM graduate program at a PWI. Creswell (2014) suggests phenomenological studies use three to ten participants for data collection. Patton (2015) stated, “in-depth information from a small number of people can be very valuable, especially if the

cases are information-rich (p. 311). Nine participants allowed this study to reach saturation; which is when no new insights are being withdrawn from the research participants (Creswell, 2014).

**Second year students.** This study sought to recruit participants in at least their second year of a STEM graduate program in hopes of maximizing the experiences a participant can share. The purpose of using this population is to work with students that have had the opportunity to build a wealth of experiences within their program. Students in their second year of their graduate program have already demonstrated persistence; therefore, they can potentially shed more light on how they have overcome any potential obstacles (in comparison to first semester graduate students). As needed, students in their second semester of their graduate program were utilized.

**Department of study.** This study sought to recruit participants from all STEM academic discipline. As previously mentioned, as a whole, women are earning fifty percent or more of the bachelor's degrees awarded in fields such as psychology, biology, and social sciences, while men are earning 79% or more of degrees awarded in fields such as engineering, computing sciences, and physics (Charleston et. al, 2014). Even though recruitment efforts were conducted in all STEM environments, including computer science, engineering, and mathematics, all nine participants were from either biological or geological science fields.

**Predominantly white institutions.** This study recruited participants from predominantly white institutions from various regions throughout the country. For the purpose of this study, participants that attended HBCUs for their graduate studies were excluded. The success rates of HBCUs graduating Black students in STEM is well documented within the literature (Charleston et al., 2014; Kendricks, Nedunuri, & Arment, 2013; Ong et al., 2011; Perna et al., 2008; Perna et

al., 2010). Because of this, the focus of this study was to better understand the experiences of students attending institutions that are predominantly White. In order to fill the gaps within the literature, it was beneficial to focus on the experiences of Black females at PWIs.

### **Gatekeepers**

Gaining access to specific groups of people and settings in order to conduct a study typically requires negotiations with gatekeepers (Patton, 2015). The degree of difficulty when it comes to gaining access to certain groups of people is dependent on the purpose of the study, controversial or sensitive issues involved in the study, and the potential for resistance to the study (Patton, 2015). For this study, gatekeepers were college and university faculty and staff members that had access to or were aware of the population of students relevant to this study. The researcher utilized different higher education professionals within her network in order to establish relationships with gatekeepers at key institutions.

### **Recruitment Strategy**

Reaching out to different STEM graduate programs at various institutions and establishing meetings and connections with gatekeepers was the primary means of gaining access to Black women in STEM graduate degree programs. Participation was solicited via emails (Appendix A) to various higher education professionals within the network of the researcher, also known as network sampling (Merriam and Tisdell, 2016). Participants were required to fill out a student demographic form (Appendix B) to collect information on their degree program; classification; professional aspirations; parental or guardian grade level, degree completion, and occupation; and how they racially identify to determine if they qualified for participation.

### **Researcher Identity**

It is important to highlight that the researcher identifies as a Black woman with both an undergraduate and graduate degree in STEM from two predominantly white institutions. During the time spent working on those degrees, the researcher had many life experiences that parallel those reviewed in the literature review such as a lack of role models involved in STEM programming or careers; discouraging interactions with her undergraduate advisor, whom did not provide relevant advice about persisting in STEM and focused strictly on structuring schedules; poor interactions with faculty within her graduate program that avoided her and suggested she didn't belong and wouldn't put the effort in to be successful in their courses; and a lack of extracurricular experiences that could have deepened her connection to STEM such as belonging to a lab and participating in research, joining STEM clubs, or other useful programming that could have prepared her for graduate school and a career in STEM.

Even though the researcher had many positive academic experiences, including opportunities for strong K-12 academic curriculum and STEM exploration, due to several obstacles and experiences during graduate school, she chose to not pursue a doctoral degree or career directly in STEM. Instead, her experiences molded her desire to work in academic affairs and academic support roles to help other students pursuing STEM degrees. The researcher currently holds a position as a staff member in an academic success role within the College of Biological Sciences at a major research institution. For a short period of time after receiving her master's degree, the researcher did serve as a STEM adjunct faculty member before transitioning into staff positions. Personal experiences may have influenced the research design, but steps such as bracketing and journaling were taken to capture researcher biases.

### **Ethical Considerations**

Denzin and Lincoln (1994) highlight the importance of taking “extreme care” when handling studies that involve human beings to “avoid any harm to them” (p. 372). Noted ethical considerations included: informed consent, the consent given by a research participant after they have been thoroughly informed of the study; right to privacy, which includes protecting the identity of the research participants; and protection from any kind of harm including physical and emotional (Denzin & Lincoln, 1994). It was critical for the researcher to avoid any covert or deceitful tactics, as well as be mindful of the degree of involvement she has with the group of participants (Denzin & Lincoln, 1994).

Additionally, researchers need to be aware of the effects the research can have on their participants. For instance, according to Van Manen (1990), the research can have positive or negative effects on the participants, on people who are interested in the work or who the research concerns, on institutions where the research is conducted, and on the researcher herself. As for the research participants, the research could have “lingering effects” that may lead to “new levels of self-awareness, possible changes in life-style, and shifting priorities of living”; on the other hand, the research could also leave the participants with “feelings of anger, disgust, defeat, intolerance, insensitivity, etc.” (Van Manen, 1990, pp. 162-163) if the research is conducted poorly. Given the issues of racist and sexist acts of oppression and discrimination that have been noted in the literature to take place in many STEM academic environments, there is the potential that recalling their experiences could cause emotional distress and discomfort during the process; it was ok if participants needed to pause to break or needed to end the interview. Additionally, each participant was given the opportunity to choose a pseudonym and their institutions were not be referred to by name, and all data was stored in locked files only accessible by the researcher.

### **Data Collection**

Qualitative research equips us with the resources to discover any deeper meaning in people's experiences and encounters with the world. According to Patton (2015), qualitative inquiry occurs alongside valuable method collection techniques such as qualitative interviewing. Interviewing affords researchers the opportunity to learn more about things we cannot observe such as thoughts, feelings, intentions, or behaviors that took place prior to observations (Patton, 2015). Interviewing grants us access to people's unique experiences and stories and allows us the ability to "enter into the other person's perspective" (Patton, 2015, p. 426). Denzin and Lincoln (1994) stated, "interviewing is one of the most common and most powerful ways we use to try to understand our fellow human beings" (p. 361). Gathering quality information about the research participant's experiences is directed dependent on the skill of the interviewer (Patton, 2015). According to Patton (2015), in addition to truly listening and hearing participants, quality research skills include:

Asking genuinely open-ended questions; being clear so that the person being interviewed understands what is being asked; asking follow-up questions and probing, as appropriate; for greater depth and detail; and making smooth transitions between sections of the interview or topics (p. 427).

### **Individual Interviews**

According to Van Manen (1990), the phenomenological interview serves two specific purposes: (1) it is used for exploring and gathering experiential narratives, and (2) it is used as a "conversational relations with a partner (interviewee) about the meaning of an experience" (p. 66). Van Manen (1990) cautions researchers from using unstructured interview methods that do not consider the specific interest of the research question. Therefore, one-on-one, semi-structured interviews, with pre-determined questions going in, were utilized in order to collect data on the

experiences of the research participants. According to Bernard (2006), semi-structured interviews adhere to a script or pre-set agenda and cover a list of topics. Semi-structured interviews are typically used when it is likely that there will only be a single opportunity to interview participants (Bernard, 2006). Ultimately, the goal of the interviews was to allow the discussion to ebb and flow on its own so each research participant could thoughtfully share her experiences. Yet, for the sake of staying on track, having uniformity between interviews, and having an idea of the topics to be explored, there was a list of general questions to guide each conversation (Appendix D). The questions acted as an outline for exploration and a checklist of topics to cover. Due to the wide geographical participant recruitment, interviews were conducted remotely via the web-based video conferencing platform, Zoom. Additionally, the interviews were audio recorded for further evaluation.

### **Focus Groups**

In addition to individual, one-on-one interviews, the participants were requested to participate in a focus group discussion. According to Merriam and Tisdell (2016), “a focus group is an interview on a topic with a group of people who have knowledge of the topic”, and due to the fact that the “data obtained from a focus group is socially constructed within the interaction of the group, a constructivist perspective underlies this data collection procedure” (p. 114). Similar to the one-on-one interviews, participants were able to virtually participate through Zoom technology. In order to protect participant’s identity, they were given the opportunity to log into the platform with a pseudonym or name configuration of their choice. Additionally, Zoom allows participants to only share video feed if they wish to. Participants were allowed to only share audio feed if they would like to keep their identity’s private from the other participants. The focus group served as a form of member checking and created opportunities to

for deeper exploration of ideas exposed in initial individual interviews. The group setting sparked ideas between the participants that they may not have thought of in their individual interview, but the goal was not to collect an abundance of new data. Therefore, questions for the focus group were derived from data collected from the individual interviews (Appendix E).

### **Interview Procedures**

In order for interviews and the focus group to take place, consent was required from all participants. Each participant was provided an interview consent form (Appendix C). The consent form outlined the purpose of the study, the confidentiality and safety measures, and all of the risks of participation. Each participant was interviewed with the same interview protocol (Appendix D). Each interview was recorded and saved to an encrypted flash drive, accessible only to the researcher.

### **Student Demographic Form**

Prior to each interview, participants were asked to fill out a student demographic form (Appendix B). The student demographic form included questions pertaining to the student's degree program; classification; professional aspirations; parental or guardian highest education level, degree completion, and occupation; and racial identity.

### **Phenomenological Reduction**

Throughout the research process, phenomenological reduction was utilized to bracket researcher biases and journaling to process thoughts and ideas. According to Ezzy (2002), journaling allows the researcher to reflect on their "understanding of the data" (p. 72). Some phenomenological methods promote the ideal of Epoche. Moustakas (1994) stated, "in the Epoche, the everyday understanding, judgments, and knowings are set aside, and phenomena are revisited, freshly, naively, in a wide open sense" (p. 33). In other words, the researcher must set



aside any prior judgements, biases or personal experiences to fully make room for the experiences of the research participants. Although, one may not be able to completely void their mind of their prior personal experiences, by journaling their experiences it allows the researcher to be aware of potential biases.

By bracketing out your experiences and worldviews, you are separating and examining your experiences to discover any potential ways that they could influence or bias the study; even if “some aspects of your experiences [are] highlighted by respondents” (Grbich, 2013p. 95).

According to Grbich (2013), the process of bracketing involves:

(1) identifying a phenomenon or object, (2) identifying a recent experience of your own of this phenomenon in terms of how it appeared to you taking certain features of this experience and developing variations on aspects of this bracketed experience and then deleting these from the object, and (3) continuing this process until you arrive at the essence or essential features of the object (p. 95).

As a result of bracketing, the researcher should be able to better “build up a picture over time in terms of merging patterns, relationships and interconnections” (Grbich, 2013, p. 95).

Additionally, as a woman, who identifies as Black, with both an undergraduate and graduate degree in STEM, it is important to set aside all personal biases that could potentially influence the how data is interpreted.

### **Data Analysis**

Although this section follows data collection, much of the literature suggests, and encourages, that data analysis happen concurrently with data collection (Creswell, 2014; Merriam & Tisdell, 2016). According to Creswell (2014), the intent of data analysis is to “make sense out of text and image data” (p. 195). Patton (2015) stated, “qualitative analysis transforms

data into findings” (p. 521). For this study, data analysis started during each interview and immediately after the initial interview in order to help drive further data collection (Merriam & Tisdell, 2016). During the interview, the researcher took notes on the participants statements and stories to be able to ask probing questions and outline similarities between participants to further explore after the interviews. Patton (2015) posits that, “the challenge of qualitative analysis lies in making sense of massive amounts of data” (p. 521). By taking the time to review the initial data such as interview transcriptions, the researcher is progressively tackling small chunks of data throughout the data collection process instead of all of data at the end, and also creates the opportunity to capture “reflections, tentative themes, hunches, ideas, and [additional] things to pursue” that could have been missed otherwise (Merriam & Tisdell, 2016, p. 196). For this study, by immediately reviewing the first interview transcript, additional questions presented that were worthy of follow up questions to the participants as well as ideas that were covered during the focus group.

During qualitative analysis the researcher has the opportunity to hone in on the most relevant information by identifying patterns and themes by “consolidating, reducing, and interpreting what people have said” in order to make meaning of the research participant’s experiences (Merriam & Tisdell, 2016, p. 202). As related to phenomenological studies, “analysis attends to ferreting out the essence or basic structure of a phenomenon” (Merriam & Tisdell, 2016, p. 227). Moustakas (1994) details a step-by-step method for phenomenological data analysis based off of modifications to Van Kaam’s methods of analysis that include: (1) listing and preliminary grouping, also known as horizontalization of relevant expressions; (2) reduction and elimination, to determine the invariant constituents; (3) clustering and thematizing the invariant constituents, or clustering related experiences into a thematic label; (4) final

identification of the invariant constituents and themes by checking constituents and themes against all participant transcripts, also known as validation; (5) construction of individual textural description of the experience for each participant; (6) construct individual structural description for each participant, which is the “underlying and precipitating factors that account for what is being experienced” (Merriam & Tisdell, 2016, p. 227); (7) construct textural-structural description that incorporates the invariant constituents and themes; and, lastly, (8) develop a composite description of the essences of the experiences for the collective research group (Moustakas, 1994, pp. 120-121). Additionally, in order to truly see the essence and create a structural description of the phenomenon, Moustakas (1994) suggests the use of imaginative variation, which is viewing the phenomenon from different perspectives or angles to get the whole picture.

### **Coding**

In order to sift through and make meaning out of collected data, the researcher utilized a three-phase coding process: open, axial, and selective coding (Ezzy, 2002; Merriam & Tisdell, 2016). This study utilized interviews as the primary source of data. Therefore, interview transcripts were reviewed using these coding techniques.

**Open coding.** The initial coding phase, open coding, connects to Moustakas’ (1994) first two analysis steps: preliminary grouping and reduction and elimination. During initial grouping, a process called horizontalization is used, which is “the process of laying out all the data for examination and treating the data as having equal weight” (Merriam & Tisdell, 2016, p. 27). During this process of coding, the researcher reviewed the initial data sets, such as interview transcripts, in order to record initial thoughts, notes, or comments, and to notate potentially relevant information. Typically, during open coding, notations are made in the margins of

transcripts by pulling out relevant words, quotes or notating comments (Merriam & Tisdell, 2016). For this study, the researcher recorded notes for each interview into an Excel spreadsheet.

**Axial coding.** Once a transcript was reviewed in its entirety, the researcher began axial coding to group the Excel notes into like categories. Each additional interview transcript was reviewed in the same manner, considering the existing codes and categories, while outlining any new codes that presented. Once all of the interviews were transcribed, the researcher reviewed all of the notes to group like experiences. These were eventually grouped into categories and themes as outlined in the following chapter. This process is connected to Moustakas' (1994) third step, clustering and thematizing invariant constituents. According to Merriam and Tisdell (2016), "categories are conceptual elements that 'cover' or span many individual examples or bits or units of the data you previously identified" in order to "capture some recurring pattern that cuts across your data" (pp. 206-207).

**Selective coding.** In the last phase, selective coding, "a core category, propositions, or hypothesis are developed" from the clustered categories; in other words, a theme is constructed to group like categories and recurring patterns within the data (Merriam and Tisdell, 2016; Moustakas, 1994). Aligned with Moustakas' (1994) fourth step, the final themes were validated against all participant's transcripts. In addition to textual and structural descriptions of each participant's description of their experiences, these themes were used in developing the composite description of the phenomenon at hand in this study.

### **Trustworthiness**

A key indicator of the quality and credibility of qualitative research is its trustworthiness (Patton, 2015). Trustworthiness is related to the researcher's ability to persuade her reader that

the topic and findings are worth paying attention to (Lincoln & Guba, 1985). Lincoln and Guba (2015) identified four questions every researcher should ask:

- (1) Truth Value: How can one establish confidence in the “truth of the findings of a particular inquiry for the subjects (respondents) with which and the context in which the inquiry was carried out?
- (2) Applicability: How can one determine the extent to which the findings of a particular inquiry have applicability in other contexts or with other subjects (respondents)?
- (3) Consistency: How can one determine whether the findings of an inquiry would be repeated if the inquiry were replicated with the same (or similar) subjects (respondents) in the same (or similar) context?
- (4) Neutrality: How can one establish the degree to which the findings of an inquiry are determined by the subjects (respondents) and conditions of the inquiry and not by the biases, motivations, interests, or perspectives of the inquirer? (p. 290)

These questions birthed the four factors of trustworthiness: (1) internal validity, (2) external validity, (3) reliability, and (4) neutrality (Lincoln & Guba, 1985). Constructivists have diverged from these traditional terms and now refer to these four factors as credibility, transferability, dependability, and confirmability (Patton, 2015).

### **Credibility**

Research credibility is dependent on alignment between participants’ views and the researcher’s data construction (Patton, 2015). Lincoln and Guba (1985) identify member checking as the “most crucial technique for establishing credibility” (p. 314). Member checking is the action of allowing participants the opportunity to review all data, interpretations, and conclusions to ensure they are aligned with their experiences and are a proper representation of

their realities (Lincoln & Guba, 1985). This study utilized member checking throughout the interview process and by allowing the participants the opportunity to review transcriptions. Each participant was sent their interview transcripts to review for accuracy. The participants that attended the focus group were also sent those transcripts for review. The participants were also sent the final dissertation document in its entirety. This provided the participants the opportunity to assess intentionality, correct errors, agree with correctness, and recall additional items they may have forgot to mention (Lincoln and Guba, 2015). Although, none of the participants followed up with any corrections, adjustments, or concerns.

### **Transferability**

Transferability deals with the ability to relate one study to a similar study. Patton (2015) states that it is the researcher's responsibility to provide readers with "sufficient information on the case studied such that readers could establish the degree of similarity between the case studied and the case to which findings might be transferred" (p. 685). Transferability is dependent on thick description of the topic (Lincoln & Guba, 1985). According to Lincoln and Guba (1985), it is up to the researcher to provide "the thick description necessary to enable someone interested in making a transfer to reach a conclusion about whether transfer can be contemplated as a possibility" (p. 316). Thick description, which is "rich and detailed" (Patton, 2015, p. 534), has the ability to transport the reader to the setting or experience being shared by the research participants.

### **Dependability & Confirmability**

Dependability refers to the researcher's "responsibility for ensuring that the process was logical, traceable, and documented" (Patton, 2015, p. 685). Lincoln & Guba (1985) suggest an inquiry audit as a dependability technique. Within this technique, an auditor would authenticate

the inquiry process and the end products – data, findings, interpretations, and recommendations— for accuracy (Lincoln & Guba, 1985). According to Lincoln & Guba (1985), a single audit can inform both dependability and confirmability. The second step of analyzing the product establishes confirmability.

Triangulation is an additional technique to establish confirmability. As data is interpreted, it was returned to the research participants in order to evaluate the accuracy of the researcher's interpretations of the meaning behind their experiences (Ezzy, 2002). Usage of multiple perspectives and sources of data, known as data triangulation, increases the credibility of the researcher and the work (Denzin, 1978; Patton, 2015). Studies that utilize only one method of inquiry such as interviewing, observations, or document analysis, are more vulnerable than studies that use multiple methods and can be linked to errors such as loaded interview questions or biased responses (Patton, 2015). Therefore, in order to maximize the credibility of this study, one-on-one interviews and member checking were used to triangulate the data.

## Chapter 4

Black women are considerably underrepresented throughout both the STEM degree programs and within STEM career fields (Charleston et al., 2014; Gayles & Ampaw, 2014; Zeldin & Pajares, 2000). Furthermore, as the degree level increases and individuals transition into career fields, the representation of Black women significantly decreases (Charleston et al., 2014). This study sought to explore how Black women, currently enrolled in STEM graduate programs at predominantly white institutions (PWIs), have navigated their personal and academic experiences in order to persist and thrive within STEM fields. In order to better understand the experiences of Black women in STEM, the following research questions were used to guide this study:

1. What are the shared experiences of Black women in STEM graduate programs at predominantly white institutions?
2. How does the intersectionality of race and gender affect the development of self-efficacy of Black women in STEM; in turn, how does self-efficacy affect scientist identity development of Black women in STEM fields?
3. How do their experiences impact their decisions to persist and/or pursue STEM careers?

To answer these questions, one-on-one interviews and a focus group were conducted with nine research participants to get to the root of their experiences and the shared phenomenon of being Black women attempting to thrive in white male-dominated fields. A combination of Social Cognitive Theory and Critical Race Feminism were used together as the theoretical framework to provide a lens that emphasizes how Black women's unique experiences can affect the development of self-efficacy and their ability to persist through STEM graduate programs and enter the workforce.



The sections in this chapter will provide a brief description of each research participant as well as a detailed description and analysis of the themes that emerged from the data collected during the interviews and focus group. Nine Black, cis-gender women participated in one-on-one interviews, and five of those women also participated in the focus group. To protect their identities, each participant was offered the opportunity to pick a pseudonym that will be used to discuss their experiences in the remainder of this study. Their experiences are categorized into the following four themes: (1) Building Academic Foundations, (2) Surviving the Culture of Science, (3) Black Woman Scientist Identity Development, and (4) Impediments to Becoming a Black Woman Scientist.

### **Participants**

Nine participants were recruited, from various STEM graduate programs at PWIs across the country, to participate in one-on-one, semi-structured interviews and a focus group. All interviews were approximately 90-minutes and took place virtually via Zoom. The focus group consisted of five participants and lasted slightly over 60-minutes. All nine participants identify as Black or African American; although, on the demographic form, one participant stated that she does not identify by her race. All nine participants have earned a Bachelor's degree in a STEM field, eight in Biology and one in Geology; four participants earned a STEM Master's degree before going into either medical school or a Ph.D. program; three participants went straight into either medical school or a Ph.D. program after their Bachelor's degree; two participants took a break between undergraduate and graduate school to gain professional experience; and one participant has graduated with her Ph.D. and is currently starting a Post-Doc program. Additional details for each participant can be found in Table 4.1. The following section will briefly describe each participant.

**Tamala.** Tamala is a second year Biology Ph.D. student at a highly selective, private university in California. She earned both her Bachelor's in Molecular Biology and her master's from two separate public universities in California. Although Tamala is currently pursuing a Biology Ph.D. degree, she does not have a strong passion for STEM. Even though Tamala's high school highly encouraged students to aim high with their professional goals by encouraging them to study to be in roles such as doctors, lawyers, or scientist, when Tamala first enrolled at her undergraduate institution she wanted to start her college journey as an undeclared student; unfortunately, her college advisor required her to declare a major. Tamala chose her major by closing her eyes and pointing at a list of offered programs, landing her in Biology. Tamala is unsure about what she would like to do once she is done with her Ph.D. program.

**Zora.** Zora is a rising second year medical student at a private research university in New York. She earned her bachelor's degree in Biology from a private HBCU in southern Louisiana and her Master's in Human Nutrition from a highly selective, private university in New York. Zora has a passion for serving others and has known since she was young that she wanted to be a doctor. Her interest in healthcare was first peaked by her grandmother, who is a midwife. When Zora finishes medical school, she would like to be a physician that works with infants and children, and she would also like to work in the community providing public health programming.

**Cecelia.** Cecelia is a rising second year medical student at a public university in Louisiana. She earned her bachelor's degree in Biology from a private HBCU in southern Louisiana. Cecelia was exposed to healthcare at a young age through her mother, a pharmacist and her role model who was a physician. Cecelia has known she wanted to be a doctor since she

was in second grade. She has a passion for emergency care and would like to be an Emergency Medicine Physician when she finishes medical school.

**Mabelle.** Mabelle is a rising second year medical student at a public research university in Vermont. She earned her Bachelor's in Biology from a private university in Maryland. In-between undergraduate and medical school, Mabelle took time off to teach high school science, and she participated in a post-baccalaureate program to help prepare her for the MCAT and medical school. When Mabelle is done with medical school, she plans to be a physician.

**Matondo.** Matondo is a fourth year Environmental Science Ph.D. student at a public research university in California. She started her higher education journey at a California community college. Initially, Matondo considered majoring in Nursing, but her interest in microbiology developed after having an influential interaction with her microbiology teacher at her community college. Matondo went on to earn her bachelor's degree in Microbiology at a public research university in California. Matondo was born in Angola and moved to California as a young child. Within her culture, the oldest daughter serves as a sort of "second mom". While she does not have concrete career plans post-graduate school, she would like to find a well-paying job.

**Kezia Hunt.** Kezia Hunt is a rising fourth year Neuroscience Ph.D. student at a public research university in Virginia. Kezia Hunt earned her bachelor's and Master's in Biology from two separate public research universities in Virginia. Her interest in STEM developed during her last year of high school after she was able to shadow the parents of a friend who were both researchers. Once Kezia Hunt is done with her Ph.D. program, she would like to participate in a post-doctoral program that will prepare her to either work as medical science liaison or in a science policy government position.

**Kenyatta.** Kenyatta is a rising second year Molecular Cellular Biology Ph.D. student at a public research university in New York. Kenyatta earned her Bachelor's in Biology from a private liberal arts college in New York. Her interest in STEM started when she was young, watching animal planet with her father, and she always had a fascination with the outdoors and living things. When Kenyatta is done with her Ph.D. program, she would like to start a career in the biotech industry.

**hillrunnergeo.** hillrunnergeo is currently participating in a Geology post-doctoral program at a public research university in New York where she earned her Ph.D. in Geology. She earned her Bachelor's in Geology at a public research university in Nevada and her master's degree in Geology from a public research university in Wisconsin. Her interest in Geology first began after six years of bouncing around in various majors at her undergraduate institute; she knew she wanted to explore a future in Geology after taking a physical geography course. When hillrunnergeo finishes her post-doctoral program, she would like to become a tenure-track faculty member at her institution.

**Alice.** Alice is currently working on her Ph.D. in Population Biology at a public research university in California. She earned her bachelor's degree in Biology from a highly selective, private research university in New York. Alice's interest in STEM started at a young age when she would take field trips to the aquarium with her elementary school and when her mother would enroll her in summer campus that explored topics like ecology. After she finished her bachelor's degree, Alice took a couple years off from academics to work as a lab manager at a marine science institution. When Alice completes her Ph.D. program, she would like to step into a professor position at a research institution.

Table 4.1 *Participant's Demographics*

<b>Name</b>	<b>Undergraduate Degree</b>	<b>Graduate Degree Program(s)</b>	<b>Current Year in Program</b>	<b>Professional Aspirations</b>
Tamala	Molecular Biology	Master's in biology; Biology Ph.D.	2 <sup>nd</sup> yr. Ph.D. student	Not sure
Zora	Biology	Master's in Human Nutrition; Medical School	Rising 2 <sup>nd</sup> yr. medical student	Physician who works with children/infants/neonates in some capacity; Public health programming
Cecelia	Biology	Medical School	Rising 2 <sup>nd</sup> yr. Medical Student	Emergency Medicine Physician
Mabelle	Biology	Post-Bac; Medical School	Rising 2 <sup>nd</sup> yr. medical student	Physician
Matondo	Microbiology	Microbiology & Environmental Toxicology Ph.D.	4 <sup>th</sup> yr. Ph.D. student	Have a well-paying job
Kezia Hunt	Biology	Master's in Biology; Neuroscience Ph.D.	Rising 4 <sup>th</sup> yr. Ph.D. student	Industry / Government Science Liaison
Kenyatta	Biology	Molecular Cellular Biology Ph.D. Program	Rising second year Ph.D. student	Biotech industry
hillrunnergeo	Geology	Geology Master's and Ph.D.	Postdoctoral researcher	Tenure track faculty
Alice	Biology	Population Biology Ph.D.	Rising 6 <sup>th</sup> yr. Ph.D. student	Professor at a research institution

### **Findings**

This study centered the voices and experiences of Black women currently enrolled in STEM graduate programs at predominantly white institutions (PWI) in order to better understand how they have been able to successfully navigate their STEM experiences. Through one-on-one

interviews and a focus groups, the research participants were given the platform to reflect on and share their experiences spanning from their developmental K-12 years through their current graduate school experiences. The participants shared stories about how their interest in STEM developed over time, people who impacted their journey, influential extracurricular and experiential learning opportunities, and the feelings they experienced within their academic environments. Four primary themes emerged from the participants stories: (1) Building Academic Foundations, (2) Surviving the Culture of Science, (3) Black Woman Scientist Identity Development, and (4) Impediments to Becoming a Black Woman Scientist.

While each participant's experiences are valuable and unique, there was considerable overlap in the experiences that have impacted their progress, their sense of belonging, and their confidence. No matter how each participant reached where they are currently in their academic journey, or what obstacles they had to overcome, the motivation to persist remains in them all; albeit, the confidence of a couple of the participants has been deflated and is a consistent work in progress. They all attribute the value of being a Black woman in STEM to being much bigger than themselves, whether it be the opportunity to make family and mentors proud, the opportunity to provide a service to their community, or the ability to pay it forward by being the role model and mentor they all needed for another young Black girl in STEM. The following sections will unpack these experiences to highlight the necessity to provide a variety of experiential and exploratory learning opportunities throughout the Pk-16 pipeline in order to prepare Black girls and women for the rigor of STEM degree programs; the need to create places of belonging, inclusion, and mentorship for women in STEM; the need for safe places that nurture opportunities for identity development; and the need for resources that can help Black

women overcome various obstacles they may encounter such as financial hardships, mental health trauma, and personal and familial obligations.

Many of the experiences within the following themes closely align with one of the guiding theories for this study, Social Cognitive Theory. More specifically, the experiences often reinforce the four tenets that influence the development of self-efficacy: (1) Mastery Experiences, (2) Vicarious Experiences, (3) Verbal Persuasions, and (4) Physiological State. As previously outlined in this study, self-efficacy is defined as an individual's personal beliefs in their "capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). Many of the experiences shared by the women in this study outline several instances where their self-efficacy, or confidence, had the opportunity to be developed, reinforced and even damaged.

### **Building Academic Foundations**

This theme discusses the academic experiences Black women encountered throughout the PK-16+ pipeline, both positive and negative, that potentially impacted their ability to not just matriculate into a STEM collegiate program but to persist, thrive, and be successful within said program. The majority of the women in this study were all exposed to STEM opportunities at a young age through various outlets such as summer camps, science fairs, STEM curriculum in school, and even casual exploration such as visiting museums and aquariums with their families. For instance, Cecelia's mother was a pharmacist who exposed her to diabetes clinics at a young age; these clinics contributed to Cecelia wanting to pursue a future in medicine.

The participants shared their academic stories in life stages that first explored childhood and K-12 academic experiences, then undergraduate school experiences, and ended with their current graduate school experiences and future goals. Each level of their academic experiences is

like the stratification of sedimentary rocks, one layer on top of another, building the academic foundations that have the potential to help propel them into a STEM career. The categories explored within this theme are: (1) Early Childhood and K-12 Academic Experiences, (2) Undergraduate School Exploration and Experiences, and (3) Graduate School Experiences.

**Early childhood and K-12 academic experiences.** Whether it be through exploration of STEM through close relationships with family, role models, mentors, or influential teachers, through STEM curriculum or extracurricular opportunities, or through some innate curiosity to explore and learn, the life and academic experiences each participant had throughout their K-12 years seemed to help pique most participant's interest in a possible future in STEM or help prepare them for the rigor of a collegiate STEM program. From this study, there is not one universal experience that can be outlined to say that if young girls follow this exact path, they will go on to be a great contributor to a STEM field. Some of the participants went to private schools throughout their K-12 years; while other participants went to "really great" public schools, such as Tamala, who went to a rigorous high school, well-known for academic achievement, or Kenyatta who went to a magnet high school. No matter the type of schools the participants went to, the similar K-12 trends that displayed for the majority of the participants were related to influential teachers, role models, or mentors; opportunities for challenging curriculum, such as honors, advanced placement (AP), or international baccalaureate (IB) coursework; and extracurricular opportunities.

***Opportunities for challenging curriculum.*** All of the participants had the opportunities to participate in more challenging academic options such as honors, AP, and IB programs. Yet, each participant varied greatly with their willingness, confidence, and approach to taking these courses. All but one of the participants took at least one honors, AP, or IB course. Some



participants were pushed by their teachers to take AP courses and some participants personally set goals to take them. For instance, in middle school, Zora set a goal to graduate from high school as valedictorian. To achieve this goal, Zora was on the “accelerated path” in ninth and tenth grade and chose to participate in the IB program because she knew the grades would give her a higher GPA ranking. On the other hand, Tamala went to a high school that heavily emphasized academic success and had high expectations for all of their students to perform well and go on to college post-graduation. Because of this, she said that she “never considered no other alternative other than becoming a doctor, lawyer, scientist.” Even though Tamala did not discuss particularly influential teachers or enjoy learning, she does believe the academic preparation her school provided her with helped build the academic self-efficacy she would need going into her undergraduate education.

While some participants displayed an inherent drive to take every AP/IB option available to them, there were a couple of participants who were either uninterested in taking any AP courses or lacked the confidence to do so. For instance, Matondo had a teacher that tried to encourage her to take AP math her senior year, but she was strongly against it. On the other hand, Cecelia took various science courses throughout high school including a basic science her freshman year, honors biology her sophomore year, chemistry her junior year, and physics her senior year, but when it came to taking AP courses, she chose not to take AP biology because she truly believed she “wasn’t smart enough to do it.” While both participants have gone on to be successful thus far in their STEM journeys, they have taken two very different routes, and it is possible that their different approaches in high school are indicative of those journeys and their current take on their future goals. For instance, Cecelia has seemingly always been very clear on her goals to become a doctor and was able to hone in on the desire to be an emergency care

physician. On the other hand, Matondo has described herself as a “smart ass” in high school that was often “disorganized” and was uninterested in taking the more rigorous courses. Matondo’s interest in STEM did not develop until she took a Microbiology course at her community college, and she is still uncertain about what exactly she wants to do once she graduates.

***Role models, mentors, and influential teachers.*** When it came to having someone to look up to, the majority of participants were able to identify a positive relationship with some sort of role model, mentor, or influential teacher. These relationships are important to highlight for K-12 years because, for many participants, they were incredibly impactful for how and if the participants pursued higher education. For instance, even though Tamala vocalized a strong disinterest in school, learning, and developing relationships with her teachers, she discussed the role her sister’s godmother played in her life, saying:

She was a scientist. She is very smart. She’s very logical, analytical, and she’s just everything my mom really wasn’t...She really taught me how to think critically at an early age about all of the thoughts I was having. So, whereas I did rebel, I didn’t do anything crazy. No drugs or, I rebelled in like really benign ways. She really helped me channel my energy into things that could benefit me. Instead of like destroying me.

A relationship like this was important for Tamala who was often compared academically to her high achieving sister, resulting in her desire to rebel against school as well as her often finding herself as a “fixer in detention.” While the source of mentorship may vary for each participant, the one commonality amongst all participants was the level of care and investment they all referenced when they were discussing their role models and influential teachers.

Some participants also shared that their role models and teachers also helped them navigate stressful situations, which helped them form positive stress coping mechanisms in the

future. For instance, in third grade Kezia Hunt was spending weekends at the hospital with an aunt who spent a year in the hospital waiting for a heart transplant. As a result, her grades started slipping and her third-grade home room teacher “took note of it” and made an effort to check-in with her student. She shared that this helped her learn to handle “difficult events” and to be “cognizant” of different factors that stressed her. In addition to teaching her how to manage her stress, Kezia associates this experience as a potential reason for why she currently studies stress in her graduate program.

Additionally, multiple participants discussed the positive affirmations, or verbal persuasions, they would receive from influential teachers. Verbal persuasions refer to the “verbal messages and social encouragement” (Zeldin & Pajares, 2000, p. 217) individuals receive from other people that can both build-up and weaken their self-efficacy. Several participants reflected on positive words of encouragement that they received from their teachers telling them that they were smart and capable of achieving their goals and encouraging them to apply for their goal colleges. For instance, when it came to applying for college, Kenyatta’s teacher told her, “listen, you're capable and you're worthy to go to this school... you deserve to go there.” The participants shared that experiences like these would help them feel connected, seen, and important; these experiences helped the participants feel valued past their academic performance.

*Extracurricular opportunities.* In addition to academics, multiple participants discussed other ways they had the opportunity to get be engaged in activities and programming that helped mold them. Participants were involved in activities such as social justice initiatives and youth activism, sports, music and band, student council government, social clubs, theater, and different science internship style activities. Engagement in extracurricular activities not only gave the participants something to do but gave them another place to belong, an additional community to

turn to, and another influential adult that cared about them and their wellbeing. Alice also reflected on the importance of surrounding herself with like-minded peers saying, “[they] were also very driven and wanted to make good grades. So being around people who have like the same goals and aspirations really helped, you know, motivate me to continue to do well.” This reflection from Alice supports the self-efficacy tenet, vicarious experiences. Vicarious experiences are gained through observing other individuals, such as peers and mentors, complete a given task. Margolis and McCabe (2006) suggest that “observing friends model a task” can provide an individual with guidance on “how to do something” and can help “learners develop the internal imagery they need to conceptualize and implement targeted skills or learning strategies” (p. 219). This is aligned with Alice’s reflection about being engaged with in positive relationships with peers.

While most extracurricular experiences were non-academic related, two participants shared about influential opportunities to deepen their interest in STEM. In high school, Kezia Hunt had the opportunity to shadow a friend’s parents who were two researchers in top labs. She reflected on the experience saying, “Just seeing the lab dynamics was really interesting because it's, it's not someone sitting in a room staring at a microscope all day. It’s collaborative. It's a bunch of people talking, bouncing ideas off of each other.” This opportunity came at a time when Kezia Hunt was trying to figure out what she wanted to do with her life. Yet again, this highlights the importance for vicarious experiences, this time through observing people, that Kezia Hunt was closely connected to, in their professional habitat.

**Undergraduate school exploration and experiences.** This category explores the academic and experiential learning experiences each participant encountered within their STEM degree program at their undergraduate institution. While many of the participants were interested

in being doctors and scientists at a young age, for a couple of participants, their future in science was not solidified until their college years. It must be mentioned that not every participant has faith in their future in science, even currently at the graduate school level. While each participant had a plethora of undergraduate school experiences that helped them grow their knowledge, academic and technical abilities, and confidence, for some, their undergraduate school experiences and interactions slowly deflated and diminished their confidence.

Participants attended a wide variety of undergraduate schools ranging from private, religious institutions to public research institutions, and both historically Black universities as well as predominantly white institutions. The trends that that will be focused on in this category are specifically related to interactions with mentors and professional staff; classroom, research, and experiential learning opportunities; and involvement in extracurricular programming such as clubs, professional associations, and service projects. While the participants shared a great deal about their interactions with professors, many of those experiences will be shared in a later theme.

***Interactions with mentors and professional staff.*** The majority of women in this study were able to share many impactful experiences they had with mentors and professional staff at their undergraduate institution. There was a consistent trend for those mentors and staff members to either be a person of color or someone engaged in some sort of diversity, equity, and inclusion programming offered by the school, or both. For instance, Kezia Hunt's mentor was the only Black woman faculty member in her department. Her mentor played a critical role in helping her package herself for graduate school after she was told by a faculty member, that she worked closely with, that she was not a competitive graduate school candidate. Fortunately, her mentor came in and told her, "We're going to help you focus your (graduate school) application to

highlight your perseverance, your diligence, the work that you do, the skills that you've learned, so that you can go to graduate school.” Were it not for her mentor’s encouragement, Kezia Hunt might not have gone on to a master’s and eventually a Ph.D. program. This experience highlights the role a supportive mentor can play outside of the classroom.

Mentors, especially those that share a racial or gender identity with the participants were incredibly valuable for a number of reasons outlined by the participants during the focus group. The literature suggests that Black women students typically prefer having access to Black women mentors; unfortunately, access to Black women faculty in higher education, particularly in STEM disciplines, is extremely limited (Lechuga, 2011; Patton, 2009). Because of this, many of the participants shared that they primarily care about having any mentor that is genuinely interested in the wellbeing a success. The participants shared that having a mentor that they share some sort of identity with is valuable because it is more likely that the individual will understand their experiences. For instance, Zora was concerned about taking organic chemistry in her undergraduate program because of the stories she heard about it being a “weed-out” course. She reflected on the first time she met the organic chemistry professor:

I remember going to see the organic chemistry professor and everybody was talking about how organic chemistry is the make or break. If you don't do that, then you're not going to med school kind of thing...I thought it was a white woman, that's just my assumption. And when I got to that door and I saw this big chocolate lady, I sort of teared up because I was like, ‘What? I didn’t even know you existed here.’ And so, knowing that helped me to know this woman is an organic chemist, so I can pass organic chemistry, totally.

This experience highlights how the mere presence of Black women in STEM presents both as a comforting factor for Black women students and as an indicator that they also could have a future in STEM. Unfortunately, this level of representation is low for Black woman in STEM, which is why the participants indicated that it is important for participants to have anyone, no matter their race or gender, that is genuinely interested in supporting them.

The participants also shared about the critical role staff members played in helping them navigate campus, navigate relationships with faculty, navigate social development, and navigate being engaged in critical experiential learning opportunities. For example, Zora shared that she was able to create personal relationships with staff members and it important to her to have relationships that were about more than just academics. Zora shared that relationships with staff, such as her academic advisor, created space for her to be vulnerable which allowed her to be “stronger academically, emotionally, and professionally” even once she left her undergraduate institution. Being able to be vulnerable was important for the participants. It created a space where they are able to open up to people, share about their needs and experiences, and ensure that they feel comfortable asking for help.

***Research and experiential learning opportunities.*** Research lab experience and involvement in various extracurricular activities are critical to the development of students in STEM (McCoy et al., 2017; Ong et al., 2011; Palmer et al., 2011). These experiences give students opportunities to further develop their academic knowledge, develop their scientific techniques, explore career interests, participate in mentorship relationships, and at the undergraduate level, research experience prepares students for the rigor of graduate level laboratory work. All of the women in this study shared that they participated in some level of undergraduate research, with both good and bad experiences. Unfortunately, multiple

participants had bad experiences with the Primary Researcher (PI) of their labs, the individual tasked with mentoring, teaching relevant skills and techniques, and guiding the research projects. For instance, Matondo shared that she had a very poor relationship with her research lab PI who was dismissive, uninterested in mentoring, and blatantly inappropriate towards students of color – such as making inappropriate jokes about students’ sexual lives. Because of the experience Matondo had in her lab and interacting with her PI, she shared that she did not gain experience in her lab that she needed in order to be successful entering her graduate program and lab. Matondo reflected saying, “I literally did the same thing for a year and a half, and I complained that I’m not learning anything, and he was just like, ‘we don’t have money for other projects.’” This experience deflated her confidence in her academic abilities while in her undergraduate program.

On the other hand, many of the participants shared about phenomenal research experiences. Various participants shared stories about being involved in “welcoming” labs with encouraging PIs that were fostered academic and technical skill development as well as invaluable assets when it came to their graduate school pursuits. Zora reflected on conducting undergraduate research abroad stating, “I had to learn like these lab techniques, I had to put what I learned in class into perspective. I had to be adaptable...I had to learn as much as I could during that short period of time.” For the women in this study, undergraduate research experience showed potential graduate schools that they had a “willingness to investigate”. According to Zora, these experiences helped build her resiliency because they also gave her something to tap into in the future when she needed to be reminded that she could do hard things.

***Extracurricular programs and opportunities.*** In addition to research, many of the participants were active in extracurricular activities, service programs, clubs, or associations. For instance, Mabelle was active in an extracurricular association called the Student National



Medical Association (SNMA), an organization geared towards supporting current and future medical students. Mabelle shared that this organization was incredibly important to her because of the representation of minority students. She reflected saying, “there's other people that are like me.” The participants shared that these opportunities gave them the change to “build community” and helped them realize they are not totally alone. Many of the participants participated in other minority serving organizations such as Black Student Union (BSU) and African Student Union. Organizations like this hold significant value to many of the participants because they can serve as a micro-community within their institutions where they are able to congregate and collaborate with people that they share cultural, racial, and gender identities with.

Multiple participants also shared about the value of serving as tutors. Reflecting on her tutoring experience, Matondo shared:

That’s probably the best thing I did in undergrad cause I got to work with students that were...a lot of them were in similar situations that I was, and a lot of them had been working for as long as I had been working or even longer. They had really extenuating family circumstances. They were all really real and honest and kind kids and they were just trying to figure out what their place was in the world and what they were good at.

The mentorship aspect of this tutoring experience was extremely important to Matondo because of the similarities she saw in herself and the students she worked with. Beyond the academic support that she provided the students, she was also able to help them navigate personal issues such as needing to take care of parents and siblings and how to balance working and school, both of which Matondo had to do herself.

Additionally, service projects were important to many of the participants because it provided them a way to give back to others. Both Cecelia and Zora attended a historically Black

university that has service engrained in their mission. Cecelia was able to help organize a service trip to Honduras her junior year of undergrad. She shared saying, “I fundraised the whole thing, so that was a really time-consuming thing, but also very influential.” She also said that the trip fueled her desire to do more service within the country. When both Cecelia and Zora talked about their identities in science, they both said that they do not see themselves as a scientist, they see themselves as servants. These participants aligned the notion of a scientist with someone conducting research in a lab; whereas they saw themselves as servants to people in their community.

**Graduate school experiences.** This category explores the academic and experiential learning opportunities each participant encountered within their STEM degree programs at their graduate institution as well as any personal and professional experiences the women explored in order to prepare for their graduate school journey. The wide range of experiences that the participants accumulated in their undergraduate program dictated how they moved forward with their next steps into graduate school. Additionally, those experiences laid the foundation for how confidently the participants engaged with their graduate curriculum, their peers, their labs, and their faculty members. The dominant trends that displayed in this category are related to the various pathways the participants took to graduate school, their experiences within their graduate research labs and extracurricular activities, and the support structures in place for graduate students.

***Divergent Pathways to graduate school.*** Even though all of the participants in this study have worked their way into a Ph.D. program or medical school, some participants felt underprepared to go directly into a Ph.D. or medical program and felt more confident progressing with a master’s program first or taking time off. For example, Zora, who had an

early acceptance guarantee into medical school, shared that she had a great deal of anxiety around whether or not she was “emotionally prepared for the rigor that would come with medical school.” Instead, Zora opted to do a one-year Master’s in Human Nutrition so that that she could get an additional year of academic experience and preparation time. As an undergraduate, Zora participated in a public health program, which influenced her decision to pursue a Master’s in Human Nutrition. For Zora, this pause before diving into the rigor of medical school was about both preparation and long-term vision. Zora has a passion for nutrition, and her goals are to incorporate nutritional wellbeing into her medical practice in the future. Taking a year before medical school equipped her with knowledge and skillset that she will need to fulfill goals that she has to serve her community in the future.

Matondo was one of three participants that went directly into a doctoral program when she graduated with her Bachelor’s, although this pathway was not the path she wanted to take. Matondo did not feel prepared to go directly into a Ph.D. program due to the poor experiences she had in her undergraduate lab. Even though she wanted to take time off after graduating, she participated in a program in undergraduate school that required her to apply for graduate programs. She reflected on this saying, “I think that if I had time to really sit and think, ‘Am I really ready, and is this what I really wanted to do?’ I would not have gone to grad school.” Additionally, when applying to graduate school, Matondo preferred to apply for a master’s program, but the director of her program told her that she did not need two more years of classes and encouraged her to go directly into a doctoral program. Matondo’s experiences highlight the importance of holistically advising and supporting students and knowing how to challenge them while simultaneously listening to what they are telling you they need.

Two participants decided to take a break and gain professional experience directly after undergraduate school. Alice knew she wanted to pursue a graduate degree, but she was exhausted and needed time away to “fall back in love with science.” These breaks in education were valuable opportunities to gain experience and clarity on what they wanted to do next, but it also gave them time to refresh their minds before heading into another academic journey that they did not necessarily feel prepared to tackle. While it wasn’t necessarily an easier process or experience for participants that have taken time off or pursued a Master’s degree before going into their terminal program, many of them seemed to have a better understanding of their needs, what types of programs and labs they’d thrive better in, and were more confident in their STEM abilities – even though their confidence wasn’t always that high.

*Graduate research labs and extracurriculars.* The medical students are not currently engaged in research, although, they do have opportunities to be engaged in other programming such as community service projects, clubs, and associations. On the other hand, all of the women currently enrolled in Ph.D. programs are involved in research labs, an essential component of their Ph.D. studies. Tamala and Matondo, two people who struggled with their lab experiences in their undergraduate programs, have continued to have difficulty in their Ph.D. labs. For Tamala, she has a hard time putting herself out there and her confidence is low when it comes to her STEM academic abilities in comparison to her peers. She shared, “I know I can do science, but I guess I’m not convinced that I can do science better than anybody else can – or that I have something unique to contribute to science.” Tamala goes to a highly selective, private institution that is predominantly white and historically known for STEM. When comparing her background to her lab mates she stated, “they come from the top labs like Oxford and these great places. So naturally, coming from two state schools, I don’t think it’s out of reason that I don’t consider

myself on these people's levels." For Tamala, even though she has a plethora of research experiences, the negative experiences she has encountered with faculty during her undergraduate years, such as being called stupid by a biology professor and being shamed for asking questions in class, negate the wealth of technical experience she has accumulated.

On the other hand, Matondo's experiences are directly related to stressful environment she experienced her first three years in her Ph.D. program. When she reflected on how her experience thus far in her Ph.D. program she shared, "I don't think I've had a single year of graduate school where I'm like, 'I like graduate school.' Every year of grad school I've been like, 'I really hate grad school. I should drop out.'" Similar to her undergraduate lab PI, her graduate lab PI openly admitted to her department that mentoring students was not something that she was interested in doing. Additionally, Matondo also shared that she got "really sick" while working in her Ph.D. lab. Instead of caring about the Matondo's wellbeing, her PI accused her of trying to avoid work and told her, "You're wasting government dollars by being in graduate school." She has since joined a new research lab where she feels like she is having a better experience; unfortunately, she now has to juggle trying to overcome the trauma she has experienced in her previous lab in order to build her confidence back up, while simultaneously trying to be engaged in her new lab and make progress on her research.

As for extracurricular engagement, many Ph.D. students shared that they did not have time for extracurricular activities. For those that have been able to have time, extracurriculars have served as additional opportunities to build community. Matondo shared that many PIs believe extracurricular involvement "would take away from time that you have in lab." Tamala also frequently discussed the idea of living and breathing science, sharing that many of her classmates tended to be all consumed with science and their work. Yet, outreach and community-

based work was something that was important to many of the participants. During the focus group, multiple participants shared about the desire to give back to other young Black girls and women in STEM.

***Graduate school support structures.*** Support in graduate school was a major trend for the women in this study. Overall support in graduate school seemed to encompass much more than just their educators and staff. Many of the participants discussed picking their graduate school based off of wanting to be somewhere that they felt like they would be supported and would feel like they would belong. Some of the participants picked their labs based off PIs that they felt like would support and nurture them in ways that they had not received in the past. Also, peers start to seemingly play a bigger role in the participants support system at this level of their education. This was understandable due to the fact that the participants had more intimate relationships with their peers since they are engaged in smaller cohort learning within their graduate school programs.

Many participants chose their graduate school because of the support they felt like they would get from their department of study or research PI. For example, Mabelle intentionally sought out a program that would support her and be able to provide her with the resources she would need to be successful. She stated, “I know that I am not the one that's like going to be the top of the class. I know when it comes to school, like I will work really hard and yet still struggle in the beginning.” Similarly, Alice chose her Ph.D. program after interacting with faculty and other students enrolled in the program. Primarily, she said it was good to see “how excited [the students] were about their research and about their programs” as well as how the faculty in the department treated the students like they were “junior colleagues”. This level of support turned out to be incredibly important to Alice who lost her mother and had to have a surgery that took

her two months to recover from. She shared that her advisor and department were all “super supportive” of what she was going through:

I was recovering from surgery and like dealing with the loss of my mom and I never had to worry about money or any of that ...feeling that I was cared about and like an important part of the community really helped me sort of get over that really dark point in my time.

This level of support is the exact opposite of what Matondo experienced with her PI when she fell ill and was told that she was just trying to get out of doing the work. These are two clear examples of how well a student can perform, be engaged, and how their confidence will fare when they are adequately supported or the opposite, if they are disregarded.

An additional layer of support that has not been discussed in previous sections are peers and classmates. Because of the more intimate connection that the participants have with their cohorts and programs, many of them reflected on being able to turn to their classmates and peers for support. For instance, Alice shared that her cohort was a “tight knit group” that often stood up for her and acknowledged her value for potentially being the first Black graduate from their Ph.D. program. The participants shared that they were able to form more meaningful relationships with peers that they could connect with on a non-academic level, in ways that went deeper than surface level and were more closely tied to a hobby or interest. While not all relationships with peers were positive and supportive. Some participants did share that they experienced microaggressions and acts of racism and sexism from their peers and classmates. Yet, the overall consensus from most participants was that they were able to develop positive relationships with peers that truly help them navigate through their program and give them someone to turn to when times get hard.

## **Surviving the Culture of Science**

This theme discusses the participant's experiences as they relate to the climate and culture created by their campuses, departments, special programs, faculty, staff, and peers. Within this theme, participants experiences are typically driven by their campuses and departments commitment to diversity, equity, and inclusion, and how these systems intentionally foster the development of students of color and other marginalized communities. Therefore, the categories discussed in this section are focused on the macroclimate & culture created by the broader institutional system and values; the microclimate & culture created by the departments, majors, and special programs; the role faculty play at setting the tone for their departments micro climate and culture; and the resulting feelings of loneliness and othering that the participants experience as a result of the climate and culture of their campuses and departments. Additionally, these categories will discuss how faculty, staff, and peers engage in behavior that either perpetuates or actively dismantles the historically isolating culture of STEM.

STEM is historically a white male dominated field that can be often unwelcoming to both women and people of color. The literature often discusses the double bind that Black women face due to the intersectionality of being both Black and a woman (Ong et al., 2011). The environment Black women are spending their formidable educational years in is a determining factor for whether or not they will persist through graduation and into STEM careers. Black students that attend predominantly White institutions are known to experiences alienation, hostility, and racial discrimination (Reeder & Schmitt, 2013). Additionally, Black women are also known to experience isolating actors such as tokenism, microaggressions, and othering (Rasheem et al., 2018). These factors directly align with the experiences shared by the women in this study.



**Campus and department climate and culture.** The majority of the women in this study have attended predominantly white schools, including their K-12 education. Two of the participants attended a historically Black university, both for their undergraduate education. Cecelia reflected on how she felt when she transitioned from attending predominantly white Catholic schools for during her K-12 years to a historically Black college for her undergraduate education:

I will say that the transition to [an HBCU] was harder but more fruitful. It was harder to do, but it stretched me more and grew me more...but it was beautiful at the same time cause it grew my idea of what Black femininity is and like what Black women can do. I didn't have very many Black role models before I got [there] at all. Seeing so many Black women in STEM and science and like higher education was like so gratifying. It kind of filled a void I didn't even know I had.

The demographic make-up of an institution can be isolating and marginalizing to different populations of people. Different participants reflected on needing to have a safe space or a place and people they could be vulnerable with. The participants in this study reflected on often not having many, if any, faculty and staff of color, and being one of few, and often the only Black students and Black women in their academic programs. For some participants, diversity was a major factor when deciding on what institutions to go to. For instance, Kenyatta shared that when she visited potential schools for her Ph.D. program, one of the main deciding factors for her was the representation of Black students on campus. When reflecting on the institution that she chose, she shared:

[They] had Black kids, not necessarily in their grad program, but just on campus. They were visible in the cafeteria, you can see them. So just walking around campus, I knew, I wouldn't feel like an outsider.

Visible diversity served as an indicator for how well they would be accepted, how well they would be able to fit into the culture of the school, and how they would potentially be treated by faculty, staff, and peers.

Many HBCUs are known for the culture and celebration that surrounds their marching bands. Zora was in the band in high school and attended field trips that frequently visited HBCU band competitions. She shared that those field trips gave her a “a lot of pride and wanting to be surrounded by Black people at a collegiate level.” However, HBCUs only make up three percent of colleges and universities in the country, and even though twenty-seven percent of students that earn a STEM degree come from an HBCU (Kendricks et al., 2013), Black students should not have to only pick from a limited numbers of schools to attend to obtain the a friendly, supportive and welcoming culture and climate that HBCUs are known for. The following sub-categories unpack the participant’s experiences as they relate to the larger institution culture as well as the more intimate cultures they encountered within their respective departments and programs.

***Macro-institutional climate and culture.*** Though many of the participants discussed the lack of overall diversity at their institution, several participants shared about different diversity programs and multicultural centers that their institution offered that helped them acclimate to the institution and find community. For example, the participants shared about being able to be involved in organizations such as the SNMA for medical students, Black & African Student Unions, minority graduate student associations, and access to different cultural and identity

centers, such as LGBTQ+ clubs. Matondo shared about her time spent with the minority graduate student association's coordinator:

[She] has been one of the best people I've ever met in my entire life and she's also like one of the few reasons to why I'm still in graduate school. She runs the program and she kinda does like these one-on-one sessions with her graduate students where she talks about life experiences and like talks about how a lot of the struggles we're having are really common and they're not like unique to just us individually. So that's always been a really big help, and she wants us to finish grad school so that we can have our degree and have our job at the end. So, it's been great always having her there and having her to help.

A space like this is specifically tailored to center the needs of and experiences of minority students. While it is important for institutions to create spaces of belonging for minority students, it is equally important for institutions to understand that these isolated spaces are not the answer for engaging students in the larger campus community. This is especially true for graduate students who may or may not have time to be engaged in extracurricular programming due to the demand of their coursework and research like several participants have shared.

At the macro university level, while HBCU's are known for their nurturing and supportive environments that have excelled at graduating Black students in STEM, even they can also be isolating and marginalizing to students that do not fit into the stereotypical model of what a Black student should be like. For example, Cecelia shared that she struggled fitting into certain groups and clubs at her undergraduate university because she did not like the same genre of activities that people were expecting a stereotypical HBCU student to like. She shared saying, "the very involved students that wanted to go to all of the different parties and all into the same

types of music and things like that, that was their kind of idea of what all students were like.”

She further reflected sharing:

Like there’s a whole ‘nother group of students that maybe they’re into things like, weird things like anime or more artsy things, things outside the normal bubble of what they thought students were into. So, I think that was a point of conflict. Trying to come at from a perspective of ‘Hey, there’s all these other students. There’s Asian students on campus, there’s Middle Eastern students on campus, and not all Black students are into these specific things that you think they’re into.’ And they didn’t like that idea.

Even though HBCU were founded to give Black students a place to safely pursue their academic goals, it is still also important for them to ensure they are providing a safe space for all the different types of students, Black and other races, to be able to exist. Being Black is not a monolithic experience. This is a concept that was unpacked by Harper and Nichols (2008) during a study of Black males at an HBCU which found that their participants were often quite different depending on where they grew up and who they predominantly interacted with. Because of those factors there would often be differences in “their styles of dress, speech, and cultural interests” (p. 6), similar to the experiences of Cecelia.

***Micro-departmental climate and culture.*** Due to the fact that the women in this study spend the majority of their time within their academic department, especially at the graduate school level, it is important to also highlight the microclimates and cultures departments and programs create and perpetuate. Though the participants shared about the lack of diversity at their universities, this issue was even more problematic within their specific departments. Multiple participants shared about being the only Black student or Black woman in their departments and how this would often contribute to an isolating, and sometimes unwelcoming,

climate. For example, Alice shared about her experience within her department at her undergraduate institute stating:

That was tough because it's hard to, you know, go into these big intro classes and only see like a handful of other Black people and you know, every single one of them from like the scholars program. And then to not have any like faculty of color to interact with, you know, it's, it was tough and not everybody [there] was nice and welcoming.

Furthermore, Alice is only one of a couple of Black students in her current graduate department, and she will be the first Black student to graduate with a Ph.D. in her department's history.

While the faculty in her department often reacts defensively when she engages them in discussions around the matter, Alice shared that she does have the support of her peers who often advocate for the department to see the value in her being the first Black graduate and the need to ensure she keeps her funding. For the women in this study, being the only one, or one of a few, can create issues of tokenism. Several participants shared that sometimes it can be as if having one Black woman dissolves departments from needing to do recruitment of more Black women. Alice also shared that her experiences are often conflated with the experiences of other students of color. She shared that her department often dismisses her discussion around being the first Black graduate by throwing out there that they have graduated students from other underrepresented minority backgrounds. Similarly, Kezia Hunt shared that her undergraduate mentor was the first Black faculty member in her department's history. Additionally, while Kezia Hunt is currently in a graduate program that has a very diverse student body, it still greatly lacks diversity within the faculty population.

Whether it is a department's intention or not, the lack of diversity can give off signals that represent a culture of exclusion. A trend that multiple participants discussed is the fact that

their departments often place the responsibility of change on the students. For example, Kezia Hunt and her classmates drafted a letter for the department requesting that they prioritize bringing in more diverse faculty and Alice serves on a diversity committee founded by the students to discuss the departments diversity needs, something that faculty have not traditionally collaborated with them on. Tamala shared that the Dean of her school specifically told her that their intentions for recruiting diverse students is that the students will in-turn be the catalyst for creating change in the department. When Tamala reflected on how her Dean's statements made her feel, she shared:

I did not come here to save [the university]. I came here for a Ph.D... I am not going to take on the burden of making this a more inclusive, maybe there are people that want to take on that burden and want to do things to increase inclusion in the department. I have a lot of friends that are willing to do that. But for me, if they thought that was going to be what I was going to do here...and to have somebody tell me that's the reason why I am here. Again, this doesn't do much for your confidence.

The idea of transformative practice was introduced in the literature review of this study. Johnson (2012) states that the responsibility of change actually has to lie with the "institution and their agents rather than on students who hold relatively little power in the educational environment" (p.344). The participants who are championing for change in the culture and climate of their departments, as it relates to diversity, equity, and inclusion, hold little power to execute the change they wish to see at their institutions.

Many of the participant's departments also battle with engrained issues of racism and sexism, which can contribute to a hostile climate for Black women. From the participants stories, microaggressions seem to be the dominate form of racism that they experience. None of them

identified overt, blatant acts of racism, such as being called racial slurs, but they shared a plethora of stories related to covert and “very nuanced” actions such as being treated differently than other non-Black students by faculty, being treated as if they were invisible, and even dating issues. For instance, Kenyatta reflected on attending seminars of visiting professors stating, “I’ll be the first one in there and nobody was sitting next to me or other professors wouldn’t sit next to me.” She went on to say, “it’s been quite interesting cause a lot of them try to act like I’m invisible, but I’m not. Cause I’m clearly the only Black person in here or like one of two.” Other participants shared experiences such as comments about or people wanting to touch their hair, doors being slammed in their face, or peers perpetuating fear-based microaggressions by treating the participants as if they were the “angry Black woman” to be afraid of.

When the participants discussed acts of sexism, they shared that it is often hard to differentiate whether the experiences they were encountering were because of their race or gender. Many of expressed similar statements to Kezia Hunt when she stated that it was “hard to know if [the experiences are] because I’m a woman or because I’m Black.” Some of the more overt acts sexism they experienced included male peers making offensive comments about women as well as male faculty members publicly talking about the female staff members poorly or dismissing their experience and skills. For example, Cecelia shared that she once overheard a male classmate in her medical school program state that “he was excited for when he became a doctor because he wanted to do breast exams on his patients.” Matondo’s undergraduate PI once made a joke about a Black female student being “promiscuous.” She also reflected on an experience dealing with a white female faculty member at her graduate school and how male faculty members acted towards her:

There was a new professor, she was white, she came from out of the country, her husband works for some huge company where they make a lot of money, but she came in with her own funding and she was computer sciences. I don't understand what it was but the men in the departments didn't like her. They were upset about the lab space that she got. They were upset that she got the job in the first place. They were upset that she brought in so much funding. They were upset that all of these students wanted to be in her lab. Overall, we had heard that they were making sexist jokes about her. She was the only female computer science person that we had so I knew that their culture was problematic. Even though the men weren't necessarily in computer science, they were in the science programs – like in biology and chemistry and stuff, they just did modeling. It was still so shocking to see how they just disregarded her because of her gender.

Similarly, Kezia Hunt shared that she was questioned at a conference on whether or not she did the research by herself when a male stated, “Oh yeah, you're a woman. I'm surprised you, like, did all this research yourself. Like, who else is like doing this? Or are you like just presenting this for them?”. Interactions like these perpetuate a culture of STEM that is unwelcoming to women. As previously mentioned, the culture of STEM can be incredibly problematic for both women and people of color. The combination of low diversity, racism, and sexism – issues that STEM fields are known for – can be even more problematic for Black women who are tasked with leading the charge on diversity matters and having to combat and push through personal experiences of racism and sexism within their departments, while simultaneously balancing their own academics and research such as the experiences shared by the women in this study.

**Engagement with faculty members.** Faculty interactions seem to be one of the most prominent relationships the participants discussed in detail. Ultimately, faculty are the



gatekeepers of learning in higher education, and they play a major role in creating the department's culture and climate. Participants discussed the role faculty played at various stages of their education in delivering content in the classroom, supporting students during office hours, being the gatekeepers to research opportunities, serving as mentors to turn to for graduate school preparation and letters of recommendation, and more. Alice shared that her undergraduate faculty and teaching assistants (TAs) were nice and great for answering questions and having extra office hours to review materials and prepare for exams. Alice also shared that faculty would host faculty dinners where students had the opportunity to eat dinner with various faculty members to learn more about them and their research journey. Similarly, Kenyatta reflected on having some "very supportive" undergraduate faculty members saying:

Especially when I applied to grad school, they were very, very supportive when I was going away on interviews. I would have like exams or presentations, but [they were] like, 'don't even worry about it. You don't even have to do this presentation just because you're going to grad school, I'm excited.'

Kenyatta shared that faculty members would connect with individuals within their network at graduate schools she was applying for to put in a good word for her.

On the other hand, various participants shared stories that highlight how faculty members were disengaged with their students, uninterested in mentoring them, and to an extent cruel – all of which creates hostile climates that made it hard for the participants to be engaged. Matondo shared that her undergraduate PI, who was Taiwanese, would often make inappropriate jokes geared towards Black student's in his lab and did not want to teach or mentor students. She shared:

He wanted to teach at Stanford or Harvard, and he couldn't get a job there, so he was stuck teaching at [a state school] and he was stuck having a lab [there]. His opinion of students that go to state schools is that they're not smart enough to have gone to a private school. He treated all of his students as if they were not smart enough to be there, and he wasn't really interested in being a mentor.

As previously mentioned, research lab PIs are there to guide and mentor their students.

Undergraduate laboratory experiences are many of the participants first opportunity to start exploring different facets of the sciences on a more specialized level; they are learning techniques, applying knowledge they are learning in their courses, and learning more detailed content about the projects they are working on. The PIs primarily guide these lessons, and if students are not gaining the experience they need, their confidence could suffer as well as their desire to persist.

Additionally, faculty are often the gatekeepers of access to research opportunities. In order for students to be engaged in research, they typically have to find a faculty member conducting research they are interested in and request the opportunity to join their lab. This can be intimidating for students that do not have existing relationships with faculty or negative relationships with faculty. Tamala shared a number of incidents with faculty members that have made her question her worth, her intelligence, and her belonging in science. After failing her second biology course, Tamala's professor called her stupid. When discussing how that experience made her feel, she said, "I had been disciplined by educators before, but I had never had an educator look at me and call me stupid to my face." Also, when Tamala sought to work in the lab of a white female professor, the professor made her perform a number of tasks to get into her lab that were not typical requirements for a student to gain access to lab experience. For

example, the professor made Tamala take multiple courses with the expectation of high performance, obtain letters of recommendation from other faculty members, and interview and present in front of both her and the post-docs in her lab. When Tamala told this professor that she wanted to eventually get a Ph.D., the professor told her, “I don’t think a Ph.D. is for you”, and she also told her “honestly, [Tamala], I don’t want to let you into my lab because I don’t think you can handle it.” She did eventually let Tamala join her lab but proceeded to give Tamala a hard time and fired her six months later. This entire research lab experience sent Tamala into a downward, depressive spiral that almost caused her to fail and dropout of her program. When she was fired, Tamala questioned whether or not she belonged in science and did not go to school for a month after that. Tamala went on to share a plethora of stories about many of her undergraduate faculty members being rude, dismissive and discouraging. Tamala has held onto these interactions well into her Ph.D. program. Because of this, she still struggles to engage in classes and her lab. This sort of hostile learning environment is damaging to the confidence of students.

Participants also shared about a culture of being used by faculty for funding. A few participants were able to participate in research programs due to funding that was specifically for minority students. This funding often came with requirements for the professors to mentor and recruit minority students to their lab. Matondo’s first doctoral lab PI received a grant to support a woman of color. Unfortunately, her PI ended up giving away that funding to a white female that needed funding and did not want to participate in the teaching assistant program. Matondo shared:

She had written this grant for me and she had gotten it funded for one year, but she ended up with a grad student whose department could not find funding for her and she did not

want that grad student to TA in another department. So, my department had TAships so with two weeks warning she was like, ‘you’re going to TA and this other student is going to be on your grant so they don’t have to TA because their department can’t find a TAship for them.’ And I was like, ‘What? This grant was specifically written for a woman of color and you’re going to give it to a white female and send me to go TA?’ I was like, ‘cool, got it.’

This type of experience perpetuates a culture of valuing research opportunities and access to funding over the actual presence of and opportunity to nurture and develop Black women and other minority students in STEM.

**Loneliness and othering.** The above issues, at both the institutional and departmental levels, contribute to feelings of loneliness and othering amongst all of the participants. Each participant was asked what it was like to be a Black woman in their graduate programs. Nearly every woman used the word “lonely”. When Kenyatta was asked to expand upon it, she shared:

It's really lonely. Um, especially being a black girl from a poor city. Cause I feel like there's two sides of me. There's a lot of code switching. Like there's me the academic, but there's like me as the around the way girl from [hometown] and it's lonely cause like nobody understands, um especially in times like this where the Black Lives Matter movement was prevalent. Like nobody gets it or how COVID affects Black people more than other groups or ethnicities. And so, it's just really, really, really lonely.

Zora added to this sentiment by stating, “It’s a lot of realization that I’m also the only one, in small group sessions or outside of class I’m often the only one around.” Other participants added that it was isolating and alienating. The idea of being the only one perpetuates feelings of “othering” where people “hyper focus” on the fact that they are a Black woman.

To offset these feelings, the participants often discussed the need of being connected to a community. Most often the participants reflected on peers that they could turn to for support, these friends became their community network. Some of the participants were able to develop a community through their peers within their departments, others were able to develop community through extracurricular activities and programs they participated in on their campuses. It was important for the participants to find people they could relate to or people who could at least empathize with the participants life experiences and struggles. For instance, Kenyatta reflected on a white female peer that has become a close friend saying, "she's somebody who understands race relations in our country as best as she could and she's always willing to learn." As previously mentioned, graduate school students interact with one another on a more intimate level due to the fact that they are in specialized coursework, in comparison to large general education courses they would take in their undergraduate programs. At this level, it is important and helpful for the participants to be able to connect with their peers, talk to them about their struggles, be able turn to them to understand a topic or technique, and have someone to share with when they're having a bad day – someone who can relate to their struggles and frustrations.

At the same time, it can be hard for the participants to find and develop community if they do not have anything in common with their peers. Zora mentioned that it is not always guaranteed that you are going to “mesh” with people just because you are studying the same topic. Tamala shared that many of her peers in her Ph.D. program live and breathe science. She shared, “If science isn’t your number one reason for living, then you really don’t have anything in common with anyone. Unfortunately for me, science is not my number one reason for breath.” Because of this, she often struggles with building community at her institution. On the other

hand, she started a club called Wine Wednesday where her classmates get together to have a drink and discuss life and leave science out of it. She shared:

Wine Wednesday and it's just a place where all of my fellow graduate students can come together and have a glass of wine, or it doesn't have to be alcohol, and there's snacks and we talk and it's very destressing. When I had no community here, I made my own community and it has really helped me get through the very hard times of Ph.D.

Ultimately, that is what community is about for the participants, having people to turn to that are familiar with their struggles and can help them navigate the hard times as they are progressing through their academics.

### **Black Woman Scientist Identity Development**

This theme explores the participant's experiences that are a result of their gender and racial identities; how their experiences influence the development of self-efficacy; how stereotype threat and imposter syndrome impact the participants as a result of their interactions with their academic communities, faculty, staff, and peers; and how all of these factors impact the participants overall scientist identity development as Black women. Scientist identity development can be a complicated issue for Black women in STEM who belong to two marginalized communities. Carlone and Johnson (2007) posit that scientist identity is about much more than what an individual thinks about themselves and their abilities. Rather than personal perception, scientist identity encompasses how other members of the scientific community judge an individual. Each participant in this study was asked to discuss how they perceived their identity as a scientist. Majority of the participants hesitated at this question, and half of them shared that they do not view themselves as a scientist. The three medical students were adamant about not being identified as a scientist. This was primarily because they associate

a scientist as someone who actively participates in research-based science, even though they all have bachelor's degrees in Biology with past research experience. Zora shared that she would likely classify herself as a clinician that serves the community. Cecelia unpacked this concept a bit further sharing:

It's hard to see myself as a scientist because, I guess in undergrad it was easier because I was doing like hardcore biology, but now it's a different science. It's a science of medicine; it's understanding people, how they work, how the body works, and how you can remedy it.

When Zora was asked about her background in Biology and whether or not that made her a Biologist, she said, "I don't feel like I can give myself those titles." This aligns with the very concept shared by Carlone and Johnson (2007), that scientist identity depends on the perception of "meaningful others" (pg. 1192). Matondo shared a sentiment, that was echoed by other participants, stating that depending on what type of crowd she was within would depend if she would confidently introduce herself as a scientist. She shared:

If I'm surrounded by Black people I'd be like, 'yeah, you're right. I'm a scientist' or other minority people or people that identify as LGBTQ, but around certain other people I'd be like, 'oh I don't have the characteristics that they have and the training that they had before grad school – so I can't say that compared to them I am a scientist.'" Even though I shouldn't be comparing myself to other people, I'm well aware of that. But it's hard not to when the majority of these students are all the same and they all have similar experiences, so they behave in a certain way.

This mindset was even shared by the participants that felt like they had a strong identity as a scientist. When discussing the factors that impact how each participant perceives their scientist

identity, they all shared stories related to imposter syndrome and stereotype threat, and ultimately, how those factors impact their confidence. The following sections will dive into many aspects represented in Matondo's statement as well as experiences shared by other participants relating to their scientist identity.

**Intersectionality.** The previous section outlined many of the experiences the participants had related to racist and sexist incidents and how those types of experiences can create a culture and climate that is hard for Black women to develop and excel academically. This category takes those experiences and discusses them under the lens of Black woman scientist identity development. It is important to highlight the intersectionality of racial and gender experiences within this section because the participants shared that it feels as if they have to prove themselves as scientists on two fronts, as a Black person and as a woman. Racial and gender identities for Black women are dominant identifiers, they are not identities that blend in or can be hidden. Some participants shared that they often experience assumptions from peers, faculty, and staff. For example, Tamala shared that her first-year mentor in her Ph.D. program once called her into the office for a talk because she noticed Tamala struggling. For context, Tamala was in the midst of planning her wedding which was a couple weeks out from this conversation. When her mentor approached her about struggling, her first instinct was to ask Tamala if she was struggling because she was Black. Her mentor asked, "It looks like you're having trouble adjusting to Ph.D. life here. Is it because of your race? Is it because you're one of the only Black people here?" Her immediate next question to Tamala was, "This department is a very male dominated department, do you feel like you can't find community because there's no females?" This conversation was incredibly discouraging to Tamala who at this point felt like no one was ever going to see her for anything but a Black woman. She reflected:



They just made me feel like I was their Black quota just so their numbers don't like suffer, like that need me to do well. That's who we are here. You know, whatever, fine. If I'm going to be their token African American female, then fine. The worst that's going to come out of this is I'm going to get a Ph.D., and that ought to come with some value and security.

Even still, Tamala also reflected that she wished her mentor would have come to her from a more overall wellbeing standpoint stating:

If I saw a human struggling, I would ask something like is everything ok in your life or is there something you need to talk about; not come at it like a phenotype standpoint, like is the Black thing a problem. Don't try and guess what's the problem. She didn't even ask me if I needed to talk. Why not start there, and maybe if I do bring up that I'm feeling marginalized or I'm feeling insecure then you can go to your preprinted questions.

Other participants shared similar situations where their peers or faculty members automatically assumed their struggles were merely because of the color of their skin or gender, and that they needed help or to "be saved". This is the opposite of what the women in this study wanted.

Rather, many of them reflected on just wanting genuine interactions with people that were more so related to their competence, academic ability, and who they were as a person.

**Stereotype threat and imposter syndrome.** Some of the participant's expressed fear of failure and the potential of living up to people's misconceptions that Black women do not belong in STEM. Beasley and Fischer (2012) define stereotype threat as "the anxiety individuals from stigmatized groups have that their behavior might confirm—to others or even to themselves—the negative stereotypes imposed upon their group" (p. 429). Many of the participants felt as if they had to perform well because of the fact that they were one of a few or the only Black woman in

their academic programs. Academically, some of the women in this study would shy away from courses such as math and physics, as early as high school, because of a self-imposed idea that they were not good in these subjects. For example, in high school, hillrunnergeo would often tell herself, “I’m not good at math. I can’t do math.” It was not until she took and performed exceptionally well in pre-calculus, at a local college the summer before her senior year in high school, that she realized she was actually capable of math. She ended up using this as a boost for her academic confidence throughout college. Similarly, in the first year of her Ph.D. program Alice struggled because she kept telling herself that she was not good at math. She shared:

So I think the first year was tough because, the program is really quantitative and like I said earlier, I'm not good at math and I'm not sure how much of it is like, I'm not good at math versus I keep telling myself I'm not good at math. And so, I sort of tripped myself up.

The fear of poor performance has been proven to have psychological effects on people that can result in the poor performance that they fear. This was demonstrated in a study conducted by Quinn and Spencer (2011) who explored what affects stereotype threat had on the performance of a group during a math test. A set of women were preconditioned with the notion that women tend to underperform men in math. As a result, these women underperformed their female counterparts that did not receive the same gender performance message prior to the exam. The women that participated in this study appear to demonstrate some of the same gender-based stereotype driven anxieties when it comes to their performance in certain subjects that are known to be male dominated.

Beyond academics, some participants worried about the image that they portray and how it may perpetuate common stereotypes that exist around Black women. The participants often

discussed the need to code switch when they were in their academic settings versus being able to be themselves. Kezia Hunt shared saying, “the stereotype of a Black woman. Isn't a scientist. It isn't an academic. It isn't a graduate degree.” She went on to say that she personally had to get comfortable with:

Just being okay with the way, not, not being afraid that people will see these long butt-length braids and think that you are XYZ because that's the idea that they have from the media that, 'Oh girl, who's dark skin with these long braids that are blonde at the end, is this' when in reality I'm not.

One of the things that Kezia Hunt loved the most about her undergraduate mentor, who was the only Black woman faculty in the department, was the fact that she did not try to change herself to make others in the department comfortable. She reflected on this, sharing:

So just like having her be a Black woman and not try to assimilate to this idea of, ‘Oh I have to change the way I speak. I have to change the way that, um, the songs that I integrate into my talks.’ She always started her talk out with Beyonce. So, seeing that and seeing someone be genuinely themselves and being this super successful scientist, um, was great.

Many of the participants had a stereotypical picture in their minds of what a scientist was or was not. For instance, when reflecting on her image of a scientist, Matondo shared:

I think that they need to be really punctual people, really knowledgeable about what’s going on in their field, and really interested in reading papers all of the time – like all of their lives. Just really well put together people and like science is the majority of their lives.

Matondo goes on to share that she feels like these characteristics are everything she is not, and that mindset could be detrimental to her scientist identity development.

Stereotype threat and imposter syndrome are closely aligned with one another. Because of many of the effects of stereotype threat, as well as other factors, the participants often discussed feeling like they were imposters in their academic spaces, like they did not belong or did not deserve to be in their programs. This often came with the women in this study judging themselves against their peers by comparing their skill levels, their past experiences, and even where they got their education. For example, Tamala, who battled with confidence issues starting in her undergraduate program, shared that she had high levels of imposter syndrome in her Ph.D. program. Even though Tamala has years of research experience and is currently in a lab at an elite university, she lacks a sense of belonging because she does not feel like she has the same quality of education as her peers, who did their undergraduate and master's level work at "great institutions with great resources" that she did not have access to. Similarly, Alice shared that she felt like her classmates had more technical skills with programs she had never used in the past saying, "[they had] skills that I hadn't learned yet that, everyone else seemed to be really, you know, up to speed on. That made me feel like I was like a little bit behind." These types of experience can have a negative effect on an individual's self-efficacy. Vicarious experiences, the experiences gained from observing others complete a task, can have negative effects on an individual if they consider themselves less than the person they are observing.

**Self-efficacy.** Many of the topics discussed in previous themes and sections demonstrate, in various ways, how the participant's experiences have directly affected the development of their self-efficacy. As previously mentioned, four tenets influence the development of self-efficacy: Mastery Experiences, Vicarious Experiences, Verbal Persuasions, and Physiological

State. For the women in this study, mastery experiences were primarily gained through engagement with science curriculum at various levels of education and hands on research opportunities; vicarious experiences were most often gained through the observation of peers and mentors; verbal persuasions were most impactfully demonstrated through both positive and negative verbal interactions with faculty and mentors; and physiological state was demonstrated through the ways that each participant utilized stress management mechanisms to remain resilient and persist through various obstacles and interactions throughout their academic journeys. While previous themes have drawn connections between certain experiences and how those experiences impact the participants self-efficacy, this category primarily focuses on how the women in this study currently perceive their self-efficacy, and in turn, how their self-efficacy has affected their scientist identity development.

Each woman in this study was asked to describe their self-efficacy, or confidence, as it related to their current academic abilities and engagement in their programs. Six of the nine women shared that their confidence in both categories was either high or improving. For the participants that categorized their confidence as improving, most of them also shared that their confidence is specifically developing when it comes to applying their knowledge to a new skill or presenting it externally. For instance, Kezia Hunt shared that while she is overall “pretty confident” in her academic abilities, she still felt uncertain when it came to presenting her knowledge to others in her field. She reflected on this by stating:

[There are] certain times where you're presenting on a big stage and you're presenting to people with knowledge in a field that you don't have a strong background in and you feel like, 'Oh do I know enough? Will I be able to answer their questions.'

Kezia Hunt's reflection aligns with the notion that science identity is influenced by the presence of "meaningful others" within their scientific fields, and it highlights how an individual's confidence in their scientist identity can fluctuate depending on whether or not said "meaningful others" recognize and accept an individual as a scientist (Carlone & Johnson, 2007, p. 1192). While many of the participants, such as Kezia Hunt, acknowledge how their confidence is still improving in some areas, many of them also acknowledged that these feelings were part of their growth cycles as scientists and they felt like their confidence would continue to improve in these areas as they continued to gain experience. As was the sentiment when hillrunnergeo stated, "The more I start to get into the new research I'm going to do, the more the confidence will come." Overall, these participants that felt like their overall confidence was high, also shared that they felt like they had a strong identity as a scientist – such as Alice who shared that she was "very proud" of her identity as an evolutionary biologist.

On the other hand, three of the participants shared that they felt like their confidence in their academic abilities and engagement in their programs was relatively low. These participants often compared themselves to their peers, which deeply impacted their self-efficacy. For instance, Tamala often compared her academic background to her peers in her lab who, in her opinion, come from "top labs" across the country. Because of this, she shared that it is often hard for her to find her "exact place" in her lab and that she was not confident that she could "do science better than anyone else". On the other hand, Matondo shared that she was sure she could do her work, but she was not confident in her abilities to analyze her data "past the basics". Unfortunately for Matondo, her low confidence in this area was further impacted by the fact that she was often dismissed by her research lab PI who would tell her he was "busy" when she would ask for help. Additionally, these three participants also shared that they either do not

identify as a scientist, that their scientist identity greatly varies depending on who they are surrounded by, or that their scientist identity depends on other “more senior” individuals and whether or not those people recognize them as a scientist. For example, when Tamala was asked to describe her identity as a scientist, she shared:

I really hate this question because I am not identified as a scientist. It’s a job. I try to [identify as a scientist] but every time I have tried to, someone has been there to tell me that I’m not. Somebody in a position, like an educator position, somebody more senior to me has been there to tell me not that I’m not good enough, that I’m not a scientist, that it’s not my career, not the career that would be best for me. So I have learned to believe them and that’s bad I guess, but I just don’t think I am a scientist.

Tamala’s reflection highlights how educators can hinder an individual’s confidence through words and actions. This also highlights how much weight other people’s opinions carry when it comes to how an individual identifies in a science world.

The confidence of all of the women in this study has fluctuated over time as new experiences have accumulated at different levels of education. For many participants, their self-efficacy has traced a trajectory similar to that of an oscillating wave, moving up and down depending on the force being exerted on it (i.e. interactions with faculty or mentors or hands on research experience). For example, many of the women that participated in a more rigorous high school curriculum shared that they entered their undergraduate programs with a high academic confidence, such as Kenyatta who stated, “I was really confident academically in undergrad cause I felt like my high school prepared me really well.” Yet, Kenyatta’s confidence dipped when she first entered her Ph.D. program because she felt like her peers knew more than her, she failed some of her first exams, and it was hard getting acquainted to her school and the new

location. Even still, as Kenyatta progressed into her next semester, she felt like her confidence was getting “better every day.” Unfortunately for some participants, their confidence has suffered an overall net loss over time – such as Tamala who started her undergraduate education with “very high confidence” due to a rigorous high school program, but has experienced her confidence plummet to a point that she hasn’t been able to recover, as it relates to her belonging and academic abilities.

Additionally, many of the participants also shared that the more confident they were in their academic abilities, the more they became comfortable being themselves. For instance, Kenzia Hunt shared:

Once I realized within myself that I know what I'm talking about, then I can do it. That started the cascade where I was comfortable with being myself in the way that I dress, in the way that I talk, like not code switching as much. Not toning down the slight valley girl tone to my voice that I have sometimes. It all stems in the confidence that you have in your own knowledge so that you can be the person that you are and reflect the diverse types of personalities in science that I think really isn't shown a lot.

The participants shared that it is hard to get to a place of confidence where they feel like they can confidently share their voice. Being comfortable to exist in their departments seems to be a trend for the participants that have reached this level of confidence shared by Kenzia Hunt. When it comes to being engaged in their departments, the participant’s confidence seems to be more related to the quality of interactions they have with their faculty, staff, and peers than it is related to their academic confidence. The participants that shared positive stories about feeling welcomed, included and supported within their academic departments seem to have the highest confidence in their current academic abilities. For example, Alice has gone through a number of



obstacles in the last year after her mother passed away and she had to have a major surgery. Her department rallied around her to make sure she had support and resources. She shared that while she was recovering from her surgery, “different people from my department would come and like bring me food to make sure that I was taken care of or they'd like try to entertain me in some way.” Participants who feel like they are cared for on an overall well-being level, seem to feel more confident in engaging with their departments. On the other hand, participants that shared that they were not very confident when it came to being engaged in her department, experienced feelings of loneliness and isolation. Participants who felt this way also shared that their confidence is improving the more they are able to “get the lay of the land” and start to build community.

### **Impediments to Becoming a Black Woman Scientist**

This theme explores the various hurdles, barriers, and obligations that presented additional layers of struggles for each participant. The previous themes discuss the participant’s experiences primarily related to their interactions with their academic environments. This theme digs into many of the additional obstacles and obligations that are present in each participant’s life that make it harder for them to pursue their academics. Many of the participants in this study discussed a variety of obstacles such as financial hardships, needing to work, familial obligations, and mental health barriers that greatly impacted their day-to-day routines and how they navigated their academics. The following sections will unpack these obstacles as they relate to finances, obligations, and mental health.

**Finances.** Finances as they relate to the cost of education, the cost of applications, and having financial access to fundamental needs were the most discussed trends for participants when it came to the different obstacles they encounter throughout their education. Most of the

participants heavily depended on a financial aid package or grants to pay for their education and these packages were the final decision factors for many participants when they were deciding between schools as well, both for their undergraduate and graduate school programs. For instance, Alice shared that her undergraduate institution offered a phenomenal financial aid package stating, “if your parents make under a certain amount of money, you don't have to pay money to go to the school.” This was important for the participants because many of them did not have financial support from their parents, such as hillrunnergeo whose mother told her a couple months prior to high school graduation that she would not be able to help her go to college and she would need to “go somewhere cheaper” than some of the out-of-state schools she hoped to attend.

Because of financial and family circumstances, many of the participants also had to work to take care of their basic needs while in college. hillrunnergeo shared:

I look back and I still don't know how I made it financially. Being, you know, remember one being, having a cold and thinking, well, I can choose to buy Kleenex box or you can choose to eat lunch. I won't trade those experiences for anything because, I think they, they shaped who I am.

This situation was impactful for hillrunnergeo who was in school for six years before she discovered her passion in Geology. During this time, her parents often told her she should “drop out of school” because she was wasting time and money on school by taking so long. Since her family could not contribute financially to her education, she had to be resourceful and she shared that these experiences “shaped” her and helped her become more resilient. Tamala shared a similar story, saying:

We were not really well off. So my dad did everything he could, we still had some problems meeting every need in school so I had to work, and that probably tacked on that fifth year [in undergraduate school]. There were times when I didn't have the means to eat; there were times when me and my dad would fight, so even what little support I would have from him, he would like withdraw. There would be nights when I would be hungry and would have to go to the food banks. [School] thank god has some food banks and places you can go to eat.

These types of financial hardships and responsibilities were hard on participants who already have a great deal to juggle with their coursework, extracurricular programs, and research responsibilities. For instance, hillrunnergeo shared that she worked at a hotel while in undergraduate school that required her to work fifty hours a week with mandatory overtime. She recalled, "I got mandatory school, you know, but they didn't want to hear it. So at the end I was just working odd jobs on campus and was flat broke." Therefore, for the participants, it often came down to choosing between taking care of themselves and ensuring they met their essential needs, or often going without so that they could remain in school.

Finances also became an additional barrier when it was time for the participants to start preparing for graduate school applications and deciding on where to attend. Several participants discussed the cost of graduate school application fees and some of the resources they had to assist them. Kezia Hunt shared that she spent \$700 on graduate school applications and GRE fees; fortunately, her parents were able to help her with these costs. On the other hand, participants such as Kenyatta shared that the "application process [to graduate school] was rough. Financially it was hard because I came up with all the money by myself... I worked a lot. I worked really, really, really, really hard. I was super diligent with my money." Similarly, at the

time hillrunnergeo was looking to apply to various master's programs, she shared that she was "flat broke" working odd jobs, her car was up for repossession, and she had collection agencies calling her. This is where her extracurricular engagement paid off because she was a McNair Scholar and she shared that, "application fees are waived at many schools for McNair scholars." This further highlights the need for and benefits to having access to different resources and extracurricular programs.

Specialized resources continued to be impactful in graduate school for many of the participants who were able to attend specifically because of the funding they received. Multiple participants shared that they received funding for graduate school from minority serving grants, such as hillrunnergeo and Tamala. hillrunnergeo reflected on the funding provided by her master's program, sharing:

[The institution] had a fellowship for minority students. And also, the department had a partnership with BP for any minority students coming into the geosciences to do graduate work, and they offered me both. And I said, you know, I can afford graduate school.

Not every student decided on a school that gave them the most financial resources. Kenyatta was offered a phenomenal financial aid package to pursue her Ph.D. at a well-known university; when it came time for her to make a decision, she went with the school that had a higher representation on Black students on campus even though it meant less money, higher cost of living, and a tighter budget.

Kezia Hunt, who had financial support of her parents, also made graduate school decisions based on a financial aid package so that her parents no longer had to pay for her education. Her Master's program offered her a teaching assistant stipend. She reflected on this sharing:

It was also really nice because they offered me the teaching position right before I accepted. So I had a stipend as a Master's student in a tuition waiver that allowed me to live in the DC area without having to rely on my parents cause I wanted to cut myself off because I didn't think it was fair for them to like pay for me since I was five-years-old to go to school.

In addition, Kezia Hunt also received a stipend for her Ph.D. program. While resources like this are helpful, it is still hard for many of the students. Some of these stipends only cover the cost of tuition which still leaves the participants responsible for coming up with the basic costs of living. For instance, even though Cecelia received a full tuition scholarship for medical school, she still has to take out student loans to help with the cost of survival. She reflected on her experience sharing:

I don't have to pay tuition but honestly that's like a huge gift to me because if I did have to pay tuition I would be \$300,000 in debt by the end of this...So now I have to take out like upwards of twenty thousand a year to pay for rent and all of the other things that I need to have for school. That will be \$80,000 of debt by time I graduate. It's not like I'm rolling in the dough, and I think people feel like because I have a scholarship I am and that's not the case at all.

To compact the issue further, the demands of the participant's programs do not create space for many of the participants to work; many of them do not have the free time to do so. This makes it hard for the participants when they have additional expenses to cover, such as Alice who has medical expenses from a major surgery. She shared that it is "financially rough" for her because her stipend is "so low" and she doesn't have family to fall back on.

**Obligations.** The issues discussed above are often increased for the participants that have the additional obligations to take care of such as supporting parents, siblings, children, or other family members. The majority of the participants could not turn to their families for support because they were not able to financially contribute, and multiple participants also had to help provide for their families in addition to taking care of themselves while juggling their coursework. Providing for families was not always a financial obligation either. Alice shared that she often had to take care of her siblings growing up. She reflected on how this affected her experience taking care of her siblings, sharing:

I feel like I had to grow up really fast. And so having that burden of being an adult before I was actually an adult, I think was something that has always sort of weighed on me. I had to like always be this really responsible person and because like the standards are, so people try to like hold us to these really high standards.

Even once Alice was in her Ph.D. program, her younger sister needed a new start in life, so she encouraged her sister to join her in California to stay with her. Matondo shared about similar obligations with her family. Matondo is Angolan and when discussing her culture she shared, “Angolan people, it’s like your oldest daughter is the second mom. I was the oldest daughter, the second child. She takes care of kind of everyone else in the family kinda helping the mom out.” Matondo makes many of her decisions based off of the need to provide for her family. When she discussed her future goals, she recalled that she did not necessarily know what she wanted to do, but she knew she would need a “well paying” job so that she could contribute to her family. She said, “if I pick a career where I don’t make a lot of money, I won’t be able to support these people that are not going to have any money when they retire.” Matondo has been helping her family financially since she was in high school and reflected on the stress that comes with that:

It's definitely a stressor, especially because I've been helping financially this entire time. I helped in high school. I helped when I was in community college. I helped when I was in undergrad, and I'm helping in grad school. I haven't stopped helping. I help a little bit less now. Well, I was helping a little bit less like starting last year, but with the covid stuff I have to help a little bit more because they can't do their jobs as much. The financial pressure has been large this entire time and it has been stressful this entire time. I've been doing that, and it does create a sense of like weariness.

Matondo shared that she even supports her brother by helping pay his rent. Because of the stress that it puts on her, she shared that she had to tell her family:

You guys are relying on me too much financially and it's like stressing me out. I can't keep giving you guys all of this money. The boys should be able to take care of themselves. They're full grown adults, they should be able to do this.

Nevertheless, she still focuses her energy on persisting in her graduate program because she knows that she will need to continue being a source of support for her family in the future, but she also acknowledges that it is the "most significant" factor that influences her graduate school performance.

One of the participants in this study, hillrunnergeo, has children. She decided to take time off to start a family after she completed her master's program. While she has the support of her husband for raising her children, they are something she had to take into consideration going back to school for her Ph.D. program and deciding on what program to attend. hillrunnergeo considered a range of graduate schools for her Ph.D. program, but when it came down to the school she decided on, she decided to remain close to home. She shared, "with two kids in school, you know, you get the call, they're sick. Well, I got to drive for an hour. It's like not

ideal.” She also shared that her involvement in extracurricular programming is often dictated by her availability since she has two small children at home. Multiple participants shared that it is hard to take care of themselves when they are focusing on the wellbeing of other people.

**Mental Health.** Access to mental health services was a trend that nearly all of the participants discussed in their interviews and the focus group. For many participants, it was important for them to have a mental health professional that they could have access to in order to discuss the stressors of their programs, their experiences and interactions, as well as everyday personal issues. When reflecting on the need for mental health services, Matondo shared:

Almost all of the Black women that go to grad school that I know have some form of general anxiety disorder or experiencing some form of depression. And a lot of Black women are also experiencing PTSD, which like, kind of like comes back at you stronger in this like really, male-dominated, but also like aggressive environment that is grad school.

Many participants shared that they were currently seeing a professional, had sought out a professional in the past, or that they knew they needed to do it in the future. For instance, Tamala state that she has many unresolved issues related to the negative interactions with professors, such as being called stupid by her biology teacher. She has started to internalize her feelings and blames herself for feeling like an imposter, saying:

It’s probably my fault cause I did not go and see counseling. If I had worked through these negative experiences right then and there instead of brushing them to the side and saying I’m just going to put my head down and move on. Maybe if I had dealt with them more and not let them fester, maybe I wouldn’t be this way.



This reflection shows that Tamala is aware of her traumas, she is able to discuss them and pinpoint exact incidents that trigger her. Yet, she has not reached a point where she feels ready to be vulnerable enough to share this with a professional counselor. The stigma of seeking mental health services was brought up during the focus group and hillrunnergeo shared, “You don't want to look like you're weak or like you can't handle this. Right. And so then here comes that pressure to try and just handle it on your own.” Unfortunately, handling it on their own becomes another obstacle to manage while focusing on academics, working, and taking care of themselves and, for some, their families.

For many participants, the obstacle they're facing is the fact that there are limited therapists on campus and limited therapists that they share an identity with. The participants shared that they would prefer to talk to a counselor that is a Black woman, which is hard to come by in their geographic areas, both on campus and their surrounding communities. Many of the participants feel like a Black woman would immediately believe and understand their struggles. Whereas some participants have shared that therapist have questioned the validity of the experiences by asking questions such as “are you sure that's really happening?” In the focus group, Alice shared:

Even like dedicated mental health services at universities tend to not have people that look like us...which sort of compounds this whole problem of not having really anyone you feel like you can talk to them, someone who understand your experience a little bit better.

Matondo agreed with this sentiment. On her campus there is one Black woman therapist, and to get access to her, students have to “indicate they were experiencing severe racial trauma on campus.” If Black students were not encountering overt racial issues, they could not request to work with her. Matondo shared that she was able to work with this therapist recently while

things were slow, but the therapist told her that they would need to “add something in” for the paperwork because her supervisors were trying to get her to stop seeing Matondo because her issues didn’t pertain to “extreme racial trauma.” Furthermore, Matondo was able to find a Black woman therapist off of campus, but it will take a two to three-hour commute to get to the therapist. This would require her to spend an entire day taking a bus and train just to access a therapist that she feels like she would be able to relate to.

The participants shared that they have a number of issues they try to work through including anxiety, depression, paranoia, racism, and sexism. These topics are hard to talk about for the participants because of how “painful” the experiences have been. While mental health services are not the solution for all of the issues mentioned above, they can equip the participants with techniques on how to overcome the feelings and stress associated with these sorts of issues. For instance, Matondo shared that working with a psychologist helped her “calm down” and reduce her stress levels, and it helped her “get out of bed in the morning and actually show up to lab and do work.” Psychological State is one of the four tenets that influences the development of self-efficacy. This refers to the mental state of an individual and how they are able to navigate stressful situations. Individuals who have a stronger psychological state are more likely able to handle stress. Black women encounter a tremendous amount of stress, as outlined in the plethora of experiences mentioned both in this category and the previous themes. Ideally, institutions could aim to create environments where students do not have to overcome stressful issues such as racism and sexism, but it is unrealistic to assume that any institution could guarantee an environment that is 100% void of racism, sexism, and other stressful situations such as anxiety. This furthers the importance of having resources such as mental health services to help Black women navigate the stressors they encounter.

According to the participants, having access to mental health services is a critical component to the success of Black women in stem. In the focus group, when they were asked what components they would include in building their most ideal STEM learning environments, all of the participants said they would ensure Black women have access to mental health services to help them navigate the different obstacles, stressors, and traumas that come with being a Black woman in STEM.

## Chapter 5

While nations around the globe are competing to be innovative leaders in the evolution of STEM fields, the U.S. is drastically falling short when it comes to providing qualified STEM graduates to enter the STEM workforce (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). More so, the U.S. is failing at fostering the potential contribution of women and minorities in STEM education and careers (Espinosa, 2011; Gayles & Ampaw, 2014; Johnson, 2012; May & Chubin, 2003; McCoy, Luedke, & Winkle Wagner, 2017; Ong, Wright, Espinosa, & Orfield, 2011; Palmer, Maramba, & Dancy, 2011; Perna et al., 2008). Historically, STEM has been a white male nominated field. Because of this, the culture and climate of STEM educational and career fields can be isolating and unwelcoming to Black women whose race and gender identities belong to two marginalized communities. Most STEM careers require an advanced STEM degree; yet, the number of Black women pursuing STEM graduate degrees and careers considerably drops from the low number of Black women graduating with STEM bachelor's degrees (Charleston et al. 2014; Johnson, 2012). If the U.S. is to be a major contender in STEM innovation, they need to prioritize the value of supporting and developing Black women in STEM education. There is a gap in the literature when it comes to exploring the experiences of Black women in STEM graduate programs at predominantly white institutions (Ong et al., 2011).

Utilizing phenomenological methodology, this study explored the experiences of nine Black women enrolled in STEM graduate programs at predominantly white institutions across the U.S. Aligned with an anti-deficit approach, this study sought to highlight the success of Black women who have persisted into STEM graduate programs in order to better understand the obstacles they have encountered throughout their STEM academic journeys as well as what techniques they have used in order to successfully navigate and persist. In order to center the voices of

Black women in STEM and understand how their experiences impact their self-efficacy, Critical Race Feminism and Social Cognitive theory were used as the guiding theoretical framework for this study. This chapter discusses the findings outlined in Chapter Four as they relate to the theoretical framework and guiding research questions of this study. Additionally, sections in this chapter will discuss the implications for policies and practices, limitations of this study, and recommendations for future research.

### **Discussion of Findings**

The findings of this study fill a gap in the research related to the lived experiences of Black women in STEM graduate programs at predominantly white institutions. More specifically, this study fills the gaps in research by outlining the different encounters Black women have in STEM programs and how they are able to navigate them in order to persist within their academic programs, departments, and larger campus communities. The experiences of the women in this study were categorized into four themes: (1) Building Academic Foundations, (2) Surviving the Culture of Science (3) Black Woman Scientist Identity Development, and (4) Impediments to Becoming a Black Woman Scientist. Amongst these themes, the most prominent trends that impacted participant's self-efficacy and ability to persist in their academic programs were relationships with mentors, the value of research and experiential learning opportunities, and the need for transformational change in the STEM.

#### **Relationships with Mentors**

The participant's experiences were explored throughout their entire academic journey, K-12 through graduate school. They revealed that relationships with some sort of role model, mentor, teacher, or professional staff member, at every academic level, had an influential impact on their self-efficacy and ability to persist. The participants shared stories about both positive

and negative interactions with various individuals that had lasting effects on them. For the participants, some of the most impactful relationships occurred during their undergraduate education. These were formidable years that laid the foundation for many of the participant's futures in STEM. According to Strayhorn (2010), half of undergraduate students that express an interest in STEM disciplines end up changing their majors within the first two years of their undergraduate studies. Therefore, it is important for students to build connections and a sense of belonging to their academics early on. According to Johnson (2012), strong student-faculty relationships help students develop a strong sense of belonging to the degree programs and increase their likelihood of persisting. Many of the participants shared about positive interactions with faculty member mentors in their undergraduate programs that kept them within STEM, even when they were considering changing majors or dropping out of school. For participants that were experiencing hostile interactions with faculty, staff, or peers within their programs, positive relationships with a mentor often superseded the negative interactions and helped them persist. While these mentor-mentee relationships do not completely negate the impact of the negative experiences for the participants, they were essential in countering potential outcomes such as the participants changing majors, dropping out of school, or not pursuing graduate school. For example, multiple participants were told by professors that they were stupid or did not have what it took to go to graduate school. The participants' mentors would often intervene and put the participants in positions that would help them excel.

For many of the participants, positive relationships with mentors were critical to their persistence for various reasons. Mentors often provided the participants with verbal encouragement that helped build their confidence. For example, some participants shared how the verbal affirmations they received from teachers in K-12 years helped them feel like they

could go to any college and accomplish their goals. Zeldin and Pajares (2000) explored the stories of women in math, science, and technology careers and found that verbal persuasions (encouragement) was one of the “critical sources of women’s self-efficacy beliefs” (p. 215). Their participants shared stories about a number of teachers, from various academic levels, that were “highly influential in the development of their competence and confidence” (Zeldin & Pajares, 2000, p. 230). For instance, their participants reflected on moments when teachers complimented their math work, encouraged them to pursue more advanced honors courses, and motivated them to tackle male-dominated degree programs such as engineering. Mentors also provided the participants in this study with social capital that helped them network new learning and professional opportunities, and often provided the participants with a role model to look up to as representation of what they could potentially accomplish. Professors in participant’s undergraduate programs helped unite many of the participants with other people in their network that they could connect with for research experience or graduate school, and many of the mentors that shared race and or gender identities with the participants were able to share stories of their personal experiences that the participants could learn from when navigating their own pathways.

Many of the participants shared that their most impactful mentors were either a person of color or someone at their institution connected to diversity, equity, and inclusion initiatives. The participants discussed the significance of having teachers and role models that they shared race and gender identities with, but overall, the participants agreed that it was more important to them to have a mentor that was genuinely invested in their success, no matter their race or gender. This concept was discussed by Griffin, Perez, Holmes and Mayo (2010) who shared that underrepresented minority students tend to seek out professors of color as role models because it can provide “proof that success in higher education is possible”, but they also found that truly

beneficial relationships relied on a “mentors commitment to fostering the mentee’s academic success” no matter their race (p. 98). This concept is important because there is a lack of Black women faculty in higher education (Lechuga, 2011). According to Gasman and Nguyen (2014), Black women only make up 1.7% of full-time STEM faculty. Therefore, Black women graduate students have few Black woman faculty mentors to pick from. Even though Black women students may prefer having a Black woman mentor (Lechuga, 2011), for STEM departments that have Black women faculty, they cannot expect Black women to carry the weight of mentoring all Black women students. This makes it essential to have access to quality mentorship from a variety of racial and gender backgrounds

Participants shared that they did not feel like many of their faculty and staff members were equipped with the skill, experience, or understanding to serve as mentors for them. One participant described mentorship as an “artform” that not everyone is skilled in. While some faculty members had the best intentions, they sometimes still displayed acts of colorblindness that would often minimize the participants lived experiences. Rasheem et al. (2018) suggests that not all faculty are equipped with multicultural competence to serve as adequate mentors. During the focus group, the participants shared that they felt like faculty and staff members at their institutions needed more bias and diversity training to be empathetic and aware of the challenges they face in their day-to-day existences. It is critical to ensure that students have access to trained faculty who are equipped to understand and meet their needs. Additionally, by ensuring all faculty are properly trained to serve as well-informed mentors, it spreads out the workload and alleviates the pressure often put on people of color to serve as mentors for all students of color. As outlined by Patton (2009), serving as a role model can often be time-



consuming and creates additional workloads that can often distract from their personal scholarly performance and research. This is not a burden that only faculty of color should face.

### **The Over-Valuation of Research**

Because of the nature of inquiry, exploration, and development, STEM degree programs and careers place a high value on research experience which has a major impact on both students and faculty. Research and scientific inquiry are core drivers of innovation in STEM. Because of this, research is a key component of STEM degree programs, faculty responsibilities, and student's experiences. For students, research participation has an impact on graduate school and career options in STEM (Zhan, 2014). Research has the potential to create deeper understanding of STEM disciplines, prepares students for graduate programs, helps students develop technical skills, and creates opportunities for mentorship and career exploration (Christe, 2013; McCoy et al., 2017; Ong et al., 2011; Palmer et al., 2011). Research also helps develop "teamwork, communication, and presentation" skills (Zhan, 2011, p. 32)

As previously mentioned, research experience is a critical component for graduate school preparation. For the participants currently enrolled in Ph.D. programs, research is the essential component of their graduate program as they are all tasked with fulfilling a research project requirement in order to graduate. Participation in undergraduate and master's level research showed Ph.D. and medical school programs that the participants had a "willingness to investigate", and it also helped them develop technical application and critical thinking skills that prepared them for research in their Ph.D. programs. For the medical students, one participant shared that her undergraduate research highlights her ability to investigate and solve complex medical problems as a future doctor. For participants who did not have the best undergraduate grades, research experience also reinforced their graduate school applications and made them a

more well-rounded applicant. Because of factors such as these, colleges, universities, and external programs, such as the National Science Foundation, understand the significance of undergraduate research opportunities and have invested funding to create research opportunities for undergraduate students (Strayhorn, 2011; Zhan, 2011). According to Strayhorn (2011), “colleges and universities have invested significant human and fiscal resources into establishing structured research programs and activities that stimulate undergraduate students’ interest in pursuing advanced degrees in STEM” (pp. 86-87). Strayhorn (2011) shared that most programs operate under the assumption that students who participate in research experiences are more likely to be successful than those who do not. While the benefits of research outlined in the literature aligns with the participant’s experiences, it calls into question whether or not institutions can truly meet the demand of creating research opportunities for all of their students with an interest in pursuing STEM graduate degrees and careers – even more so for larger schools that have several hundreds of students within a single major. Yet, even the smaller institutions are likely to have more students than they can accommodate with 1:1 mentorship and laboratory space.

Additionally, many of the participants shared that they had to navigate finding undergraduate research opportunities on their own by taking the initiative to reach out to faculty members and request to join their labs. For some of the participants, this was a challenge as they encountered faculty members that were not interested, unwelcoming, or created hurdles for the participants as if to discourage them from wanting to be in their labs; these are common experiences for Black students at PWIs (McCoy et al. 2017). Fortunately, some participants had access to minority serving organizations and programs that facilitated research lab pairings and funding opportunities. Multiple participants also shared that they only knew the benefits of and

how to seek out research opportunities because of the minority serving organizations or diversity officers that discussed research with them. As previously mentioned, colleges, universities, and external programs are investing significant financial resources to create research opportunities for students. Unfortunately, some participants shared that their faculty members would accept funding to have minority students in their labs, but they would fall short on providing the mentorship requirements that came with the funds. Other participants also shared stories of how faculty members would misappropriate grant funding for minority students; for example, using grant dollars allocated for Black or minority students on white students instead. Ultimately, this type of behavior seemingly betrayed an image of valuing research and funding opportunities more than the development of the Black women and other minority students in their labs.

Research has a major impact on faculty productivity as well as the quality of mentoring provided by faculty. The participants shared a wide range of positive and negative experiences within their research programs, both at the undergraduate and graduate school levels. While this study does not focus on the experiences of faculty members, multiple participants shared that many faculty members seemed to be torn between prioritizing their personal research goals or mentoring students within their labs. Matondo shared that two of her research PIs were openly vocal about being disinterested in mentoring and teaching students and instead wanting to focus on their research. According to Hesli and Lee (2011), research publications “are an important factor in performance evaluations, research grant awards, and promotion and salary decisions” for faculty (p. 393). Because of this, research becomes incredibly important for faculty members that are in tenure-track positions. In addition to employment security, tenure provides faculty members with a “guarantee of status in the academic profession” (Youn & Price, 2009, p. 212).

Therefore, many faculty potentially find themselves in a compromising position of needing to balance their own professional goals while supporting the development of students.

In addition to research, STEM-related extracurricular activities also help students reinforce skills and create space for students to explore career opportunities, develop leadership skills, and keep students informed about available opportunities such as summer programs and financial aid resources (Palmer et al., 2011). Throughout their academic journeys, all of the participants engaged with both research and extracurricular activities, although, sometimes the participants could not do both and often, at the Ph.D. level, the participants did not have time for extracurricular engagement or had to be extremely selective with their time. For many of the participants, extracurricular programming gave them an additional place to belong, provided them with a sense of community and support, and provided them with opportunities to interact with other Black women and individuals from other marginalized communities. Yet, some participants also discussed not having the opportunity to be engaged in extracurricular programming at the graduate school level because their programs either did not offer much programming for graduate students or their research lab PIs didn't want them to be distracted from their research by being involved in extracurriculars. This is yet another example of how faculty can get consumed with research productivity over the well-being and engagement of students, contributing to the over-valuation of research.

Overall, the literature outlines the benefit of students engaging in research and STEM-related enrichment programming (Ong et al., 2011). While the women in this study have shared stories that align with those benefits, they have also outlined several ways that the emphasis of research productivity, both on them and their faculty members, has caused added stress, caused them to question their belonging, and has sometimes put them at an additional deficit when they

are partnered with disinterested faculty or tasked with an additional workload for improving the culture of their labs and programs. Ultimately, when faculty prioritize research productivity over holistic student development, Black women may suffer due to the fact that they are already juggling “multiple systems of oppression” on a daily basis, they have to prioritize research over engagement in other activities such as meaningful extracurricular enrichment or mental health services, and they may end up prioritizing their faculty members professional advancement if their lab PIs are prioritizing their own professional growth goals.

### **Transformative Change**

Historically, STEM spaces are known to be dominated by white, cisgender men. For the women in this study, they are often one of a few, if not the only, Black woman or student of color in their academic programs and research labs. Furthermore, many of them shared that there is rarely a Black woman faculty member or diverse options of faculty in their programs. For some participants, they have the potential to be the first Black graduates from their programs. Because of this, many participants described their various programs as often lonely, isolating, unwelcoming, and dismissive of their unique experiences as Black women. Linder et al. (2019) shared that:

Students of color experience racism and microaggressions from their peers, faculty, and administrators in the form of assumptions of intelligence and ignorance, assumptions of criminality, tokenism, stereotyping and isolation, and expectations that they will educate white people about race and racism (p. 528).

All of the women in this study have reported experiencing at least one of the above-mentioned acts of racism or microaggressions. Unfortunately, most of the participants have experienced multiple acts of racism and sexism as they belong to multiple marginalized communities. The

participants reported that having to navigate these experiences while also trying to maintain their scholarly achievements put an added stress on them.

For some participants, when they approached their departmental leaders to address the lack of diversity within their departments, they were often met with defensive and/or minimalizing responses. Linder et al. (2019) conducted a study that explored the experiences of students of color as they related to identity-based activism and resistance. This study found that power imbalances often presented between the students of color, whose identities are “often in opposition to the administrators they were challenging”, and institutional leadership who were “disproportionately white, cisgender, heterosexual men” (p. 529). According to Linder et al. (2019), these power imbalances were “based on both positional power and social identity power” for the administrators. For the women in this study, the power imbalances often displayed as defensive, avoidant behavior, and the responsibility for change was often pushed off onto the participants.

The participants reported that they were often charged or tasked with the responsibility of driving diversity initiatives in their programs and departments. The participants in the Linder et al. (2019) study referred to activism work as a “burden or responsibility” (p. 529). Similarly, the women in this study shared that they often had to carry the burden of serving on diversity committees, drafting call of action letters to the department to request more diverse faculty members, and being tasked with the responsibility for being the “catalyst for change” within their departments. Tamala reflected on the experience at her institution saying, “I didn’t come here to save [them]. I came here for a Ph.D. I did not come here to take on the burden to make this a more inclusive [program].” Transformative change, which “puts the responsibility of change on institutions and their agents rather than on students who hold relatively little power in

the educational environment” (Johnson, 2012, p. 344), is a concept that many STEM education spaces need to fully embrace. The women in this study, and students in general, hold relatively little power when it comes to enacting changes to policy and practices. Besides the fact that Black women and other marginalized students shouldn’t have to carry the burden of enacting change while simultaneously focusing on their studies, the students do not have the ability to change STEM cultures engrained with an exclusive, elite mentality that values research over teaching and student development; especially if students of color are being met with defensive and dismissive behavior at the mention of the discouraging effects of unwelcoming, isolating environments riddled with acts of sexism, racism, and microaggressions. Additionally, these are burdens that white students do not have to carry while they focus on their academics. This put Black and other marginalized populations at a disadvantage when it comes to making quality progress within their programs.

Higher education institutions are responsible for providing a service – the transfer of knowledge and space and resources to master it – to students. The responsibility of ensuring learning spaces are welcoming, inclusive, equitable and supportive should lie at the core of an institutions mission and values, and the institutional leadership should take sole responsibility for ensuring it meets those standards and takes necessary actions when it does not.

### **Addressing the Research Questions**

This study utilized three guiding research questions: (1) What are the shared experiences of Black women in STEM graduate programs at predominantly white institutions? (2) How does the intersectionality of race and gender affect the development of self-efficacy of Black women in STEM; in turn, how does self-efficacy affect scientist identity development of Black women in STEM fields? (3) How do their experiences impact their decisions to persist and/or pursue

STEM careers? The literature review highlights the fact that there is an underrepresentation of Black women in STEM, even more so as degree level advances and in STEM career fields (Charleston et al. 2014; McCoy et al. 2017; Ong et al., 2011). It also highlights that there is a gap in the literature when it comes to the specific experiences of Black women in STEM graduate programs at PWIs. Instead of centering the voices of Black women in STEM, their experiences are often conflated with all women, other women of color, or Black men. (Ong et al., 2011).

**Research Question #1.** For the first research question, “what are the shared experiences of Black women in STEM graduate programs at predominantly white institutions?”, the most common shared experience across participants, at the graduate school level, involved feelings of loneliness that came with being a Black women in a homogenous environment that lacked diverse faculty, staff and peers. Other experiences were common across many participants such as having to navigate financial obligations and the lack of adequate funding as well as having inadequate access to mental health resources, but nearly every participant shared that being a Black woman in their graduate programs was lonely. Participants shared that they felt lonely because there were not many people that looked like them. As a result, they often felt like the “only one in small groups” or a sense of “othering”, which resulted in some participants experiencing tokenism, which Linder et al. (2019) identified as a form of racism and microaggression that students of color often face in higher education. Participants shared that these feelings were hard to overcome even when no one was saying or doing anything to make them feel that way.

These feelings of loneliness, othering, and tokenism were often accompanied by imposter syndrome. According to McGee and Bentley (2017), imposter syndrome is “defined as the normalization of being perceived as a fraud in spite of high achievement in their academic



domains” (p. 267). Many of the participants shared that they felt like imposters in their programs, like they did not belong or deserve to be there – even though they have a plethora of skills and experiences to support their existence in these programs. Many of the participants felt this way because they were comparing themselves to peers within their program. The lack of representation of Black women in their programs often caused participants to question if they belonged in their program. To add to that, many of the participants peers came from a variety of academic backgrounds with very different skill levels and experiences. Many of the participants viewed their peer’s skill and academic backgrounds as indicators of where they were supposed to be academically, often causing the participants to feel like they were lacking the skill, experience, and/or right to be within their programs.

Chakraverty (2020) conducted a mixed-methods study that explored the experiences of 15 Black or African American STEM Ph.D. students that included 13 women and 2 men. Their participants reported experiencing moderate to intense imposter syndrome triggered by experiences such as: being the only one in their departments and not having anyone they identify with, having a sense of not belonging, experiencing stereotyping and microaggressions, and feelings of only being in their programs to help their departments meet a diversity quota. Imposter syndrome is not something that is limited to student nor an issue only experienced by Black women in STEM. Allen and Joseph (2018) conducted a study that included 18 Black women students, faculty, and staff from various colleges within a PWI including, but not limited to, the College of Education, School of Theology, and the Graduate School of Professional Psychology. This study evaluated the benefit of having a support program called the Sistah Network, which intended to help Black women students, faculty, and staff navigate challenges such as differential treatment and/or experiences of isolation or invisibility. According to Allen and Joseph (2018), these

experiences “can leave Black women with perspectives of inferiority and imposter syndrome affecting their academic and social progress while in the academy” (p. 1). These studies are aligned with the experiences of the women in this study and demonstrate that imposter syndrome is something that Black women face throughout academia, no matter their academic level or professional status.

The participants shared that while these experiences were hard to navigate on their own, finding a community and having access to mental health resources often helped them counter those feelings. Some participants had an easier time finding community, but most participants had to be intentional about finding people that they could connect with beyond a superficial academic level. McGee (2016) discussed racial battle fatigue, which describes “the stress associated with being Black in predominantly White educational environments” (p. 1632). McGee (2016) went on to state that the time students expend trying to “function among stereotypes” can lead to “detrimental psychological and physiological stress” (p. 1632). This is aligned with the types of stress and anxiety the participants shared regarding their needs to have access to mental health resources. Unfortunately, most of the participants shared that it has been hard to find a counselor that can adequately meet their needs and genuinely understand their experiences. The participants shared that there were typically not Black woman counselors on campus, and when there was, she was often booked because of the number of students that intentionally seek out her services. They also shared that non-Black counselors often minimize their experiences or have questioned whether or not things were happening exactly as the participants described. Watkins, Hunt, and Eisenberg (2011) shared that “mental health problems of students, [in general], are more severe now than they have been in the past and that a greater number of students are seeking help” (p. 2). Yet, they also shared that institutions are faced with

multiple issues such as “budgetary cutbacks” that make it difficult to provide and grow mental health services” (Watkins, Hunt, & Eisenberg, 2011, p. 2). They also acknowledged that with “an increase in the number of students of color” there will be a demand for counseling services that are “culturally appropriate” (Watkins, Hunt, & Eisenberg, 2011, p. 15).

**Research Question #2.** The experiences outlined with the first research question also connect to the second question. As outlined by Bandura (1986 & 1987), self-efficacy is influenced by four tenets: Mastery Experiences, Vicarious Experiences, Verbal Persuasions, and Physiological State. For the participants, the intersectionality of their race and gender often had a direct effect on all of these tenets. Because Black women belong to two marginalized communities, being Black and a woman, they have the potential to face adversity on dual fronts in STEM as they often have to navigate acts of both racism and sexism (Charleston et al., 2014; Ong et al., 2011; Soldner et al., 2012; Thomas et al., 2009). The intersectionality of race and gender greatly influenced many of the participants experiences, and it was often hard for them to discern if their experiences were specifically a result of racism or sexism. The participants shared that it was hard for them to tell if some of their encounters were because they were a woman, because they were black, or both because they were often covert and very nuanced experiences – such as someone questioning if they did their research on their own, feeling like their opinions were disregarded during discussions with their research PIs and classmates, not getting good projects to work on, or often being treated as if they were invisible. Additionally, some participants felt like if they showed any signs of struggling in their programs, people automatically defaulted to the reason being because they were a Black woman who needed help to progress.

The participants had the unique opportunity to have experiences within all four self-efficacy tenets within their research lab environments: mastery experiences from the hands-on learning opportunities; vicarious experiences by having the chance to observe peers, mentors, and their PIs in the labs; verbal persuasions through dialogue and guidance they received in their labs; and physiological state by how they were able to handle and navigate any stress they encountered. None of the participants always had positive experiences in every category. Each participant had unique lab experiences where they had a combination of positive and negative interactions aligned with the four self-efficacy tenets. Some participants shared that they had good hands on experiences in their lab (mastery experiences) as well as opportunities to observe other (vicarious experiences) but did not have great verbal experiences (verbal persuasions). On the other hand, some participants shared that they had both an overall terrible lab experience, with negative experiences for all four self-efficacy tenets, only to be followed up with an overall phenomenal lab experience with positive interactions for all four self-efficacy tenets.

For the participants who often encountered racism and sexism in their labs, they often lacked quality opportunities to have positive or successful experiences that would have helped them develop their confidence. These participants did not always get the opportunity to develop strong hands-on experience through quality projects, many of them did not gain positive vicarious experiences because their lab mates were often having similar experiences, and they were often verbally dismissed and spoken to poorly. These participants also reported having low self-efficacy, and unfortunately, perceived self-efficacy did not necessarily improve when they had opportunities for better experiences. If anything, their negative experiences provided opportunities for them to develop their physiological state. The literature suggests that people are more likely to be successful if they are able to handle adverse and stressful situations, which may

be an indicator of how these participants were able to persist (Thomas et al., 2009). On the other hand, the participants who have developed a strong self-efficacy shared about opportunities to develop in a welcoming, supporting lab environment, with more positive than negative experiences aligned with the four tenets. These participants are more confident in their technical skills and performance and had an awareness of how to navigate stressful situations that they encounter.

For the second portion of this research question, “how does self-efficacy affect scientist identity development of Black women in STEM fields?” Overall, at the graduate school level, majority of the participants shared that their self-efficacy was either high or improving as it related to their confidence in their academic abilities and engagement in their programs, and most participants were confident in their identities as a Black woman scientist. As mentioned in Chapter 4, most of the participant’s confidence has fluctuated over time as they have encountered new and different sorts of experiences, people, and obstacles. On the other hand, the participants with a lower self-efficacy reported that they did not have a strong identity as a scientist. Many of the participants shared that their sense of identity as a scientist was directly affected by whether or not other individuals in their fields saw them as a scientist. The literature discusses the importance being recognized by a legitimate science person by other meaningful individuals within the science community (Carlone & Johnson, 2007; Ong et al., 2011). In a science identity model outlined by Carlone and Johnson (2007), Competence (knowledge), Performance (skills), and Recognition (by self and meaningful others) all interact with each other forming a scientist identity. In this model, racial, ethnic, and gender identities also have an effect on competence, performance, and recognition (Carlone, 2007). The experiences of the women in this study align with this concept, whereas the intersectionality of race and gender, and

potentially other salient identities, have a fluid effect on their competence, performance, and recognition.

**Research Question #3.** For the third research question, “how do their experiences impact their decisions to persist and/or pursue STEM careers?”, the majority of the participants have a clear vision of what they would like to do when they are done with school. Aligned with the literature (Christe, 2013; McCoy et al., 2017; Ong et al., 2011; Palmer et al., 2011; Zhan, 2014), participating in research, summer programs, and STEM related extracurricular activities has helped these participants figure out what they want to do with their futures. Six of the nine participants were able to give specific future goal, although, the participants that identified as having a low self-efficacy were not able to identify what they would like to do when they are done with their graduate programs. For those individuals, they appear to be in survival mode, just trying to get through their program one day at a time. The literature states that career exploration is a benefit of participating in research and experiential learning opportunities (Strayhorn, 2010; Zhan, 2014). Given the fact that these participants also shared some of the most negative academic and research experiences of all of the participants, this may be an indicator of why they do not have a clear outlook on the future in STEM or possible careers.

### **Connection to Theoretical Framework**

In order to better understand the experiences and decision-making process of Black women as it relates to the ability to pursue and persist in STEM, Critical Race Feminism (CRF) and Social Cognitive Theory (SCT) were used in conjunction as the guiding theoretical framework for this study. In the literature (Crenshaw, 1991; Wing, 2003; Charleston et al., 2011; Ong et al., 2011), the specific experiences of Black women are often conflated with the experiences of Black men or all women. Therefore, this study found it essential to use CRF as a

theory that both highlights the power dynamics at play when it comes to minorities in STEM, while centering the specific experiences of Black women. SCT attempts to explain human behavior under the assumption that behavior, cognitive and other personal factors, and environmental events all interact and affect each other to influence human behavior (Bandura, 1986). Self-efficacy, an individual's confidence, is core to SCT which suggests that individuals with a higher self-efficacy in a certain area are more likely to attempt tasks in that area. Marra, Rodgers, Shen, and Bogue (2009) highlight the fact that the skills gap for women engineering students is closing. Because of this, they explored the self-efficacy of women engineering students to better understand why the representation of women in engineering continues to remain low. Marra et al. (2009) suggest that self-efficacy "offers a framework for exploring phenomenon that is broader than that of a skill deficit" (p. 27). Zeldin and Pajares (2000) shared that women who are "aptly competent in mathematics often fail to pursue mathematics-related careers because they have low self-efficacy perceptions about their competence" (p. 218). Therefore, SCT was used in this study under the notion that Black women with high self-efficacy in STEM would be more likely to persist and enter the STEM workforce. Together, SCT and CRF were used to posit that the experiences Black women face because of the intersectionality of race and gender would potentially impact their self-efficacy, and ultimately, their decisions to persist and pursue STEM-related careers.

### **Critical Race Feminism**

It was important for this study to dismantle the ideal of a monolithic Black or monolithic woman's experience, seeing as Black women belong to multiple marginalized communities. This study exposed many of the dual oppressions Black women face in STEM degree programs that have the potential to go uncovered when they are explored under the guise that all women

experience STEM the same; this is important because many of the studies that explore the experiences of women or Black people in STEM often have little representation of Black women (Evans-Winters & Esposito, 2010). Participants acknowledged that some of their white female counterparts experienced similar acts of sexism, such as their opinions being dismissed by male peers and faculty members. What is important about the experiences of the women in this study is the fact that Black women face these instances in conjunction with racism. While the participants did not share blatantly overt acts of racism such as being called racial slurs, they did share about nuanced experiences such as people wanting to touch their hair, not receiving the same kind of support in their classes and labs as their white counterparts, having assumptions made about the abilities or struggles based off their race, being tokenized as one of the few or only Black students in the department, and so on. The participants often reflected on the fact that they could not discern whether their experiences were motivated by their race or gender identities, or both. Therefore, this theory helped center the voices of Black women to capture the essence of their experiences of being both Black and woman in white, male dominated STEM fields (Ong et al., 2011; Wing, 2003).

Every participant in this study reflected on at least one instance where they questioned their belonging at some point in their academic journeys because they were one of a few or the only Black woman or minority in their programs. Many participants reflected on experiences of being rejected, mistreated, or dismissed by faculty members. Multiple participants shared stories about having to educate their peers related to their inappropriate sexist and/or racist behaviors. For instance, Cecelia shared a story about overhearing a white male peer joke about looking forward to becoming a doctor so that he could administer breast exams. The participants agreed that it was often exhausting to have to explain to their peers why this type of behavior was



inappropriate. Additionally, many of the participants were tasked with the responsibility of championing cultural and diversity changes in their departments. This is a burden that Black women are responsible for on two fronts and ultimately, their white female counterparts do not know the extensive burden of having to advocate for themselves across multiple dimensions as noted by Johnson (2007) who stated “women of color fit even less easily than white women into university science [spaces]” (p. 806).

Critical Race Feminism is a theory described to still be in its infancy (Wing, 2003). Therefore, there is not an abundance of literature that has used it in higher education. Childers-McKee and Hytten (2015) describe CRF is an “untapped resource in school reform” as they used it to explore K-12 education reform. This study shows the benefit of using a critical feminist theory in order to specifically highlight the experiences of Black women in spaces that are historically white male dominated.

### **Social Cognitive Theory**

As for SCT, perceived self-efficacy is at the core of this theory, which is how individuals perceive their ability to “take the actions required to achieve a particular outcome” (Marra, Rodgers, Shen & Bogue, 2009, p. 27). According to Bandura (1997), individuals with a higher self-efficacy are more likely to attempt a task. How participants experiences influenced their self-efficacy is discussed in the previous section. It is important to highlight here that while majority of the participants reported a high self-efficacy, three of them shared that they had low self-efficacy and have still been able to persist. This notion suggests that more goes into human behavior than just perceived self-efficacy. As mentioned in previous sections, there are four tenets that influence the development of self-efficacy. While this study did not focus on whether or not one of these tenets had a larger influence on the participant’s confidence, it is worth

exploring how experiences in the different categories influence individual's overall self-efficacy, as well as if one tenet has the power to outweigh other tenets. Mastery experiences (first-hand experiences) are identified as the most important source of self-efficacy (Bandura, 1986). While three of the participants shared that their overall confidence in their academic ability, program engagement, and scientist identity was low, these participants all had successful mastery experiences throughout their academic journeys. According to Bandura (1986), successful mastery experiences have the potential to strengthen self-efficacy. Similarly, each of these participants were able to reflect on at least one positive experience related to the other three tenets of self-efficacy: vicarious experiences, verbal persuasions, and physiological state. Therefore, while the participants have a low perceived self-efficacy, they have also had some positive experiences which ultimately might serve as a tether to keep them rooted in STEM and able to persist.

Zeldin and Pajares (2000) conducted a narrative analysis study with 15 women in mathematics, science, and technology careers and found that verbal persuasions and vicarious experiences were "critical sources of the women's self-efficacy beliefs" (p. 215). This aligns well with the findings in this study as many of the women reflected heavily on the verbal encouragements they received from influential teachers, role models, and mentors over the years. Zeldin and Pajares (2011) discuss the idea that women tend to report more vicarious and persuasive experiences in mathematics than their male counterparts, who tend to report more performance-based accomplishments. This notion may also explain the dynamic at play for the women who reported having low self-efficacy, despite their continued persistence. Two of the participants that reported having low self-efficacy shared stories about several negative verbal exchanges with faculty and lab PIs both in their undergraduate and graduate school programs.

For instance, Tamala shared that one of her biology professors called her stupid for failing an early biology course. She also shared that her first undergraduate PI told her that she did not see a Ph.D. in Tamala's future. Tamala reflected on the fact that she has an abundance of phenomenal research experiences (mastery experiences) but still struggles with her confidence stating:

I do have a lot of research experience, I do deserve this for all of the blood, sweat, and tears that I've done to get where I'm at now. But with the confidence issues and people telling me that I'm not supposed to be here, how am I not supposed to feel like an imposter.

Additionally, according to Margolis and McCabe (2006), self-efficacy and an individual's willingness to attempt a task depends both on the individual's belief they will be success and the credibility of the "message giver" delivering verbal persuasions. Therefore, if faculty members, the gatekeepers of knowledge in higher education, are sharing negative messages with the participants, it is reasonable to draw conclusions to why their confidence is suffering. In reverse, many of the participants the reported a high or improving self-efficacy, reflected on having multiple verbally supportive teachers, role models, and mentors throughout the years.

Many of the participants in this study also demonstrated an innate internal drive to succeed and persist. Physiological state is the fourth tenet that influences the development of self-efficacy and is described as an individual's mental state and ability handle adverse and stressful situations.

Thomas et al. (2009) suggests that individuals who are able to handle adverse and stressful situations are more likely to be successful. Many of participants discussed the burden that their experiences have placed on their mental wellbeing. McGee (2016) discussed the various racial biases that Black and Latino/a students encounter in institutions with "racially hostile academic

spaces” – such as STEM (p. 1626). McGee (2016) unpacked the notion that many institutions attempt to increase the academic performance of minority students by enhancing their grit, defined as “perseverance and a passion for long-term goals (p. 1629). Yet, they also point out that advocates of grit “do not address the structural restraints perpetuated by everyday forms of racism and discrimination” (McGee, 2016, p. 1630). This is important for Black women in STEM due to the fact that they do encounter a variety of racism and gender discrimination in their white male dominated programs. While their physiological state may indicate an influence on their self-efficacy and ability to persist, it comes at the cost of internalizing volatile and problematic experiences.

### **Implications for Future Policies and Practice**

This study explored the shared experiences of Black women enrolled in STEM graduate programs at PWIs across the U.S. The participants had the opportunity to share their academic stories during semi-structured, one-on-one interviews and during a focus group session. The findings from this study expose several themes that can aid in developing future policies, practices, and programming to better support Black women in STEM. While this study focused on Black women in graduate programs, data collection explored their experiences from K-12 through graduate school in order to holistically understand what Black women face throughout the education pipeline. The researcher hopes that this study will shed light on the various obstacles Black women encounter throughout STEM that potentially hinder them from persisting, graduating, and entering the STEM workforce.

In many regions, the PK-16+ pipeline is fragmented with poor communication and programming between the different segments of education (Gayles & Ampaw, 2014). Hopefully, education systems will utilize this research in ways that seal off the metaphorical leaks causing

systems to lose students at critical junctures (i.e. from high school to undergraduate school or undergraduate school to graduate school). This study highlights a number of issues Black women face during their STEM academic pursuits most prominently being access to quality mentee-mentor relationships, a balance between extracurricular engagement and experiential learning opportunities, and access to resources such as financial aid and mental health services. The participants stories highlight how the culture and climate of STEM still holds on to an elite, exclusive mentality that is often unwelcoming and hostile to Black women and other marginalized communities. This study can encourage STEM degree programs and larger campus communities to assess their campus and departmental climates to ensure it is welcoming and supportive to all students no matter what racial, gender, sexual, or religious identities they belong to. According to Linder et al. (2019), “students of color are frequently pushed to under-resourced identity-based centers (e.g. multicultural centers, women’s centers, LGBT centers) to address their concerns so that administrators and educators do not have to change the ways university systems operate” (p. 529). This is not an adequate solution to solving the essence of the issues at hand. Institutional and departmental leadership must hold themselves accountable at addressing the cultural and climate issues that Black women and other minority populations face in higher education as a whole and within their programs.

### **Implications for Future Policies**

Based on the findings, implications for policy include recommendations for both larger campus communities as well as the specific STEM departments. Faculty and staff play a major role in the development of students. Ultimately, they are the gatekeepers of knowledge, policy and program makers and it is up to them to ensure that students have a welcoming, supportive environment to learn and reach their goals. The literature review of this study discussed Outcalt

and Skewe-Cox's Reciprocal Engagement theory that suggests there is a "mutual nature of the student/campus relationship" that is dependent on both students being actively involved with their campus but that student success truly lies on the institution environment (Outcalt & Skewe-Cox, 2002, p. 333). Aligned with this notion and the premise of Transformative Change, institutions have to take the initiative to ensure students have a safe space and adequate resources in order to persist and graduate. For Black women in STEM, this includes: access to faculty and staff who are trained to recognize personal biases and embrace the diverse identities students possess; access diverse faculty and staff that can serve as mentors; supportive experiential learning opportunities, both on and off campus; and access to mental health services. When developing resources for Black women in STEM, institutional leaders must use a critical feminist lens that embraces the intersectionality of race and gender of Black women as well as focuses on the historical power imbalances that have set the tone for the culture and climate of STEM. Institutions must acknowledge that STEM has historically been a white, male dominated field known for being unwelcoming and isolating for Black women and other marginalized communities.

Additionally, previous literature has highlighted the benefits of mentor-mentee relationships for students of color (Crawford & Smith, 2005; Gasman & Nguyen, 2014; McCoy et al. 2014; Rasheem et al., 2018). For Black women interested in pursuing a STEM graduate degree and career, faculty are often the best individuals situated to serve as a mentor due to the fact that they interact with students as their professor, faculty advisors, and potentially provide students with research lab experience. Because of this it is important for students to have access to diverse faculty members that understand their background and experiences, but it also important for white faculty members to be trained to recognize implicit and explicit bias, how to

embrace diversity and the many backgrounds that students come from, and how to actively engage students while they're progressing towards their goals.

Additionally, many tenured or tenure-track faculty have the burden of having a high research productivity due to the obligations of making tenure. According to Miller and Struve (2020), non-tenure track faculty are often “involved in a variety of service and mentoring duties, which are undervalued and/or unrecognized by the institution and by their tenured/tenure track peers (p. 3). They went on to say that tenure track faculty often assume more research and doctoral level responsibilities (Miller & Struve, 2020). In STEM disciplines, tenure track faculty should not pass off mentor and service responsibilities to non-tenure track faculty members. Students with aspirations to pursue graduate degrees and careers in STEM needed to be linked up with faculty members that are doing the research and deeply connected to their fields. The participants in this study highlighted many occasions where they felt like their faculty members valued research and funding more than mentoring and teaching. Ultimately, mentoring and teaching is the key component of higher education. The researcher hopes that institutions will consider revisiting incentives for tenure to include mentoring budding scientists as well as diversity, equity, inclusion, and bias trainings.

### **Implications for Future Practice**

The women in this study were asked to build their ideal STEM environments. As part of their recommendations, they included: more diverse faculty members and better diversity and bias trainings, more opportunities to engage in extracurricular programs and organizations as graduate students, opportunities to give back and serve as mentors for other up and coming Black girl scientist, additional funding for scholarships and research, mental health therapists embedded in graduate departments, and more opportunities for cohort learning across disciplines

and institutions. For this last item, it was incredibly important to the women in this study to have access to a larger network of other Black women in various STEM disciplines. Many of the participants wanted to have a “Black-woman centered group” that they could check-in with, communicate about research, and share ideas. The participants wanted to be able to work with women across different disciplines in order to connect with individuals that might be more proficient in areas that they are not, such as coding or computer science. Therefore, the researcher hopes that institutions will develop more cohort learning opportunities for students as well as cross-campus partnerships to connect their students to a larger, global population of Black women pursuing STEM degrees.

Many of the participants put an emphasis on the need for better diversity and bias trainings for faculty and staff members. The researcher hopes that institutions will assess and implement ways to engage faculty members in professional development opportunities related to pedagogy, diversity, and implicit and explicit biases. For instance, institutions could engage faculty, staff, and students in seminar opportunities that specifically focus on dismantling racist, sexist, and bias STEM environments. As mentioned in previous sections, institutions can leverage these opportunities by including them in tenure and professional development requirements for faculty – similar to how staff members have required professional development trainings. While the appeal and prestige of research and scientific discovery are influential for faculty as well as their departments and institutions, one must remember that the purpose of higher education is to create learning, mentoring, and growth opportunities for students. Therefore, the development and welfare of all students needs to be prioritized to ensure students have safe, welcoming and encouraging places to learn. These professional development



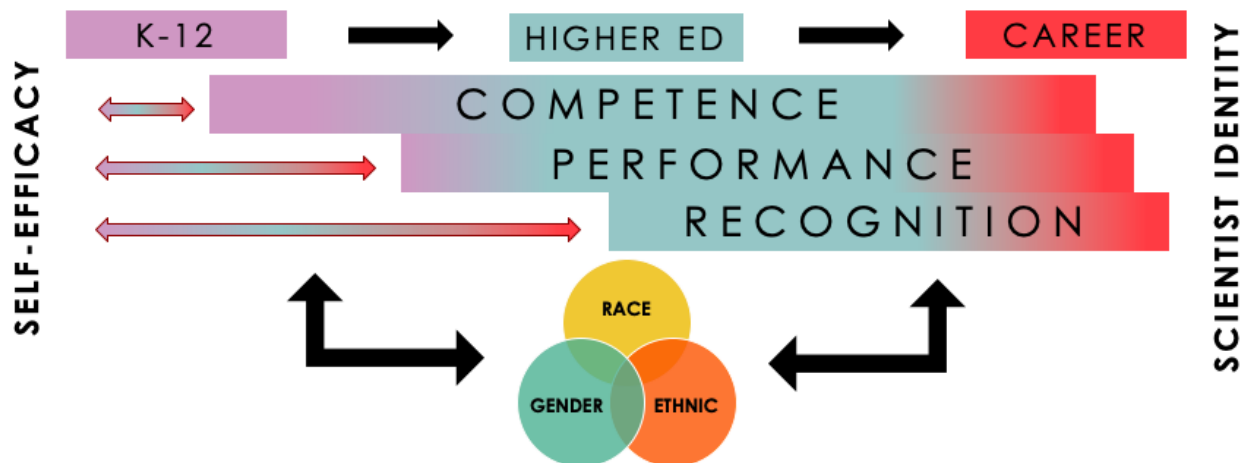
opportunities are also important because faculty often have free reign when structuring research lab opportunities and set the tone and rules for interactions and conduct.

**Black woman scientist identity development model.** Carlone and Johnson (2007) conducted a grounded theory study that resulted in a science identity model that outlined how science identity forms in women of color, including Latina, African American, Asian American, and American Indian women. Their model suggest that three interrelated components impact science identity: (1) competence, “knowledge and understanding of science content”; (2) performance, “requisite skills to perform”; and (3) recognition, including both self-recognition and recognition from others (Carlone and Johnson, 2007, p. 1190). Additionally, their model “is based on the assumption that one’s gender, racial, and ethnic identities affect one’s science identity” (Carlone & Johnson, 2007, p. 1191). This study found recognition to be “problematic” because it “hinged so crucially on an external audience” of “mostly white males” (Carlone & Johnson, 2007, p. 1207). They further stated that “it is much easier to get recognized as a scientist if your ways of talking, looking, acting, and interacting align with historical and prototypical notions of scientists” (Carlone & Johnson, 2007, p. 1207).

This study aligns with the logic of Carlone and Johnson (2007). Participants had solid opportunities to build their competence and performance. Yet, many participants shared that their scientist identity fluctuated or depended on who they were around or interacting with. For example, Matondo shared that if she was in a space with her friends or people that looked like her, she had a greater sense of confidence and identity as a scientist; on the other hand, if she was surrounded by predominantly white people or individuals she was not familiar with, her sense of confidence and identity as a scientist diminished. As previously mentioned, there is a disconnect in the PK-16+ pipeline (Gayles & Ampaw, 2014). Yet, this study highlights the importance for

STEM engagement throughout the pipeline as it relates to: (1) academic engagement; (2) interactions with faculty, mentors, and peers; and (3) involvement in extracurricular activities and research. Therefore, this study suggest that the scientist identity model should be displayed across time, typically from K-12 into careers.

**Figure 1. Proposed Scientist Identity Development Model**



Within this model, competence, performance, and recognition develop and interact to influence scientist identity development. This model demonstrates how competence and performance will typically start to develop during K-12 years and are refined in higher education and careers. Additionally, recognition starts to have an influential impact during higher education when many individuals are beginning to explore research, publications, and conferences that allow for interactions and potential recognition from others in the science community. Aligned with the experiences of the participants within this study, an individual’s self-efficacy and the central components – competence, performance, and recognition – have a mutual impact on one another as depicted with the double-sided arrows. Lastly, this model retains the notion that race, gender, and ethnicity have an impact on scientist identity, but is displayed in a venn-diagram as to highlight how the intersectionality of these factors can impact scientist identity development. For this study, it is also important to recognize that both race and ethnicity are listed due to the

fact that Black people do not have a monolithic Black experience. Therefore, including ethnicity encompasses the African diaspora. This is important for the participants in this study because while they all identify as Black, participants came from a variety of Black cultures.

### **Limitations and Future Research**

This study has a number of limitations that should be addressed with additional research. While nine participants were used for this study, and all but one them were from a Biological Sciences background. The one participant that does not have a background in Biological Sciences has degrees in Geology. While this participant is an outlier for degree programs, her experiences are aligned with the other participants. The participants experiences should not automatically be assumed to be the same for Black women in Technology, Engineering, Physical Sciences or Mathematics based programs without further exploration. While participant recruitment was done for women from those programs, this study was unsuccessful at finding a willing participant. This is aligned with the literature that outlines that there has been an increase in the number of women pursuing degrees in fields such as biology while men still make up 79% of degrees in fields such as engineering, computer science, and physics (Charleston et al., 2014; Marra et al., 2009). Because of the fact that these fields are even more male dominated, it would be incredibly valuable to explore the shared experiences of women in these fields.

Only five of the nine participants were available to participate in the focus group session. The purpose of the focus group was to allow participants to further unpack similar themes that presented across the individual, one-on-one interviews. The researcher believes that the data collected from the focus group participants would have been similar to information collected from participants that were not present due to the fact that the absent participants had already shared experiences and stories that were in alignment with the focus group discussions. For

instance, the participants had opportunities to discuss their ideal STEM environments where they agreed that it would be important to have access to mental health counselors, funding, and bias and diversity training for faculty and staff. These are all topics that the absent participants discussed during their individual interviews.

Each participant in this study self-identified as Black women. Although, one participant discussed her preference to not be identified by race. While this participant acknowledge and discussed her experiences as a Black woman, she also discussed just wanting to be seen as a scientist. Additionally, this study only explored the experiences of cisgender women. There were participants in this study that shared that they have a queer identity, but recruitment was done to only include the experiences of cisgender women. Importantly, transgender women are going to have a plethora of experiences that are valuable and potentially distinctly different than cisgender women. Because of the scope of this study, that explored the experiences of women from early childhood through graduate school, transgender participants were excluded because they would have a variety of different experiences depending on when they started identifying and/or presenting to the public as a woman. Because of the additional layer of intersectionality that transgender Black women face, a study should be done to focus on their shared experiences.

### **Conclusion**

There is a disparity in the number of Black women pursuing STEM graduate degrees and entering STEM career fields. When it comes to the education of Black women in America there are deeply rooted racial and gender power dynamics at play, in both K-12 and higher education spaces. This study sought to better understand the shared experiences of Black women in STEM graduate programs at PWIs across the U.S. in order to better understand what obstacles Black women encounter in STEM and how they are able to successfully navigate them. In order to

center the voices of Black women and understand what factors influence their decisions to persist in STEM, Critical Race Feminism and Social Cognitive Theory were used as guiding theories for this study.

This study reaffirmed many aspects of the literature as it relates to STEM environments often being unwelcoming and isolating for Black women. The lack of diverse representation amongst faculty, staff, and students in both higher education as a whole and STEM degree programs often makes it hard for students to develop a sense of belonging and often contributes to environments riddled with racism, sexism, and microaggressions (Linder et al., 2019). This study revealed that Black women in STEM greatly depend on quality interactions with mentors, research experience, minority serving organizations to stay connected to their studies, prepare for graduate school and careers, and develop a sense of community. It is important for higher education institutions to break away from historical traditions that are often engulfed in racist and sexist traditions, to path the way from more inclusive, welcoming, and supporting learning environments that ultimately prioritize student's overall wellbeing and learning.

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## APPENDIX A

### LETTER OF INVITATION TO PARTICIPATE

Dear student \_\_\_\_\_,

My name is Ebony Blackwell, and I am a doctoral student in the Department of Educational Leadership, Counseling and Foundations at University of New Orleans. The reason of this email is to solicit your participation in my research study. The purpose of my study is to explore the experiences of Black women who are currently pursuing STEM graduate degrees at predominantly White institutions.


For this study, participants whom meet the following criterion will be chosen:

1. Racially identify as Black or African American
2. Female
3. Graduate STEM field (second year or higher classification)

Once the participants are selected, they will complete a personal demographic sheet that will gather information on the following topics: degree program; classification; professional aspirations; parental or guardian highest academic level, post-secondary degree completion, and current occupation; and racial identity. This study is confidential and the records of this study will be kept private. Participants will be asked to commit to a 60 or 90-minute online interview and focus group through the web-based platform, Zoom scheduled around the student's availability. Your identity in this study will remain confidential, only referenced by a pseudonym of your picking, and no identifiers linking you or your institution of study will be included in any sort of report that might be published.

Moreover, research records will be stored, secured, and only accessible by me and my dissertation chair Dr. Christopher Broadhurst. Interviews will be audio recorded and the recording will be used throughout this study. All interviews will be transcribed and returned to the research participants to ensure accuracy of statements and experiences. The risks associated with this study are minimal and are not greater than the risks ordinarily encountered in daily life. The information gained from this study would allow for a greater understanding of the experiences of Black women pursuing STEM graduate degrees at predominantly White institutions.

If you are interested in participating or have any questions or concerns regarding my research study, please feel free to contact me.

Ebony C. Blackwell, M. S.  
Doctoral Candidate  
Educational Leadership, Counseling and Foundations Department  


**APPENDIX B  
DEMOGRAPHIC FORM**

**Demographic Information**

Please fill out the following information pertaining to demographics.

1. What is your current degree program? \_\_\_\_\_
2. What discipline did you earn your undergraduate in? \_\_\_\_\_
3. In your current graduate program, what year are you in? \_\_\_\_\_
4. What are your professional aspirations? \_\_\_\_\_
5. Related to your parent or guardian(s):
  - a. Do either of your parents or guardians have a college degree? If so, Who and in what field? \_\_\_\_\_
  - b. What occupation(s) do you parent(s) or guardian(s) hold?  
\_\_\_\_\_
6. How do you racially identify? \_\_\_\_\_

## APPENDIX C

Ebony C. Blackwell  
Candidate for Doctoral Degree in Education Administration

Department of Educational Leadership, Counseling and Foundations  
University of New Orleans  
2000 Lakeshore Dr.  
New Orleans, LA 70148

[Date]

### LETTER OF INFORMED CONSENT

Dear [Name],

I am a graduate student under the direction of Dr. Christopher Broadhurst, Assistant Professor in the Department of Educational Leadership, Counseling and Foundations at the University of New Orleans (UNO). I am conducting a phenomenological research study to explore the lived experiences of Black women enrolled in STEM graduate programs. The purpose of this phenomenological study is to examine the essence of the shared experiences of Black women currently enrolled in STEM graduate programs at predominantly White institutions (PWIs) in order to understand how their experiences could help increase retention of Black women through STEM graduate programs and into careers.

I am requesting your participation, which will involve the following online activities:

- A 60 to 90-minute, semi-structured Zoom interview, with a follow up interview if needed
- A 60 to 90-minute Zoom focus group with the other research participants either through voice or video chat

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. Compensation is not being offered for your participation in this study. The results of the research study may be published, but your name will not be used.

There are limited foreseeable risks to you if you agree to participate in the study. As a participant, you may be asked to disclose information that you may consider personal and/or sensitive surrounding your current participation within your academic programming. However, your confidentiality will be protected by the use of a pseudonym for you and your institution. Interviews will occur electronically and can be done in a private location. Although the interview and focus group with you will be audio recorded and transcribed, they will be stored on a password protected hard drive.

Please be advised that although the researchers will take every precaution to maintain confidentiality of the data, the nature of focus groups prevents the researchers from guaranteeing confidentiality. Should you choose to participate, you will be asked to respect the privacy of other focus group members by not disclosing any content discussed during the study.

If you have any questions concerning the research study or your participation in it, before or after your consent, will be answered by Ebony Blackwell at [REDACTED] or Dr. Christopher Broadhurst, Assistant Professor in the Department of Educational Leadership, Counseling, and Foundations at the University of New Orleans at [REDACTED].

Sincerely,

Ebony C. Blackwell

By signing below, you are giving consent to participate in the above study.

\_\_\_\_\_  
Signature                                  Printed Name                                  Date

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact Dr. Ann O'Hanlon, member of UNO Institutional Research Board, at [REDACTED] or [REDACTED].

**APPENDIX D**  
**INTERVIEW PROTOCOL**

**Rapport Building**

1. Tell me about your background. Where are you from, and how did you get here?
2. What about your family? What are their interests and work experiences?

**Early Life**

3. Tell me what you were like as a student through your K-12 years?
4. Can you tell me about influential interactions you had with school teachers growing up?
5. Tell me about influential interactions you had with individuals you'd consider role models or mentors growing up.
6. Tell me about how your interest in STEM first began and developed over time.
7. Can you talk about your process of deciding on a college to attend?

**Undergraduate**

8. Tell me about your decision on where to pursue your post-secondary education.
9. Tell me about when and why did you decided your major in college?
10. Can you describe your confidence during your undergraduate program?
11. Can you describe the interactions you'd have with classmates, peers, staff and professors at your undergraduate institution and within your program?
12. Related to undergraduate school, tell me about influential experiences involving extracurricular activities or research?
13. Tell me about your process of deciding what to do after your undergrad career.

14. What did faculty or staff at your undergraduate institution do to help you prepare for your graduate program?
15. What are out of classroom experiences that have been meaningful to you?
  - a. Have they helped you academically?

### **Graduate School**

16. Tell me about how did you decided on a graduate program/school?
17. Can you describe your experiences in your graduate program?
18. Related to graduate school, tell me about influential experiences involving extracurricular activities or research?
19. How would you describe your institutions options for you to be involved in enrichment programs?
20. Tell me about your favorite professor.
21. Describe people in your program that you can depend on for support.
22. Tell me about influential interactions you've had with your classmates.
23. What compels you to persist in STEM?
24. What are out of classroom experiences that have been meaningful to you?
  - b. Have they helped you academically?

### **Influence of Race & Gender**

25. What is it like to be a Black woman in your graduate program?
26. Will you describe any obstacles you have overcome while pursuing your STEM degree?
27. If you've encountered any sexist incidents, how were you able to navigate and overcome them?
28. How do you perceive your identity as a scientist?

29. Can you describe your confidence when it comes to your STEM academic abilities?
30. Can you describe your confidence when it comes to your involvement in your current department?

**Wrap up Questions**

31. Can you tell me about your post-graduate school plans?
32. What advice would you give to someone like yourself who was interested in pursuing a graduate degree in your field?
33. Is there anything I should know about being a black woman in STEM that I haven't asked you?

## **APPENDIX E**

### **FOCUS GROUP PROTOCOL**

1. Majority of you all shared how important it is for young women to find a mentor. Can you discuss this more. In your opinion, is it more valuable to have a mentor that share's your race and/or gender identities or to have any genuinely invested individual, regardless of race and gender?
2. Can you describe situations where you all felt like imposters in your STEM spaces?
3. What kind of mental health issues do Black women in STEM face that other groups do not?
  - i. Do you feel comfortable sharing any personal stories?
4. What does it mean to a Black woman scientist?
5. If you all could build your ideal STEM learning environment for Black women, what would it look like?



## Vita

Ebony Brown Blackwell considers herself an advocate for students, passionate about empowering and creating pathways for marginalized and often underrepresented students to pursue their goals. As a scientist, Ebony prioritizes increasing the representation of Black women, and other underrepresented populations, in STEM disciplines and careers. Ebony is dedicated to improving diversity, equity, and inclusion throughout the PK-16+ pipeline as well as finding innovative ways to holistically serve students. In her professional experiences, Ebony has served in various roles at both the community college and university level including enrollment and academic advising, tutoring services, and as an instructor for various Biological Sciences courses. She has also volunteered and worked for various non-profits including Youth Run NOLA – a grassroots New Orleans non-profit that partners with public schools to provide programming for K-12 youth focused on creating and empowering young leaders through running. Additionally, Ebony co-founded Be Preppy – a college success coaching company that provides high quality college planning to students and their families. She also served the U.S. in the Louisiana Army National Guard for 8 years as both an enlisted soldier and officer.